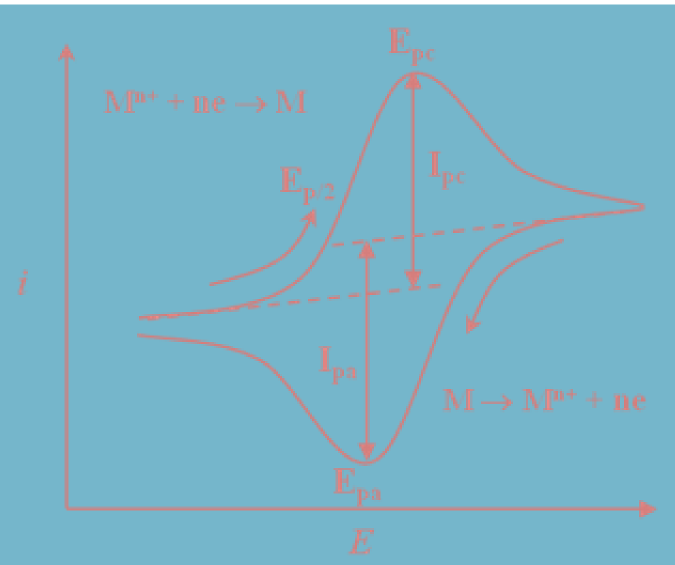

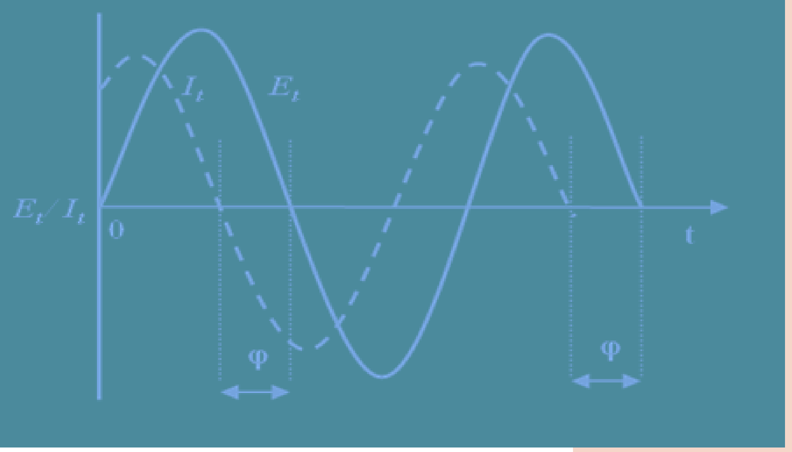

**Indian Society for ElctroAnalytical Chemistry**
**Mumbai, India**
**www.iseac.org.in**

**Abstract Booklet of**
**DAE - BRNS Conference on Electrochemistry for Industry Health and Enviornment - 2025**

# EIHE 2025

DAE-BRNS Sponsored Conference

## Abstract Booklet of
## DAE - BRNS Conference on
## Electrochemistry for Industry Health and Enviornment - 2025

**January 21 – 25, 2025**
**DAE Convention Centre,**
**Bhabha Atomic Research Centre, Mumbai**

*Organized by*

Electrochemistry for Industry, Health and Environment
EIHE 2025

Editors:
S. Sahoo
M. K. Dey
P. K. Mishra
A. K. Satpati

Analytical Chemistry Division, Chemistry Group
Bhabha Atomic Research Centre
Trombay, Mumbai

# Abstract Booklet of
# 3rd DAE-BRNS Conference on Electrochemistry for Industry Health and Environment-2025

**Being released during**

***DAE-BRNS-EIHE-2025***

**January 21-25, 2025**

*DAE Convention Centre, Anushaktinagar,*

*BARC, Mumbai*

**Editors**

S. Sahoo
M. K. Dey
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A. K. Satpati

**Organized by**
**Analytical Chemistry Division**
**Bhabha Atomic Research Centre &**

**Indian Society for ElectroAnalytical Chemistry**
**Mumbai, India**
**www.iseac.org.in**

# DAE-BRNS-EIHE-2025

*Analytical Chemistry Division, Chemistry Group, Bhabha Atomic Research Centre &*
*Indian Society for Electro Analytical Chemistry* (ISEAC)

Welcomes you to

***DAE-BRNS-EIHE-2025***

January 21-25, 2025

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विवेक भसीन
**Vivek Bhasin**

भारत सरकार
Government of India

निदेशक, भाभा परमाणु अनुसंधान केंद्र
**Director, Bhabha Atomic Research Centre**
सदस्य, परमाणु ऊर्जा आयोग
**Member, Atomic Energy Commission**

## MESSAGE

Electrochemical Science and Technology is one of the frontier areas of research, which has evolved important strategies in solving several recent industrial and societal challenges, especially in relation with the energy, environment and health care. Over the years, these subject areas have grown immensely leading to applications in industrial challenges like, recovery of rare materials, investigation of corrosion and its mitigation, development of batteries, supercapacitors, solar energy harvesting devices, biomedical sensors, and fabrication of devices. Electrochemical techniques have also been utilized in the preparation and characterization of some of the advanced radiopharmaceuticals. I am glad that our Research Centre has the finest state-of-the-art facilities for this kind of frontline research and are actively pursuing developmental activities in this discipline, covering almost all of its dimensions, from laboratory scale studies to the industrial scale applications.

I am delighted to know that the 4th DAE-BRNS Conference on, "Electrochemistry for industry, Health and Environment (EIHE-2025)" is organized by Analytical Chemistry Division (ACD), Chemistry Group (CG), Bhabha Atomic Research Centre (BARC), in association with the Indian Society for Electroanalytical Chemistry (ISEAC) during January 21-25, 2025 at DAE Convention Centre, Anushaktinagar, Mumbai. Present conference has attracted participation of scientists from all over the world whose interaction with young researchers will pave the way into cutting-edge research in the days ahead.

I am sure that the deliberations of the conference will be very exciting and will offer a common platform for the intense scientific discussions and exchange of ideas amongst the young researchers in this field. It will bring out new ideas and understandings to carry forward quest for collaborative and interdisciplinary research activity in emerging frontiers.

I complement the organizers for putting forward such a technically enriched event and wish EIHE-2025 a grand success.

Vivek Bhasin

30.12.2024

(Vivek Bhasin)

भाभा परमाणु अनुसंधान केंद्र, ट्रॉम्बे, मुंबई- 400 085, भारत • Bhabha Atomic Research Centre, Trombay, Mumbai 400 085, India
दूरभाष/Phone:+(91) (22) 2550 5300, 2551 1910 • फैक्स/Fax: +(91) (22) 2559 2107, 2550 5151
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**Bhabha Atomic Research Centre**

**Analytical Chemistry Division**

**Chandra N. Patra**
Head, Analytical Chemistry Division
Tel: 2559 0295 ; Fax: 2550 5151
Email: chandra@barc.gov.in

3-237-S, Mod. Labs
Mumbai 400 085

## MESSAGE

Greetings and a Happy New Year 2025 from the desk of the Organizing Committee of EIHE-2025.

Electrochemical Science and allied subjects have always provided a major break-through in many industrial challenges due to its inherent association with the modern technologies and devices. Research in the field of generation of molten salt database, electrochemical metal processing, corrosion engineering and energy storage devices are some of the important projects, on which many scientific institutes are currently working on. A number of state-of-the-art instruments, fabricated using electrochemical principles ware at various stages of their operations and functioning.

On behalf of the Organizing Committee, it gives me great pleasure in welcoming you all to the to this DAE-BRNS Conference on, “Electrochemistry in Industry, Health and Environment (EIHE 2025)”. The conference has been planned to provide ample opportunities to the students and young researchers to present their scientific findings and discuss along with the peers. The topic of the conference has been shortlisted considering the recent societal programs in scientific and technological challenges in Electrochemistry for Industry, Health, and Environmental Sciences.

I welcome all the invited speakers from India and abroad for attending the conference.

With great expectations from you all, let us collectively wish the conference a grand success!

Sincerely,

Cnpatra

January 10, 2025

Chandra N. Patra

Indian Society for ElectroAnalytical Chemistry
(Reg. No. MAH/MUM/1173/2006 GBBSD)
Bhabha Atomic Research Centre, Mumbai - 400085

Dr. Ashis Kumar Satpati
Head, Electrochemical Methods Section
Secretary, ISEAC and Convener, EIHE-2025
Bhabha Atomic Research Centre, Trombay, Mumbai 400085, Phone: 022-25590744 (O)
Email: asatpati@barc.gov.in & aksatpati@gmail.com

**Dear Delegates**

**Greetings!!**

On behalf of the organising team, I welcome you all in this DAE-BRNS conference on “Electrochemistry for Industry, Health and Environment, EIHE-2025” at DAE Convention Centre Anushaktinagar, Mumbai durig January 21-25, 2025. I thank all of you for coming here to attend this conference.

We have tried our best to make this event technically reach, and thank you for your cooperation and enthusiasm. Since its inception, scope of the society has been broadened to cover the entire spectrum of the scientific activities in the field. I take this forum to request all of you to enhance the activities of the society and promote your colleagues and students to become the life member of this organisation.

Being stationed at Bhabha Atomic Research Centre, we enjoy the fame of this institute and excellent logistics support, we sincerely thank our authorities for their supports in making those facilities available to us. I thank Heavy Water Board (HWB), ONGC Energy Centre, International Society of Electrochemistry (ISE), American Chemical Society (ACS), Royal Chemical Society (RSC), Elsevier for supporting this event.

I am happy to announce that some selected abstracts will be published as full paper in a special volume in **Electrochimica Acta**. I wish all of you for excellent outcome from your research, ISEAC will provide all possible platform to promote your research activities. Let us join together and bring the fascinating science in the field of ***electrochemical science and technology*** to its fullest potential for the benefit of the society.

On behalf of the organising committee EIHE 2025 and the Secretary, ISEAC, I express my sincere thanks once again to DAE-BRNS, the ISEAC life members, all sponsors and the delegates of EIHE 2025.

January 10, 2025

(A K Satpati)

# Indian Society for ElectroAnalytical Chemistry

*Reg. No. MAH/MUM/1173/2006 GBBSD*
*(**Website:** www.iseac.org.in; **Email:** electrochembarc@gmail.com)*

*Since foundation, the Society has evolved magnificently to represent a truly National Organization and at present, it comprises more than 350 life-members from different parts of India and Overseas. The Executive committee of ISEAC, which manages the activities of ISEAC, is being elected triennially by all the members of ISEAC.*

***International Events organized by ISEAC:***

*ISEAC organizes International Conferences, Discussion Meets and Workshop cum Symposium on Electrochemistry and allied topics in association with the Departments of Government of India, International Society of Electrochemistry (ISE) and other Scientific Organizations and Industries. ISEAC has organized several national and International Events in India.*

1. *Workshop EST-2024 at Multipurpose hall, Training School Hostel, Anushaktinagar, Mumbai 400094 on during July 06, 2024.*
2. *International Conference on Electrochemistry in Industry Health and Environments (EIHE 2023) at DEA Convention Centre, Anushaktinagar, Mumbai during February 7-11, 2023.*
3. *International Conference on Electrochemistry in Industry Health and Environments (EIHE 2020) at DEA Convention Centre, Anushaktinagar, Mumbai during January 21-25, 2020.*
4. *Discussion meeting on Spectro electrochemistry (DM-ISEAC-2022) at Multipurpose hall, Training School Hostel, Anushaktinagar, Mumbai 400094 on 16-07-2022*
5. *International Conference on Electrochemistry in Advanced Materials, Corrosion and Radiopharmaceuticals (CEAMCR-2018) at DEA Convention Centre, Anushaktinagar, Mumbai during February 15-17, 2018.*
6. *Twelfth ISEAC Discussion Meet in Electrochemistry (12th ISEAC-DM-2016) held at The Acres Club, Chembur, Mumbai during December 7-8, 2016.*
7. *Eleventh ISEAC International Discussion Meet on Electrochemistry and its Applications (ISEAC-DM-2014) held at Hotel Radisson Blu, Amritsar during February 20-25, 2014.*
8. *Fifth ISEAC Triennial International Conference on Advances and Recent Trends in Electrochemistry (ELAC-2013) held at Sitara Hotel, Ramoji Film City, Hyderabad during January 16-20, 2013.*

9. *ISEAC International Symposium cum Workshop on Electrochemistry (ISEAC-WS-2011) at Cidade de Goa, Dona Paula, Goa during December 7-10, 2011.*

10. *Fourth ISEAC International Discussion Meet on Electrochemistry and its Applications (DM-ISEAC-2011) at Mascot Hotel, Thiruvananthapuram, Kerala during February 7-10, 2011.*

11. *Fourth International Conference on ElectroAnalytical Chemistry and Allied Topics (ELAC-2013) at Toshali Sands, Puri, Orissa during March 16-18, 2010.*

12. *Discussion Meet on ElectroAnalytical Techniques and Their Applications (DM-ELANTE-2008) held at Tea County, Munnar, Kerala during February 25-28, 2008.*

13. *Third International Conference on ElectroAnalytical Chemistry and Allied Topics (ELAC-2007) at Toshali Royal View Resort, Shilon Bagh, Shimla during March 10-15, 2007.*

14. *Discussion Meet on Role of Electrochemistry in Biosensors, Nanomaterials, Fuel Cells and Ionic Liquids (DM-BNFL-2006) held at Bhabha Atomic Research Centre, Mumbai during September 24-25, 2006.*

15. *Discussion Meet on Coulometry (DM-COUL-2005) at Bhabha Atomic Research Centre, Mumbai on May 5, 2005.*

16. *Second International Conference on ElectroAnalytical Chemistry and Allied Topics (ELAC-2004) held at The International Centre, Dona Paula, Goa during January 18-23, 2004.*

17. *Workshop cum Seminar on ElectroAnalytical Chemistry and Allied Topics (ELAC-2000) held at Bhabha Atomic Research Centre, Mumbai during November 27 – December 1, 2000.*

***Objectives of ISEAC:***

- *Promote the growth of Electrochemistry in India.*

- *Provide a common world-wide platform to the experts, scientists and scholars working in the area of Electrochemistry and its Allied Sciences.*

- *Disseminate scientific and technological knowledge in the area of Electrochemistry to advance both national and international collaborations.*

- *Share the information on Electrochemistry with other International Societies viz. European Society for Electroanalytical Chemistry (ESEAC), Society for Electroanalytical Chemistry (SEAC) and International Society of Electrochemistry (ISE), Bioelectrochemical Society (BES).*

- *Work in harmony with other Indian Electrochemical Societies viz. Society for the Advancement of Electrochemical Science and Technology (SAEST) based at CECRI,* *Karaikudi and Electrochemical Society of India (ECSI) based at Indian Institute of Science, Bengaluru.*

- *Provide incentive by way of awards to researchers for the best thesis, the best paper published in the journal and the best paper presented in National and International Conferences/Symposia.*
- *Encourage young as well as experienced Indian researchers for participation in International Electrochemistry Conferences by providing partial funds, if possible.*

***Procedure to join ISEAC:***

*ISEAC has the provision for individual to join as Life-members and for company to join as Corporate Member. The Life-membership fee w.e.f. April 1, 2011 is Rs. 4000/- (Rs. Four thousand only) for Indians and € 300/- (Euro three hundred only) for others. The Fee has to be transferred electronically (NEFT or wire transfer) to ISEAC Bank Account and then you have to sign-up through "Join ISEAC as Life-Member" icon available on www.iseac.org.in with the fund transfer details.*

*Name of Bank:* ***State Bank of India, BARC Branch, Mumbai-400 085, India***
*Branch code:* ***1268***
*Beneficiary name:* ***Indian Society for ElectroAnalytical Chemistry (ISEAC)***
*Account number:* ***34209997299***
*BIC (Swift Code):* ***SBININBB508***
*IFSC code (for within India):* ***SBIN0001268***

***Please contact us for any further information:***

*Dr. A K Satpati*
*The Secretary, Indian Society for ElectroAnalytical Chemistry (ISEAC)*
Analytical Chemistry Division,
Bhabha Atomic Research Centre, Trombay,
Mumbai – 400 085, India
Email: electrochembarc@gmail.com;
web.: www.iseac.org.in
Phone: +91-22-2559 0744 (office hours only)

You are Welcome to Join

ISEAC

EIHE 2025

# DAE-BRNS Conference on Electrochemistry for Industry, Health and Environment

**January 21-25, 2025**

**DAE Convention Centre, BARC, Mumbai – 400094, INDIA**

**Email: electrochembarc@gmail.com**

## Organized by :

**Analytical Chemistry Division, Chemistry Group, Bhabha Atomic Research Centre Mumbai – 400085, INDIA**
***In Association with***
**Indian Society for Electroanalytical Chemistry, Mumbai**

## Supported by :

**Board of Research in Nuclear Sciences**
**Department of Atomic Energy**
**Government of India**

*Present conference under the series title **"DAE-BRNS Conference on Electrochemistry for Industry, Health and Environment, EIHE-2025"** is proposed to be organized in association with the **Indian Society for ElectroAnalytical Chemistry (ISEAC)** at DAE Convention Centre, Anushaktinagar, Mumbai 400094 during January 21 to 25, 2025. Excellence of electrochemistry in a wide spectrum has been included under the scope of this conference. This series of conference has been admired by national and international scientists and is expected to have a large number of eminent scientists from India and overseas attending the conference. It will be an excellent opportunity to the academia and students of the country to interact with national and international experts and widen the scope of scientific collaboration. Experts, researchers, students, and industrial units working in this interesting area of research are invited to participate.*

## Patron

*Vivek Bhasin, Director, BARC, Mumbai*

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EIHE 2025

# DAE-BRNS Conference on Electrochemistry for Industry, Health and Environment

## Scope

- Catalysis and interfaces
- PEC water splitting
- Instrumentations and devices
- Battery, Supercapacitor, Fuel cell and Solar cell
- Nonaqueous Electrochemistry
- Computational Electrochemistry
- Electrodeposition, Electrosynthesis
- Scanning probe technique and spectroelectrochemistry
- Electrochemistry in Pharmaceuticals and Drugs
- Nanoscale Electrochemistry
- Electrochemistry in Nuclear Energy
- Electrochemical Sensors and Biosensors
- Corrosion and mitigation

## Registration

*Registration fee includes conference proceedings, lunch & dinner during the conference. Accommodation can be arranged during January 20– 25, 2025 at the conference venue or at nearby hotels at a separate cost. The conference proceeding will be given to the primary registered delegates. Life members of ISEAC will avail a discount of INR 500 on the registration fee*

## How to reach

*Mumbai is well connected to other parts of India and the rest of the world.*

*Participants arriving by train may alight at Lokmanya Tilak Terminus (LTT), Dadar, Mumbai Central, Mumbai CST or Bandra Terminus.*

*Participants travelling by flight will arrive at Chhatrapati Shivaji International Airport (Terminal T1 or T2)*

*Plenty of options for cabs are available at airports and railway stations. Delegates are advised to take prepaid cab/call cabs (UBER, OLA etc.) service at airport and railway stations.*

*Conference venue is at Anushaktinagar, which is also known as BARC Colony. The conference venue can also be reached by suburban trains in the harbour line and the nearest railway station is Mankhurd and the conference venue can be reached from Mankhurd by Autorickshaw. Accommodation for most of the delegates will be arranged close to the conference venue.*

## Important dates

### *Abstract submission*

Up to 30th November, 2024

### *Registration*

Up to 15th December, 2024

| *Category* | | *Registration fee* |
|---|---|---|
| ***From Universities/ Government institutes, India*** | ***Faculty*** | ***INR 5500*** |
| | ***Student*** | ***INR 3000*** |
| | ***Accompany*** | ***INR 3000*** |
| ***From Universities/ Government institutes, Overseas*** | ***Faculty*** | ***US$ 300*** |
| | ***Student*** | ***US$ 200*** |
| | ***Accompany*** | ***US$ 200*** |
| ***Industries/ Public Sectors/Private institutes*** | ***Employee/ Accompany*** | ***INR 12000*** |

***Registration fee is only accepted through Online Fund Transfer to the following account:***

***Name of Bank: State Bank of India, BARC Branch, Mumbai-400 085, India***
***Branch code: 1268***
***Beneficiary name: EIHE 2025***
***Account number: 00000043314680195***
***BIC (Swift Code): SBININBB508***
***IFSC code (for within India): SBIN0001268***

***Please pay the specified fees through your online banking system and then submit the registration form enclosing the transaction receipt (your name.pdf) through the conference website.***

*We have limited funding option for the students presenting a paper in the conference and the selection will be based on the quality of abstract. There will be poster and oral presentation awards possibly sponsored by ACS, Elsevier and RSC to encourage the students to carry out research in this area.*

*The delegates from abroad (holding Foreign Passport including PIO) must submit their details of valid passport (which will be carried during the event) at the earliest through email. It is mandatory to obtain Conference VISA for foreign nationals.*

**Contact:** Convener, EIHE-2025, Analytical Chemistry Division, Bhabha Atomic Research Centre, Trombay, Mumbai – 400 085, India, Email: electrochembarc@gmail.com; Web.: www.iseac.org.in; Phone: 91-22-25590744/0326/3227/2223/9532

# 3rd DAE-BRNS Conference on

# Electrochemistry for Industry, Health and Environment

# EIHE-2025

## January 21-25, 2025

DAE Convention Centre, Anushaktinagar, Mumbai – 400094, India

## *Organized by*

## *Academic Partners*

# Programme Schedule

| | | |
|---|---|---|
| | | **January 21, 2025; Tuesday** |
| **9:00- 10:30 hrs** | : | **Registration** at ***DAE Convention Centre*** |
| **10:30 – 11:45 hrs** | : | **Session 1 (Auditorium A)**<br>***Invited Lecture (20+5 minutes)*** |
| | | **Chairperson: C. N. Patra** |
| | | ***IT-39; Prof. Deepa Khushalani***<br>**New Materials for New Batteries: Formation of Solar Rechargeable Batteries** |
| | | ***IT-26; Prof. Subir Kumar Ghosh***<br>**Electrochemical Investigation of Molten Salt and Exploration of Deposition of Thick Mo and W Coatings** |
| | | ***IT-45; Prof. Shilpa N Sawant***<br>**Designing electrochemical biosensors for affordable healthcare** |
| **11:45-12:00 hrs** | | **Tea at Lobby** |
| **12:00-13:30 hrs** | | **Session 2 (Auditorium A)**<br>***Invited Lecture (20+5 minutes)***<br>**Chairperson: P.D. Naik** |
| | | ***IT-48; Prof. Rubel Chakravarty***<br>**Production and Electrochemical Separation of Radiometals for Formulation of Radiopharmaceuticals** |
| | | ***IT-35; Prof. Jyoti Prakash***<br>**Electrochemical Energy Storage and Sensing by Carbon Nanomaterials** |
| | | ***Technical Presentation by Sinsil International*** |
| **13:30-14:30 hrs** | : | **Lunch at dining hall, DAE Convention Centre** |
| **14:30– 17:00 hrs** | | **Session 3 (Poster Session)**<br>**Poster session (CP 1-CP 56)** at ***Poster Hall*** |

|  |  |  |
|---|---|---|
| **16:30– 17:00 hrs** |  | **Tea at Lobby** |
| **17:00 - 18:30 hrs** | : | **Inauguration of the Conference**<br>**(Auditorium A)**<br>**Opening of exhibition, Group photograph & High Tea** |
| **19:00-19:40 hrs** |  | **Evening Lecture**<br>**(Auditorium A)**<br>**Chairperson: A.C. Bhasikuttan** |
|  |  | ***Speaker: Dr. Sudeep Gupta, Director, Tata Memorial Centre***<br>**"Cancer care in India - Contribution of TMC"** |
| **20:00-21:30 hrs** | : | **Dinner at dining hall, TSH, Anushaktinagar** |
|  |  |  |
|  |  | **January 22, 2025; Wednesday** |
| **09:30 – 11:30 hrs** | : | **Session 4 (Auditorium A)**<br>**Chairperson: A.K. Tyagi** |
|  |  | ***Plenary Lecture* (30+5 minutes)** |
|  |  | ***IT-30; Prof. Ritu Kataky***<br>**Electrochemical studies of Biological Interactions at Soft Interfaces** |
|  |  | ***Invited Lecture (20+5 minutes)*** |
|  |  | ***IT-15; Prof. T N Narayanan***<br>**Role of Electrolyte Structure in Heterogeneous Catalysis** |
|  |  | ***IT-09; Dr. S. Senthil Kumar***<br>**Electrogenerated Chemiluminescence : Carbon Based Nanomaterials As An Effective Luminophores And Co-Reactants And Its Application Towards Biosensor** |
|  |  | ***IT-12; Prof. Amit Paul***<br>**Electrochemical Dimerization of 3-Substituted-2-Oxindoles: Many Routes, One Destination** |

| | | |
|---|---|---|
| **11:30-11:45 hrs** | : | **Tea** at ***Lobby*** |
| **11:45–13:00 hrs** | : | Session 5 (Auditorium A)<br>***Invited Lecture (20+5 minutes)*** |
| | | **Chairperson: H Pal & D. K. Maity** |
| | | ***IT-06; Prof. Stijn F. L. Mertens***<br>**Real-time Dissolution and Speciation of Manganese from Battery Electrodes during Charging and Discharging** |
| | | ***IT-18; Prof. Jogendra Nath Behera***<br>**Inorganic Functional Materials for Sustainable Energy Applications** |
| | | ***IT-24; Dr. M. Kathiresan***<br>**Electrochemical Conversion of $CO_2$ to value-added chemicals** |
| **13:00-13:45 hrs** | | **Lunch at dining hall, DAE Convention Centre** |
| **13:45-16:00 hrs** | | Session 6<br>**Poster Presentations: CP-57** to **CP-112** at ***Poster Hall*** |
| **15:30-16:00 hrs** | | **Tea at Lobby** |
| **16:00–18:30 hrs** | | Session 7 (Auditorium A)<br>***Invited Lecture (20+5 minutes)*** |
| | | **Chairperson: Probal Chaudhury & R. Acharya** |
| | : | ***IT-31; Prof. A.K. Mishra***<br>**Metal Air Batteries: Alternatives to Li-ion Batteries** |
| | : | ***IT-07; Prof. Sasanka Deka***<br>**Non-Precious Metal-Based Electrocatalysts for efficient Overall Water Splitting Reaction** |
| | : | ***IT-38; Prof. Thandavarayan Maiyalagan***<br>**Molybdenum based Electrocatalysts for Efficient and Low-cost Green Hydrogen Production** |
| | : | ***IT-17; Prof. Bhaskar R. Sathe***<br>**New Modifications in Electrocatalytic Hybrid materials for Water Splitting and Fuel Cell Reactions** |

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|  | : | *IT-33; Prof Pravin Popinand Ingole*<br>**Reactive $CO_2$ capture and photo-electrochemical photocurrent polarity switching effect via tuning the electrochemical interfaces** |
|  |  | *IT-47: Prof. Ujjal Pal*<br>**Beyond Single-Atom Catalysts in Green Energy Transition** |
| **18:30–19:00 hrs** |  | **Tea** at ***Lobby*** |
| **19:00 – 20:00hrs** | : | **Cultural programme (Auditorium A)** |
| **20:00-21:30 hrs** | : | **Dinner at dining hall, DAE Convention Centre** |
|  |  | **January 23, 2025; Thursday** |
| **09:30–10:40 hrs** | : | **Session 8 (Auditorium A)** |
|  |  | **Chairperson: R. Tewari** |
|  |  | ***Plenary Lecture* (30+5 minutes)** |
|  | : | ***IT-44; Prof. Shalini Prasad* (online)**<br>**Electrochemical Point of Care device for profiling of vWFA2 for Systemic Inflammatory State Detection** |
|  | : | *IT-28; Prof. Sangaraju Shanmugam*<br>**Single-Atom Electrocatalysts for Nitric Oxide Reduction to Value-Added Chemicals** |
| **10:40–11:00 hrs** | : | **Tea at *Lobby*** |
| **11:00–13:00 hrs** | : | **Session 9 (Auditorium A)** |
|  |  | **Chairperson: Sulekha Mukhopadhyay & N. Choudhury** |
|  |  | ***Plenary Lecture* (30+5 minutes)** |
|  |  | ***IT-29; Prof. Frank Marken* (online)**<br>**Intrinsically Microporous Polymers in Electrochemistry** |
|  |  | *IT-25; Prof. Rama Kant*<br>**EIS Response for Anomalous Dynamics of EDL and Supercapacitor: Theoretical Aspects** |

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| | | *Invited Lecture (20+5 minutes)* |
| | | *IT-32; Prof. Partha Sarathi Mukherjee*<br>Water-Soluble Molecular Vessels |
| | | *IT-22; Prof. Ruma Ghosh*<br>Reduced Graphene Oxide based Portable Sensors for PCA3 |
| 13:00 – 13:45 hrs | : | Lunch at dining hall, DAE Convention Centre |
| 13:45– 16:00 hrs | : | Session 10<br>Poster Presentations: CP-113 to CP-168 at *Poster Hall* |
| 15:30-16:00 hrs | | Tea at lobby |
| 16:00 – 18:15 hrs | : | Session 11; (Auditorium A & Auditorium B) |

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| Auditorium A<br>Chairperson: R. Pai & T. Das | Auditorium B<br>Chairperson: S. Jeyakumar & Virendra Kumar |
| *Short talks (12+3 mins)* | *Oral presentation (8+2 mins)* |
| *IT-43; Dr. S. Sahoo*<br>Engineering Nano Composites for Electrochemical Sensing Applications | CP 3, 15, 35, 60, 82, 93, 111, 117, 121, 144, , 155, 221 |
| *IT-20; Dr. Bholanath Mahanty*<br>Polymeric membrane based potentiometric sensors for lanthanides and actinides | |
| *IT-51; V Nafees Ahmed*<br>Feasibility study of closed loop Iodine-H2S process for Hydrogen production | |
| *Oral presentation (8+2 mins)* | |
| CP 2,7, 29, 37, 46, 118, 148, 160, 215 | |

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| 18:15 hrs | : | Tea at *Lobby* |
| 20:00 21:30 hrs | : | Dinner at Anushaktinagar |
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| | | January 24, 2025; Friday |
| 09:30 – 11:35 hrs | : | Session 12 (Auditorium A)<br>*Invited Lecture (20+5 minutes)* |

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| | | **Chairperson: S. Malhotra & Amrit Prakash** |
| | | ***IT-37; Prof. Raj Ganesh S. Pala***<br>**Catalysing Nuclear Reactions & Channelizing its energy** |
| | | ***IT-10; Prof. Kothandam Krishnamoorthy***<br>**Rechargeable Batteries with Organic Polymers and Small Molecules** |
| | | ***IT-19; Prof. S.T. Aruna***<br>**Indigenization of Ceramic Tapes and Substrates for Space Electronics and Electrochemical Device Applications** |
| | | ***IT-36; Prof. A.K Satpati***<br>**Spectroelectrochemical investigations in Characterisation of $BiVO_4$ and Hematite interface** |
| | | ***IT-34; Prof. Sandeep K C***<br>**Electrochemical Technologies for Hydrogen Economy** |
| **11:35-11:45 hrs** | : | **Tea** at ***Lobby*** |
| **11:45–13:00 hrs** | : | **Session 13 (Auditorium A)**<br>***Invited Lecture (20+5 minutes)*** |
| | | **Chairperson: K. Bhanja & S. Parida** |
| | | ***IT-51; Prof Sudhakar Prasad***<br>**Innovative Paper Electrodes for Clinical and Preclinical Diagnostics and Validation** |
| | | ***IT-49; Prof. Sanghamitra Chatterjee***<br>**Effortless Devising and Theranostic Applications of Nanomaterial**<br>**Modified Sensors: State of The Art** |
| | | ***Prof. Stijn F. L. Mertens***<br>***Tutorial Lecture*** |
| **13:00 – 13:45 hrs** | : | **Lunch at dining hall, DAE Convention Centre** |
| **13:45– 16:00 hrs** | : | **Session 14**<br>**Poster Presentations: CP-169** to **CP-224** at ***Poster Hall*** |
| **15:30-16:00 hrs** | | **Tea during poster session** |
| **16:00 – 18:05 hrs** | : | **Session 15 (Auditorium A)** |

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| | | *Invited Lecture (20+5 minutes)* |
| | | **Chairperson: R N Singh & A Awasthi** |
| | | *IT-23; Prof. Rajesh Ganesan*<br>**Molten salt electromotive force method for thermodynamic measurements** |
| | | *IT-04; Prof. Chinmoy Bhattacharya*<br>**Effect of Dopants & Co-Catalyst in Enhancement of Photo electrochemical Applications for Microwave-assisted Synthesis of $BiVO_4$ Semiconductor** |
| | | *IT-40; Prof. Balaji P Mandal*<br>**Strategies to improve electrochemical performance of Li-S batteries** |
| | | *IT-08; Prof. Manisha Malviya*<br>**Unveiling enigmatic selenides for alkaline water splitting process** |
| | | *CP-211; Prof. R. K. Lenka*<br>**Interpretation of electrode reaction mechanism in High Temperature Steam Electrolysis cells by deconvolution of impedance spectra** |
| **20:00 21:00 hrs** | : | **Dinner at TSH, Anushaktinagar** |
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| | | **January 25, 2025; Saturday** |
| **09:30 – 11:55 hrs** | : | **Session 16 (Auditorium A)** |
| | | **Chairperson: G Sugilal & M L Mascarehnas** |
| | | *Invited Lecture (20+5 minutes)* |
| | | **IT-50; Prof. Tharamani C. Nagaiah**<br>**Designing greener energy conversion system for a sustainable future** |
| | | *Short talks (12+3 mins)* |
| | | *IT-41; Dr. Jyothir Ganeshwar Reddy Ummadi*<br>**Advancing Electrochemical Sensing for Healthcare and Environmental Applications** |
| | | *IT-21; Dr Balaji B. Mulik* |

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| | | **Electrochemical and Catalytic Conversion $CO_2$ on Graphene Oxide hybrids** |
| | | ***IT-13; Dr. Jitendra Kumar***<br>**Application of Electrochemical and other biosensors in agricultural monitoring** |
| | | ***CP-98; Dr. Anupriya Haridas***<br>**Tailoring Multi-electrolyte Additive-Mediated Electrode-Electrolyte Interphase for Stable Electrochemical Cycling of Lithium Iron Manganese Phosphate Cathodes** |
| | | ***IT-46; Dr. Rahul Agarwal***<br>**Best Practices in the Evaluation of Electrochemical Kinetic Parameters for Reversible and Irreversible Redox Couples Utilizing Cyclic Voltammetry** |
| | | ***IT-27; Dr. Rajini P Antony***<br>**Operando Spectro-Electrochemical Approach for Evaluating Electrochemical Interfaces Relevant to Industrial Electrolysers** |
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| | | **Valedictory Function of EIHE 2025** |
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| CP-208 | **Probing Biochemical Interactions of dsDNA on Iron Oxide Nanoparticles Modified Surfaceby electrochemical method**<br>*Alok Mahato, S Manna, Sanjukta A Kumar and A.K. Satpati* |
| CP-209 | **Hydrothermally Synthesized NiS/ZIF 67 Composite as a High Performance Anode Material for Lithium-Ion Batteries**<br>*Bristisnata Kashyap, Dr. Priyanka Ruz, Dr. Dimple P. Dutta* |
| CP-210 | **One-Step Approach using Spray-Pyrolyzed Cobalt Doped ZnO Photoanodes with Engineered Bandgaps for Enhanced Photoelectrochemical Water Splitting**<br>*Komal V.R. Jarhad, Aniket Pawanoji Sudipa Manna and A.K. Satpati* |
| CP-211 | **Interpretation of electrode reaction mechanism in High Temperature Steam Electrolysis cells by deconvolution of impedance spectra**<br>*R K Lenka, Akhilesh Kumar, and T Mahata* |
| CP-212 | **Electrodeposition and Characterization of Fe-Ni thin films for functional Applications**<br>*Dr.Kalyan Raj* |
| CP-213 | **Facile Synthesis of Tantalum-Doped $WO_3$/Carbon Composite Sensors for Electrochemical Detection of Diuron and Dichlone**<br>*Nagaraj P. Shetti* |
| CP-214 | **Development of Electroanalytical Methodology And Interactions in Curcumin**<br>*M. Jafar, P. K. Mishra and A. K. Satpati* |
| CP-216 | **Efficient Water Splitting with a Semi-conductor based Supramolecular Catalyst: A computational study**<br>*Naman Kumar Bharti, S. Kancharlapalli and M. Sundararajan* |
| CP-217 | **High-performance anti-corrosive coatings based on rGO-$SiO_2$-$TiO_2$ ternary nanocomposites for superior protection for mild steel specimens**<br>*Alexander Pinky Steffi , Pravin Nemade , Narendhar Chandrasekar* |
| CP-218 | **Enhancement in PEC efficiency and modulation of surface states in $BiVO_4$ through $TiO_2$ Atomic Layer Deposition**<br>*Sudipa Manna ,Abhishek Sharma, A. K. Satpati and C.N.Patra* |
| CP-219 | **Electrodeposited prussian blue over Ni-foam for enhanced Electrochemical energy storage devices**<br>*Vaishnavee Kasar, Suresh S. Shendage, S Sahoo and A. K. Satpati* |
| CP-220 | **Chronoamperometric Response on Rotating Disk Electrode for Reversible Redox System with Uncompensated Solution**<br>*Neha and Rama Kant* |
| CP-221 | **Advanced Kinetic Analysis of Hematite for Solar Water Splitting Using Intensity-Modulated Spectroscopy**<br>*Abhishek Sharma, Sudipa Manna and A.K.Satpati* |
| CP-222 | **ZIF-67 templated cobalt doped $MoS_2$ for bifunctional electrochemical water splittin**<br>*Sudipa Manna, Abhishek Sharma, and A.K. Satpati* |
| CP-223 | **Electrochemical Investigation of Cysteine and its interaction with 6-MP and BSA**<br>*M. Jafar, S. Manna and A. K. Satpati* |
| CP-224 | **Nitrogen-Doped Reduced Graphene Oxide/NiO Nanocomposites for High-Performance Supercapacitor Applications**<br>*S. Sahoo, Nidhi Tyagi and A. K. Satpati* |
| CP-225 | **Fabrication of DSSC by incorporating Gel- electrolyte**<br>*Aafreen Mirza, Rohidas B. Kale* |
| CP-226 | **Electrochemical deposition of Pt, Pd over SS, Cu and Al coupons**<br>*S. Phapale, D.Tyagi ,A.N.Shirsat, S. Varma* |
| CP-227 | **Ultra-trace detection of As(III) using AuNPs/V2C Mxene modified electrode by Voltammetry**<br>*Kalpesh Sanjay Tambe, Srikant Sahoo, Ashis Kumar Satpati.* |

# Abstract Presented as Plenary, Invited and Short Lectures

**EIHE 2025: IT 02**

# Poly-Pyrrole Hydrogel: A Versatile Support for the Design of Non-Precious Metal Based Electrocatalysts for Oxygen Reduction Reaction

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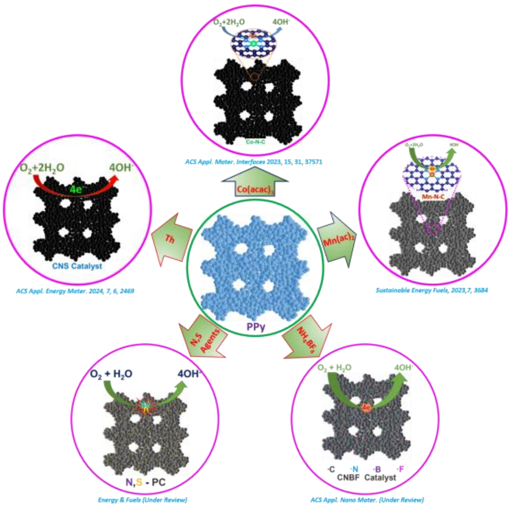
## Abstract:

Oxygen reduction reaction (ORR) plays a pivotal role in energy conversion and storage devices such as fuel cells and metal air batteries[1].However, the large-scale commercialization of these technologies is hindered by their dependency on precious-metal catalysts such as Pt/C. Thus, in a global perspective, current research is aimed towards design of active and stable PGM-free alternatives. In this scenario, hetero-atom doped porous carbon (PC) and single-atom catalysts (SACs) stand as two potential candidates. Although, most of the SACs are metal-organic framework (MOF) derived but they also suffer from low metal loading, inefficient utilization of the active sites buried inside carbon matrix etc.[2] We explored the potential of PPy hydrogel to design both heteroatom doped PC and SACs which demonstrate excellent performance towards ORR in contrast to Pt/C. This talk shall summarize the synthesis and properties of this interesting material and the design of various catalysts thereupon.

The unique 3D network structure of poly-pyrrole (PPy) hydrogel portrays an interesting chemistry, serving as a promising support for the design of various non-precious metal based electrocatalysts. In our works, we exploited the porous morphology of PPy network to synthesise a series of catalysts staring from metal-free to single-atoms each one demonstrating excellent performance towards oxygen reduction reaction in comparison to state-of-the-art Pt/C catalyst. Through our study, we revealed that in addition to poly-aniline (PANI), PPy can also be a suitable candidate for the design of cost-effective alternate catalysts in renewable energy technology.



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EIHE 2025: IT 03

# Advanced Molecularly Imprinted Polymer based electrochemical Sensor forNanoscale Detection of Atrazine in Environmental Samples.

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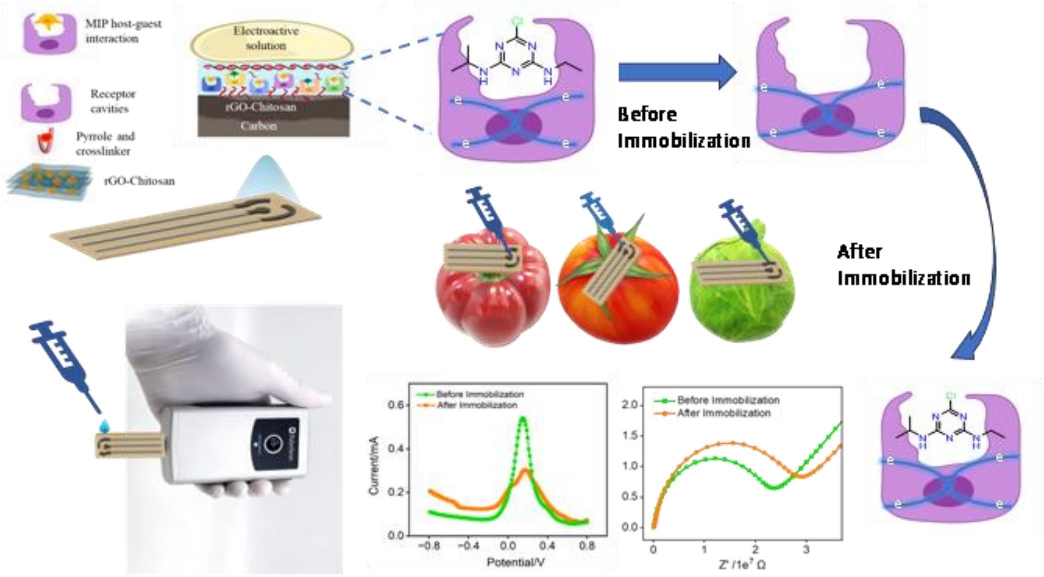
## Abstract:

The study introduces a SPCE electrochemical nanosensor that analyzes vegetable and water samples in real-time to detect herbicides. The sensor uses a molecularly imprinted polymer (MIP) and reduced graphene (rGO) oxide for atrazine (ATZ) detection, a common herbicide in farming.[1] We characterized the nanomaterial using an X-ray diffractometer and Raman spectroscopy. We assessed the efficacy of the sensor using various methods such as square wave voltammetry, cyclic voltammetry, and electrochemical impedance spectroscopy.[2] We performed morphological characterization of the MIP sensor using scanning electron microscopy, X-ray photoelectron spectroscopy, Fourier transform infrared spectroscopy, and atomic force microscopy. The sensor demonstrated remarkable selectivity and repeatability, identifying atrazine within a concentration range of 0–50 µM with minimal interference from other pesticides. The sensor is versatile for various sample types, exhibiting high recovery rates (> 96.05%) and a low relative standard deviation (< 5.7%). The MIP sensor is effective for quick and sensitive detection of ATZ, and it integrates parameters, signal processing, and calibration. The nanosensor allows real-time monitoring of pesticides and small toxic molecules in vegetables with and without spiked atrazine, enhancing the understanding of the environmental impact of herbicides.[3]



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**EIHE 2025: IT 04**

# Effect of Dopants & Co-Catalyst in Enhancement of Photoelectrochemical Applications for Microwave-assisted Synthesis of $BiVO_4$ Semiconductor

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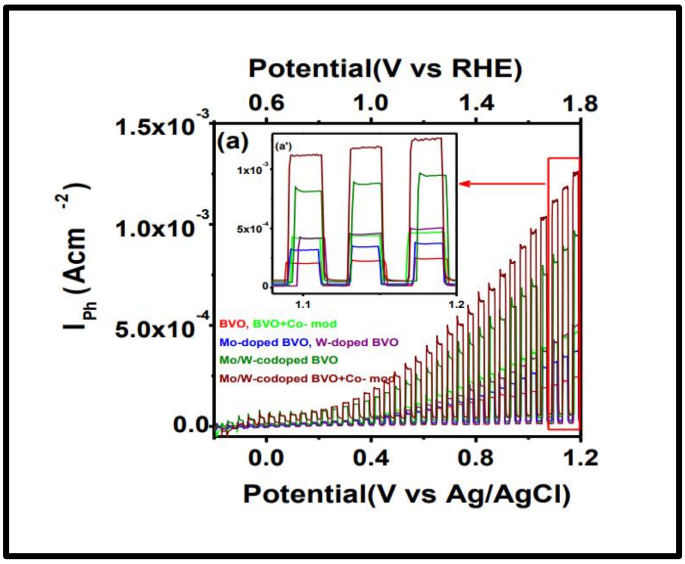
## Abstract:

Pure $BiVO_4$, an n-type semiconductor with excellent chemical and photostability, having band gap energy of ~2.4 eV, is a potential candidate for solar energy harvesting, but it suffers from slower water oxidation reaction kinetics and poor electron mobility. The PEC performance of $BiVO_4$ (BVO) can be enhanced by doping with metals (Mo, W, etc.). Microwave synthesis offers several advantages over other photocatalyst synthesis methods, such as a swift rise in temperature, shorter reaction time, highly controllable and energy efficient process, requirement of minimum amounts of solvents, etc. The simple microwave synthesis in the presence of UV light of Mo-doped, W-doped, and Mo/W-co-doped BVO for enhancing the PEC activity of the photocatalyst is reported. The Mo/W-co-doped BVO exhibits the best PEC performance among the prepared photocatalysts at optimized conditions, i.e., temperature (T) 100ºC, power (P) 300 W, time (t) 15 min and exposure of UV light for 2 min achieves maximum photocurrent of ~0.9 mA $cm^{-2}$ vs. Ag/AgCl in water oxidation reaction. The addition of an optimized amount of oxygen evolution catalysts, i.e., Co (II), over the $BiVO_4$ surface boosts the PEC performance of the photocatalyst. The catalytic property improves by ~75% with minimum charge transfer resistance towards water oxidation reaction. The dual modification strategy, i.e., metal doping and adsorption of OEC materials with $BiVO_4$ surface strikingly improves the performance, in towards oxygen evolution reaction and Co (II) modified Mo/W-co-doped $BiVO_4$ had exhibited the maximum photocurrent, 1.2 mA $cm^{-2}$, during the photoelectrochemical water oxidation reaction.



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## EIHE 2025: IT 05

# Sunlight Assisted Photocatalytic Water Remediation

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**Abstract:**

Sunlight-assisted photocatalytic water remediation is one of the hot topics to explore in terms of green methodology. Organic pollutants such as organic dyes, antibiotics, pesticides, endocrine disruptors, etc, are piling up in the water resources. This could cause serious health issues in living beings and pollution too. Hence photocatalysis with suitable catalyst active in solar region could effectively degrade these pollutants in a greener way. So herein we have utilised a novel $TiO_2$ nanocomposite for the water remediation.

**EIHE 2025: IT 06**

# Real-time Dissolution and Speciation of Manganese from Battery Electrodes during Charging and Discharging

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## Abstract:

Rechargeable alkali metalion batteries are widely used in portable electronic devices, medical instruments and electric vehicles, but suffer from a limited lifetime and capacity fading. To improve these characteristics, a deeper understanding of the electrodes' degradation mechanism, in particular transition metal dissolution, is necessary. In my talk, I will discuss the study of Mn dissolution from $Li_2MnO_4$in real time using a flow cell and inductively coupled plasma-optical emission spectroscopy (ICP-OES) [1], and demonstrate that Mn disproportionation ($Mn^{3+} \rightarrow Mn^{2+} + Mn^{4+}$) in itself is not enough to explain the Mn dissolution behaviour [2]. We use rotating ring-disc electrode (RRDE) collection experiments to identify the oxidation states of the dissolved Mn and show that different Mn species dominate during lithiation and delithiation. Our results improve the understating of the mechanism of transition metal dissolution and subsequent battery deterioration. On this basis, effective strategies for battery life extension, next-generation material selection, and better battery operation practices can be developed [3].

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**EIHE 2025: IT 07**

# Non-Precious Metal-Based Electrocatalysts for efficient Over all Water Splitting Reaction

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## Abstract:

Recent research has focused on electrochemical methods for energy storage and electrocatalytic/photocatalytic processes for energy conversion, aiming to identify sustainable and efficient alternatives to depleting fossil fuels. In this context, we have developed highly efficient nanostructured materials for electrochemical energy conversion, specifically green hydrogen production.[1-4] A novel nanoarchitecture is designed by percolation dealloying of a NiCu alloy on Co nanosheets, which serves as an efficient electrocatalyst for the hydrogen evolution reaction (HER), oxygen evolution reaction (OER), and overall water splitting (OWS) in an alkaline medium. This material operates at a low cell voltage of 1.46 V with excellent stability. Additionally, we have developed a spiky, ball-shaped, monodispersed $Fe_{0.5}CoNi_{0.5}P$ catalyst, which, when applied to overall water splitting, enables the $Fe_{0.5}CoNi_{0.5}P||Fe_{0.5}CoNi_{0.5}P$ electrolyzer to achieve a current density of 10 mA $cm^{-2}$ at cell voltages of just 1.52 V and 1.56 V in 1.0 M and 30 wt.% KOH, respectively—significantly lower than the voltages required by commercial $IrO_2||Pt/C$ systems.[3] We alsodeveloped a Mo-doped $Ni_2P$ nanoring electrocatalyst ($Mo_{0.1}Ni_{1.9}P$),and the $Mo_{0.1}Ni_{1.9}P||Mo_{0.1}Ni_{1.9}P$ electrolyzer achieves seawater splitting at just 1.45 V in 1.0 M KOH and 1.47 V in untreated seawater at a current density of 10 mA $cm^{-2}$.[5]

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## EIHE 2025: IT 08

# Unveiling enigmaticselenides for alkaline water splitting process

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**Abstract:**

Since last decade, metal selenides have reported enthusiastic results in the field of water splitting including OER and HER owing to the optimumparticipation of their d-orbitals among chalcogenides. Though selenides exhibits high electrocatalytic activity, their intermediate selenide redox species involved in water splitting was unknown. Unfortunately, selenide also got blemished for phase deformation and deactivation after OER.To unveil these mysteries of selenide, out of many stoichiometric compositions, the research group prepared monoselenides and diselenides*viz*;ZnSe, α-MnSe and $CoSe_2$, $NiSe_2$,$CuMnSe_2$, $MnMoSe_2$, respectively, under different conditions of hydrothermal synthesis. Interestingly, they found to have different lattice structures and exhibited good to high electrocatalytic activity towards OER.We carried out physicochemical and electrochemical, kinetic and operando spectroelectrochemical studies. The important finding was that we found the remedies to avoid phase deformation by using different conducting polymer composites which can directly enhance both its stability and electrocatalytic activity towards OER in alkaline medium. Further, *Operando* spectroelectrochemical study determined the generation of intermediate selenide redox species, metal oxyhydroxides and other various intermediate oxygen species involved in the process. Finally it's proven synergistic effect of metal-selenide and conducting polymer validated by DFT, electrochemical characterizations and in-situ spectroelectrochemical studies.

EIHE 2025: IT 09

# Electrogenarated Chemiluminescence (ECL): Carbon based nanomaterials as an effective luminophores and co-reactants and its application towards biosensor

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**Abstract:**

ECL is unique fascinating researchtechnique which combines electrochemistry and spectroscopy methods. Generation of ECL involves, electrochemically produced species under electrode/electrolyte interface which combines to undergo highly energetic electron transfer (oxidation or reduction) reactions that emit light from excited state without involving any external light source. Moreover, the ECL emissions are very high sensitivity, low background noise, good temporal and spatial control and simplified optical setup, it has been extensively used not only as a powerful tool in many analytical chemistry related areas such as medical diagnostics, detection of hazardous chemicals in food and water, and bio-warfare agent detection. Recently, researchers have been paid more attention to identify new luminescence emitters which includes organic and inorganic molecules, semiconducting nanostructured materials, carbon quantum dots and metal nanoclusters, to name few, for enhancing quantum yield efficiency and its suitable applications. Using this kind of unique ECL technique offers a grand avenue to understanding the fundamental properties like physicochemical and electrical properties of organic molecules, semiconducting nanostructured materials, quantum dots, metal clusters and etc. Also,ECL emission could be used in the estimation of biologically important molecules especiallyat the single molecular level by either selective quenching or enhancing ECL signal. The aim of the present talk is to provide the principles of ECL and classical reaction mechanisms-particularly involving the carbon-based nanomaterials used as aluminophores and co-reactant ECL systems.

# Rechargeable Batteries with Organic Polymer and Small Molecules

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## Abstract:

Considering low global warming potential of organic materials, they are attractive candidates over transition metal based materials for rechargeable batteries. In the batteries, graphite is used as anode. They cannot be substituted with Li ion transporting functionalities and the Li ion intercalation in graphite is complicated. Therefore, we have designed and synthesized conjugated polymers with Li ion transporting moieties that are used as anodes in Li-ion batteries. Among the polymers, the one substituted with urethane moiety showed stable specific capacity over 2000 charge discharge cycles.[1] The polymer with oligoethyleneglycol side chaindegraded and showed inferior performance. Although urethane moieties are good Li ion transporters, oxygen atoms in metal organic frameworks (MOF) are also good Li ion transporters. In fact, we have shown that a MOF showed impressive performance compared to graphite.[2]

The energy density of Li-ion batteries is five times higher than that of Li-ion batteries. However, polysulfide dissolution is an issue, which was suppressed using polyvalent electrostatic attraction in low sulphur loading batteries.[3] Subsequently, we used Lewis acid-base interaction in an organic small molecule with pyridinic nitrogen to suppress the polysulfide dissolution. The polysulfide showed high binding energy with the pyridine containing molecule than the control molecule. Due to this reason, Li-S battery fabricated using pyridine containing molecule showed stable specific capacity over five hundred charge-discharge cycles. I will discuss all these results during my talk.

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## EIHE 2025: IT 11

# Optimizing Oxygen Reduction Selectivity: Cost-Effective Catalysts and Supports

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## Abstract:

Tuning the two- or four-electron selectivity of oxygen reduction is critically important for a wide range of applications, including green hydrogen peroxide production and fuel cell cathodes. Green hydrogen peroxide production relies on the two-electron reduction pathway of oxygen, while fuel cells require the highly selective four-electron reduction of oxygen. Therefore, optimizing selectivity in the oxygen reduction reaction (ORR) is a key challenge.This selectivity can be adjusted by modifying the electronic properties of the catalyst's active site. Such modifications can be achieved through functionalization of the catalyst and/or its support materials. Carbon-based materials are particularly well-suited for integrating various ORR catalysts due to their ability to securely anchor catalysts on their surface through multiple interactions, such as covalent bonding, electronic interactions with charged moieties, π-π interactions, and hydrogen bonding.In this study, we systematically explore methods to tune ORR selectivity towards either the two-electron or the four-electron pathway.

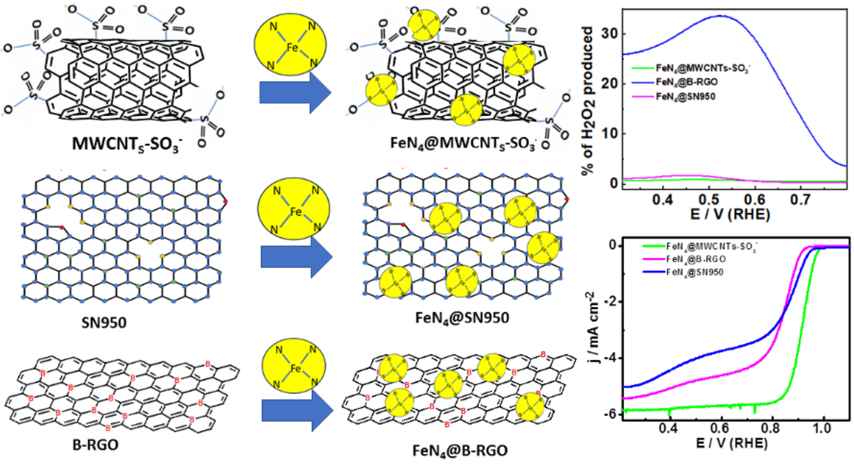

**Figure:** Integration of $FeN_4$ system onto multi-walled carbon nanotubes, mesoporours carbon, and boron-doped reduced graphene oxide demonstrating efficient electrocatalytic oxygenreduction.

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## Acknowledgments:

ANRF/SERB (CRG/2022/003370), New Delhi and IoE programs of BHU (6031, 6031-B, and 3254).

## EIHE 2025: IT 12

# Electrochemical Dimerization of 3-Substituted-2-Oxindoles: Many Routes, One Destination

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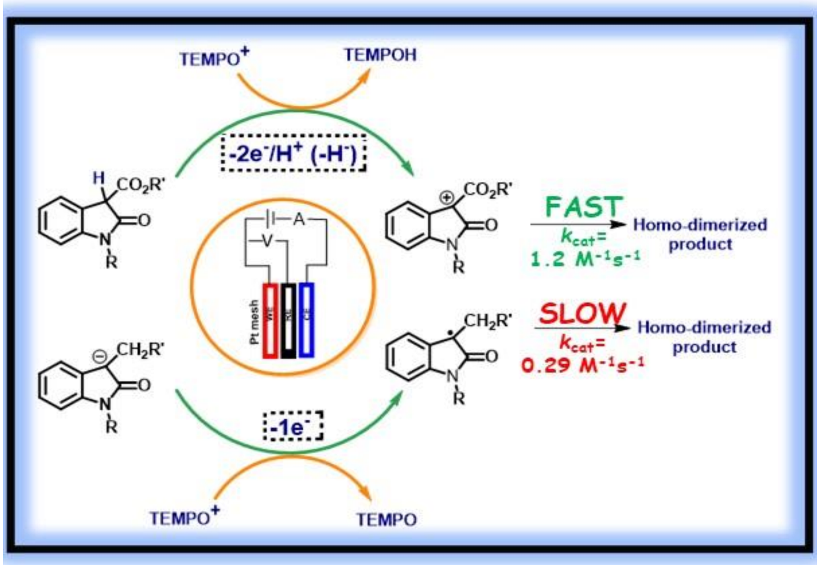
## Abstract:

Dimerized 3-substituted 2-oxindoles are building blocks for alkaloids, and hence, the synthesis of these molecules is of great interest. Previously, synthesis of these molecules was reported employing chemical methodologies with toxic catalysts. Electrochemical synthesis of these molecules can make the process significantly greener and more sustainable. In this regard, first, I will discuss the dimerization of 3-carboxylate-2-oxindole and 3-alkyl-2-oxindole by direct oxidation of these substrates on the electrode surface.[1,2] A detailed mechanistic investigation involving proton-coupled electron transfer (PCET) will be discussed.[1,2] For the dimerization of 3-carboxylate-2-oxindole, three different routes will be discussed.[1] Thereafter, I will present electrocatalytic routes involving TEMPO as a redox mediator and TEMPO$^+$ as an active catalyst for the dimerization of three different types of 2-oxindoles.[3] 3-carboxylate-2-oxindole followed a 2e$^-$ transfer/hydride transfer mechanism for the dimerization, while 3-alkyl-2-oxindole and 3-alkylcaroxylate-2-oxindole followed a 1e$^-$ transfer pathway involving radical species for dimerization.[3] Moreover, many aspects of green chemistry, such as minimizing waste generation, recovery of electrolytes etc., will also be discussed.[3]



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**EIHE 2025: IT 13**

# Application of Electrochemical and other biosensors in agricultural monitoring

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## Abstract

A biosensor is a tool that aids in more accurate analysis. It transforms biological signals into electrical ones. In essence, it consists of physiochemical detectors and biological components. One of the key industries that needs innovation and change is agriculture, which is needed to boost production and advance sustainability.Agriculture is a complex but systematic practice that includes various processes, techniques, methods, and technologies that lead the produce from farm to fork.The process of augmenting crop production has made the agricultural ecosystems face a lot of challenges. This presentation willprovide a concise overview of the range of applications for electrochemical and other biosensors in agriculture for monitoring of soil conditions to agricultural product post-harvest and consumption.

**EIHE 2025: IT 14**

# A Unified Electrochemical Approach for the Conversion of Biomass and Waste Plastic into Valuable Chemicals and Hydrogen Fuel at High Current Densities

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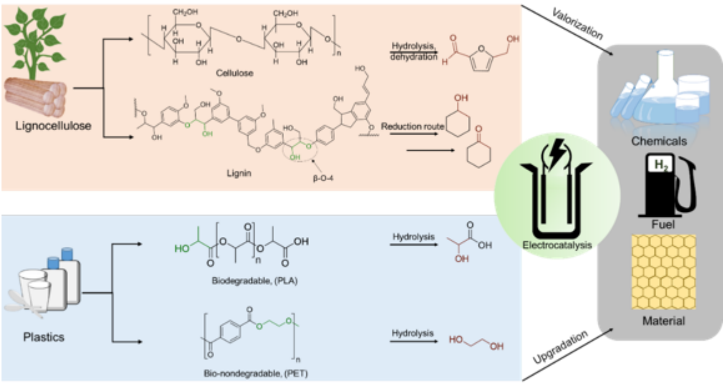
## Abstract:

The electrochemical oxidation of lignocellulose and plastic waste to value-added chemicals represents a promising approach to addressing critical environmental challenges. However, selective oxidation to specific products at higher current densities remains challenging. Oxidative cleavage of C(OH)-C moiety of various lignocellulose and mixed biodegradable and bio-nondegradable plastics can be a tackling strategy. In this study, we demonstrated electrochemical oxidation with a monometallic Ni(O)O-H for cellulose-based biomass, a series of lignin-based model complexes, lignin-derived secondary alcohols (KA oil), mixed plastic wastes based on the O-H bond dissociation energy of the catalyst. The catalyst performs exceptionally well for the selective oxidation of cellulose and lignin-based model complexes like HMF and PED at 100 mA cm$^{-2}$ with87 – 100 % yield. KA oil oxidation to adipic acid with 54% yield was observed at constant current electrolysis of 20 mA cm$^{-2}$. Also, plastic waste precursor shaving C(OH)-C bond oxidation were investigated using the same catalyst to selectively obtain the oxidized product. This was further applied to mixed plastic waste upgradation to generate formate and acetate with Faradaic efficiency of 66% and 74%, respectively, and 100% yield in terephthalic acid along with the co-production of hydrogen.



**Scheme 1.** Structural similarities between biomass and waste plastic and their electrochemical upgradation to valuable chemicals.

*Keywords:* Electrocatalysis, Biomass, Plastic, Hydrogen, Nickel

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EIHE 2025: IT 15

# Role of Electrolyte Structure in Heterogeneous Catalysis

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## Abstract:

Electrolyte effect on the kinetics of electrochemical reactions is an emerging phenomenon in electrocatalysis. Recently we have shown that engineering aqueous electrolytes with high/low amounts of additives to achieve tunable products can be a facile strategy in different electrocatalytic processes. For example, a large amount of salt in water changes the structure of the hydration sphere around the ions and this can affect the water splitting process kinetically or thermodynamically. Water-in-Salt electrolytes based catalysis is found to be playing different roles in different metals and hence enhancing or decreasing the water splitting process. Such electrolyte engineering processes can be useful in different electrocatalytic processes such as hydrogen generation, nitrogen reduction, $CO_2$ reduction reaction etc. The talk will be focussing on such aspects of electrochemical reaction control in aqueous electrolytes and also will be on the importance of electrolyte structure probing near the electrode surface. Such engineering approaches are also important in energy storage devices such as metal-air batteries and phenomena such as photoluminescence.

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**EIHE 2025: IT 16**

# ‘Layered’ transition metal oxides as electrode materialsfor Na-ion batteries: Composition - Structure - Environmental stability - Electrochemical behaviour/performance

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## Abstract:

‘Layered’ transition metal ($T_M$) oxides are a fascinating class of materials, whose properties can be suitably tuned in a variety of ways; such as, by selecting $T_M$-ions/dopants having preferred electronic configurations, engineering the crystallographic site occupancy by dopants,controlling/modifying the degree of covalence of $T_M$-O bonds, modifying lattice spacing(s), tuning phase assemblage etc. Such modifications done from the fundamental perspectives influence the performances of $T_M$-oxides for a variety of applications, including their widespread usage as cathode-active materials in alkali metal-ion batteries. In the context of the upcoming Na-ion battery system, O3-type ‘layered’ Na-$T_M$-oxides are promising as cathode-active materials due to their inherently high initial Na-content (as compared to the P2 counterparts); but suffer from instabilities caused due to multiple phase transformations during Na-removal/insertion and sensitivity to air/moisture. Against this backdrop, by tuning the overall covalency of the cation-oxygen bonds in the $T_M$-layer (which, in turn, influences the Na-O bond) and also with the help of a dopant having $d^0$ electronic configuration (*viz.*, no OSPE), we have been able to tune the composition and structural features to suppress the phase transitions upon Na-removal/insertion and improve the air/water-stability in significant terms; so much so that long-term cyclic stability has been achieved with health/environment-friendly ‘aqueous processed’ electrodes (sans, usage of toxic/expensive chemicals like NMP and PVDF) [*J. Mater. Chem. A* **8** (2020) 18064, *Adv. Energy Mater.***13**[19] (2023) 2204407]. The changes in structural features, which have led to such outstanding water-stability, include differential contraction/dilation of the Na-‘inter-slab’/$T_M$-‘slab’ spacing and partial occupancy of the dopant at tetrahedral sites of the structure. The former aspect has also been invoked to enhance the Na-transport kinetics and, hence, the rate-capability of the, otherwise, inherently sluggish O3-structured $NaT_MO_2$-based cathode material [*ChemComm* **59** (2023) 4332].Furthermore,in the context of the more‘rate-capable’ P2-structured ‘layered’ Na-$T_M$-oxide based cathode materials, but lacking in terms of having a lower starting Na-content (typically, 0.67-0.7 Na-ions *p.f.u.*), a universal strategy towards designing and developing high Na-containing P2-structured ‘layered’ Na- transition metal oxides has been evolved. Thisis based on increasing the average ‘charge:size’ ratio of the cation-combination in the $T_M$-layer and concomitant $T_M$-O bond covalency, resulting in lower effective negative charge on O-ions; and, in turn, rendering the prismatic coordination of O-ions around Na-ions more favourable even at higher Na-content. Accordingly, by careful selection of the combination of non-$T_M$-/$T_M$-ions in the $T_M$-layer, a high Na-containing (*viz.*, ~0.84 p.f.u.) P2-type Na-$T_M$-oxide has been developed, which, as a cathode material for Na-ion batteries, exhibits a high desodiation capacity of ~178 mAh/g (@ C/5; within 2-4 V vs. $Na/Na^+$), exceptional cyclic stability pertaining to ~98% capacity retention after 500 galvanostatic desodiation/sodiation cycles @ 2.5C and also stability upon exposure to air/water [*Chem. Mater.***34** (2022) 10470].

**EIHE 2025: IT 17**

# New Modifications in Electrocatalytic Hybrid materials for Water Splitting and Fuel Cell Reactions

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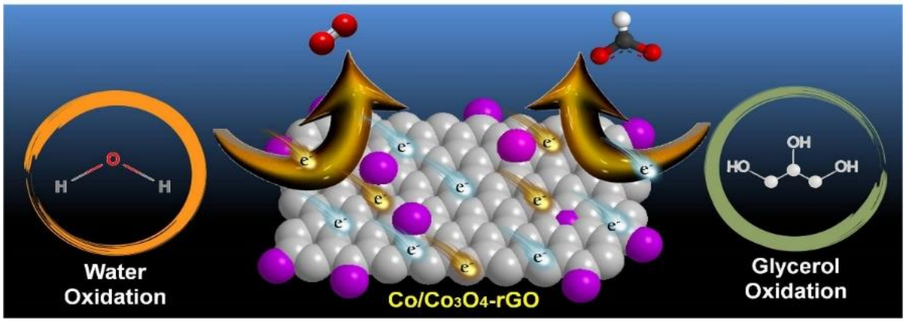
## Abstract:

Developing efficient viable alternate renewable energy sources in the context of the ever-growing demand for energy is the need of the hour. The energy security and supplies of energy are the key components for progressing countries. Renewable energy resources are rapidly being recognized as clean sources of energy to withstand damages to environment and to avoid future crisis. Many materials related challenge exist in electrochemistry covering the entire span of electrode materials as an active component of fuel cells and next generation energy conversion devices. With this motivation, surface engineering at nanoscale plays an important role in energy generation, conversion and utilization applications. Our current research is systematically examining and developing the efficient and cost-effective electro-catalysts for hydrogen generation reactions from hydrogen rich species, water splitting and fuel cell reactions, wherein metal nanostructures anchored on carbon-based materials (enhancing surface area/activity) and substitutional doping of non-metal demonstrate extraordinary electro-catalytic performance in water splitting and other hydrogen generation reactions.The observed efficient electrocatalytic activity of the as-synthesized electrode is attributed to the co-operative response and associated structural defects due to their oxidative functionalization along with their cooperative functioning at nano-dimensions. We expect that these findings will stimulate future research on synthesis of other innovative and sustainable metal-free nanomaterials and investigation of the fundamental structure-property relationships for renewable energy and other applications.



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## EIHE 2025: IT 18

# Inorganic Functional Materials for Sustainable Energy Applications

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**Abstract:**

The current energy crisis, driven by scarcity of natural gas, coal and their environmental impact, necessitates clean energy solutions. Water splitting and supercapacitors are appealing for their energy conversion and storage applications. A key challenge is to develop transition metal-based electrodes with high energy conversion and storage capacity. Our research includes preparation of $VS_2$ and a $VS_4$/rGO nano-composites, which exhibit excellent stability and efficiency for hydrogen evolution reaction with minimal overpotential of 41 mV. Additionally, Metal-Organic frameworks-derived $Co_3S_4$ nanoparticles demonstrate significant oxygen evolution reaction, with $Co_3S_4$-3h electrocatalyst achieving an overpotential of 285 mV and stable performance under harsh conditions. A 3D Ni-MOF has shown to undergo bias-induced transformation to $Ni(OH)_2$that has intercalated organic constituents and exhibit better storage performance than bulk $Ni(OH)_2$.

The formation of a $SnO_2$/MXenehybrid increases the interlayer spacing of $Ti_3C_2T_x$, and this increment in the interlayer spacing supports the charge transport in the electroactive material. Thus, the resultant composite with 80 mg of $Ti_3C_2T_x$($SnO_2$/$Ti_3C_2T_x$-80) displays a specific capacitance of 620 F/g at 2 A/g current density. Density Functional Theory (DFT) calculations have been performed to comprehend the structural and electronic properties of SnO2 and hybrid SnO2/$Ti_3C_2T_x$systems. The formation of a hybrid structure has significantly increased the conductivity of the $SnO_2$system due to the charge transfer from $Ti_3C_2T_x$to $SnO_2$. The quantum capacitance is higher in the hybrid system than in the pristine $SnO_2$system. This validates and supports our experimental results that the hybrid system has enhanced charge storage performance.

EIHE 2025: IT 19

# Indigenization of Ceramic Tapes and Substrates for Space Electronics and Electrochemical Device Applications

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## Abstract

Technical or advanced ceramics play a vital role in the proliferation of various technologies that are finding applications in many end-use industries such as electronics & semiconductors, automotive, energy & power, medical, industrial, military &defense, and others. These myriad applications are possible owing to the characteristic properties of ceramics like high-temperature stability, robustness, high thermal conductivity, low thermal expansion, and electrical properties ranging from insulators to semiconductors to highly conductive materials, etc. Technical ceramics in the form of substrates are used in electronic circuits and sensing elements as they withstand harsh environments. They are cost-effective and hence promising for various automotive and aerospace applications. Modern electronics are all based on integrated circuits consisting of millions of interconnected components built on a tiny silicon chip. These circuits depend on insulating ceramic substrates/packages to maintain their reliability due to the insulating properties of ceramic materials. Ceramics such as alumina and zirconia in the form of free-standing sintered substrates or green tapes are employed for the fabrication of electronic circuits, sensing elements and membrane electrode assemblies for electronic devices, oxygen &NOx sensors and solid oxide fuel cells (SOFCs) respectively. Aluminum nitride is another promising futuristic material that can replace the toxic BeO substrate that is used in space electronics. The tapecasting method is usually employed to produce thin ceramic sheets or tapes that can be cut to the required size and shape, followed by screen printing desired circuits with conducting pastes and stacked to form packages for electronics and sensing applications. It is despairing to note that only companies from the US, Germany, UK, Japan, Taiwan and China are having an excellent foothold in the global technical ceramics market and none of the Indian industries feature in this list. The present talk will highlight our endeavors in the indigenization of ceramic tapes and substrates for space electronics and electrochemical device applications.

***Keywords:*** Ceramics; Substrates; Tapes; Circuits; SOFC; Sensor

## EIHE 2025: IT 20

# Polymeric membrane based potentiometric sensors for lanthanides and actinides

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**Abstract:**

Determination of lanthanides and actinide ions are required at trace level at various stages of nuclear fuel cycle (NFC). It is therefore important to develop a simple, fast and low-cost method which will give desired precision and accuracy. Although, potentiometric sensors for lanthanide and actinide ions possesses several challenges like poor Nernstian sensitivity, poor selectivity, possibility of hydrolysis at higher pH, then also it has not lost its importance since it offers a simple, fast and low-cost technique [1]. In the present case, we have developed several potentiometric sensors for trivalent lanthanide ions, such as $Eu^{3+}$, $Gd^{3+}$ and tetravalent ions, $Th^{4+}$ using different diglycolamide (DGA) or tripodal amides as ionophores, polyvinyl chloride (PVC) as polymer and 2-nitrophenyl octyl ether as plasticizer. All the components of the membranes, such as polymer, plasticizer, ionic additive and the ionophore together were dissolved in tetrahydrofuran (THF) and casted on a flat bottom petri dish. The sensor membranes were characterized using different techniques, such as thermogravimetric (TG), atomic force microscopy (AFM), Fourier transform infrared (FTIR) spectroscopy and photoluminescence (PL) spectroscopy. The membrane sensor showed good sensitivity towards analyte ions with wide linear dynamic range and low detection limit. The membrane sensor also exhibited fast response time and stability over more than two months. The effect of different monovalent, divalent, trivalent and tetravalent interfering metal ions on the potentiometric response was also tested in the presence of analyte ions. Finally, the membrane sensors were employed for direct potentiometric determination of analyte ions in various samples.

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## EIHE 2025: IT 21

# Electrochemical and Catalytic Conversion $CO_2$ on Graphene Oxide hybrids

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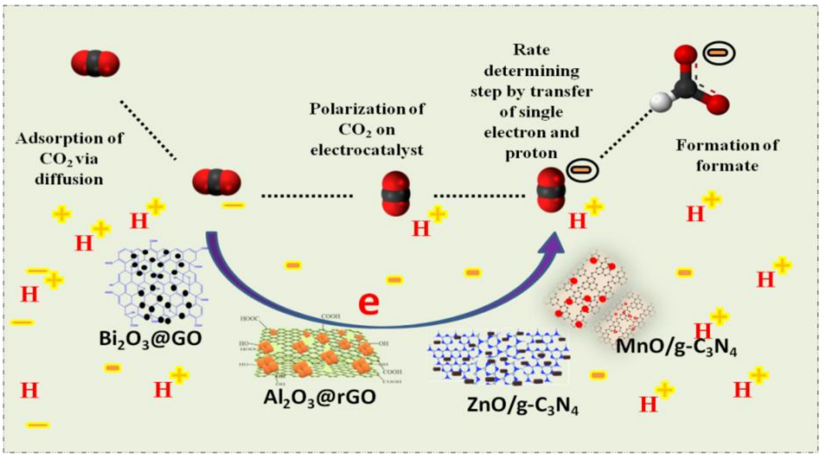
## Abstract

Carbon dioxide ($CO_2$) and global warming challenges and need to be develop electrocatalytic reduction of $CO_2$ to valuable organic compounds and fuels which significantly contributes to the control of climate change using energy efficient techniques is presently of great importance. Here in this regard we have developed $Bi_2O_3$@GO, $Al_2O_3$@rGO, MnO/g$C_3N_4$ and ZnO@g$C_3N_4$ electrocatalytic systems. All the electrocatalysts has been characterized by various structural morphological and spectroscopic techniques like XRD, Raman, SEM, TGA, FTIR, TEM and XPS. The electrocatalysts have demonstrated for electrochemical reduction of $CO_2$ to formate with high Faradic efficiencies by using cyclic voltammetry, linear sweep voltammetry, chronoamperometry and electrochemical impedance spectroscopy (EIS). Additionally, electrocatalysts having higher Faradic efficiency (FE) for formate formation 83, 92, 91 and 69% for $Bi_2O_3$@GO, $Al_2O_3$@rGO, ZnO/g-$C_3N_4$ and $MnO_2$/g-$C_3N_4$ nanocomposites respectively. The present methodologies will applicable for industrial scale up and will try to solve the energy and environmental issues.



**Schematic:** Representation of $Bi_2O_3$@GO, $Al_2O_3$@rGO, MnO/g$C_3N_4$ and ZnO@g$C_3N_4$ based modified electrode for electrochemical hydrogenation of $CO_2$ to Formate via possible intermediates in aqueous electrolyte.

**EIHE 2025: IT 22**

# Reduced Graphene Oxide based Portable Sensors for PCA3

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## Abstract:

Prostate cancer is one of the most common cancer types among men. While the current screening is heavily dependent on the prostate specific antigen (PSA) levels, PSA is not very specific to the cancer and can increase even in multiple benign cases too. This underscores the necessity of finding a better biomarker which can specifically indicate the incidence of prostate cancer. PCA3 is one such RNA marker which exhibits better specificity towards the disease. However, the current evaluation method of any RNA is predominantly polymerase chain reaction (PCR) based which makes the procedure lab-intensive. Our research group has developed simple 2-port resistive sensors which captures the RNA/DNA hybridization through the change in the resistance of the device. The device comprises of surface modified reduced graphene oxide and single stranded DNA and could detect 0.1 – 100 ng/mL PCA3 RNA demonstrating excellent sensitivity and high specificity towards the target. Two such research will be discussed in details during this talk.

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# Molten salt electromotive force method for thermodynamic measurements

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**Abstract:**

Electrochemical methods are important tools for the determination of thermodynamic properties of materials. The electromotive force (EMF) method is one such technique wherein both solid and liquid electrolyte-based methods are employed for the precise measurements. The molten salt electromotive force (EMF) method is one such technique employed for the determination of thermodynamic properties at high temperatures. In this method, ionic compounds dissolved with corresponding ions responsible for establishing the EMF are used as electrolytes. The measurement at low temperatures is limited to the melting or eutectic temperature of the salts and at high temperatures the vapour pressures of the materials involved and contribution to electronic conduction. An important step is the purification of the electrolyte free of moisture or hydroxide which would contribute to electronic conduction. Purification of molten salt is carried out by bubbling dry hydrogen chloride or by chlorine gases. In this talk, molten salt EMF measurements of two examples, namely, binary and ternary alloy systems and the determination of thermodynamic properties of these systems will be discussed.

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# Electrochemical Conversion of $CO_2$ to value-added chemicals

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## Abstract:

Transforming carbon dioxide ($CO_2$) into valuable chemicals *via* electroreduction presents a sustainable and viable approach to mitigating excess $CO_2$ in the atmosphere.[1,2]Currently, our group is working on the development of MOF, POP and MXene based electrocatalysts for the efficient conversion of $CO_2$ to value-added products in aqueous/organic media. $CO_2$ reduction in 0.1 M $KHCO_3$ produces products such as Syngas, formate, methane, etc. While indirect $CO_2$ reduction in the presence of benzylbromides or alkenes, aldehydes or ketones produces their corresponding carboxylic acid derivatives in organic media. It is observed that the product selectivity in both aqueous as well as organic medium is governed by various factors such as applied potential/current density, electrolyte, solvent and the electrode.

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EIHE 2025: IT 25

# EIS Response for Anomalous Dynamics of EDL and Supercapacitor: Theoretical Aspects

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## Abstract

Supercapacitor electrodes consist of complex nanoporous structures in carbonaceous and non-carbonaceous materials causing alteration of electric double layer (EDL) structure, energy and time scales of response. We develop a modular theory for DC-bias dependent electrochemical impedance spectroscopy (EIS) for EDL in the heterogeneous bimodal porous electrode, viz. arbitrary mesopores with embedded heterogeneous micropores. Theory accounts for the compact- and diffuse-EDL dynamics along with charge transfer kinetics with resultant pseudocapacitance. The influence of applied DC-bias on various phenomenological components is accounted through a approach based on physical arguments. This is achieved by using the potential and concentration dependent diffuse layer thickness for unsymmetrical electrolytes, charge transfer resistance, and electric field dependent dielectric constant. The generic nature of theory is further highlighted by extending it for the composite porous electrode materials. The theoretical response shows that increasing the magnitude of DC-bias enhances the characteristic ion relaxation rates therefore, increases the rate capability of supercapacitors. The electrode morphological parameters, viz. mesopore size, micropore size, micropore length, and the pore surface heterogeneity, can effectively tune the capacitance and charging-discharging rates therefore, influence the performance of supercapacitors. Finally, our theory explains the experimental EIS data for hierarchical porous electrodes.

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EIHE 2025: IT 26

# Electrochemical Investigation of Molten Salt and Exploration of Deposition of Thick Mo and W Coatings

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## Abstract

Molybdenum (Mo) and Tungsten (W) being refractive in nature with high melting point, high hardness and low hydrogen permeability have got tremendous importance in various high temperature as well as fusion reactor applications. In this study, an effort has been made to electrodeposit thick, adherent pore-free Mo as well as W coatings by molten salt electrolysis. Prior to electrochemical deposition, a detailed electrochemical investigation was carried out in molten salt of Mo containing potassium molybdate ($K_2MoO_4$), sodium tetraborate ($Na_2B_4O_7$) and potassium fluoride (KF) to understand cathodic discharge of $MoO_4^{2-}$ to Mo. Similarly, for W-deposition, a suitable electrolyte was formulated to obtain compact coating. Adherent, metallic Mo and W coatings having thicknesses in the range of 10-60 μm were successfully deposited on SS-316L and variety of other metallic substrates by molten salt electrolysis and optimized electrolyte composition as well as deposition parameters. Post deposition, coatings were characterized well in terms of crystal structure, microstructure, coating adhesion with substrate etc. Deposited coatings were found to be compact porosity free without having any cracks with bcc crystal structure. Temperature dependent hydrogen permeation data across SS316L/W substrate/coating combination was also measured.

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**EIHE 2025: IT 27**

# Operando Spectro-Electrochemical Approach for Evaluating Electrochemical Interfaces Relevant to Industrial Electrolysers

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## Abstract:

Probing the local electrochemistry is crucial in technologically relevant electrochemical interfaces, involving proton-coupled electron transfer reactions. The activity, selectivity, and stability of the electrocatalysts are influenced by local electrochemistry, where the formation of reactants modulates the microenvironment of the electrocatalysts. A key parameter is the local pH, which changes due to the consumption or generation of protons and hydroxyl species during electrochemical reactions, leading to a significant difference between the local pH at the electrochemical interface and the bulk pH. Furthermore, the electrocatalyst can undergo structural transitions, forming active sites responsible for catalytic reactions. Monitoring these phases is vital for optimizing the catalyst performance with respect to efficiency and stability. The talk will highlight the importance of operando techniques in investigating the electrochemical interface, particularly focusing on the Water Oxidation Reaction (WOR), and will provide meaningful insights for industrial water electrolysis processes.

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EIHE 2025: IT 28

# Single-Atom Electrocatalysts for Nitric Oxide Reduction To Value-Added Chemicals

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## Abstract

Recently, single-atom catalysts have garnered significant attention in electrocatalysis due to their maximized atomic utilization, adjustable metal centers, and diverse coordination environments. Their key advantage stems from the fully exposed active sites, facilitating strong interactions with neighboring coordination atoms, thereby affording exceptional activity and stability to the single-atom catalysts. I will focus on our recent efforts to promote the single-atom catalyst's performance in electrochemical NO reduction to ammonia (Fig.1). The synthesis and characterization of dual metal FeNi single-atom active sites anchored on porous graphitic nanospheres [1] and Cu nanowires in multichannel-carbon nanorods catalyst will be discussed [2,3]. Finally, their potential applications in single-cell electrolysis of NO to $NH_3$ and primary Zn-NO- batteries will be presented.

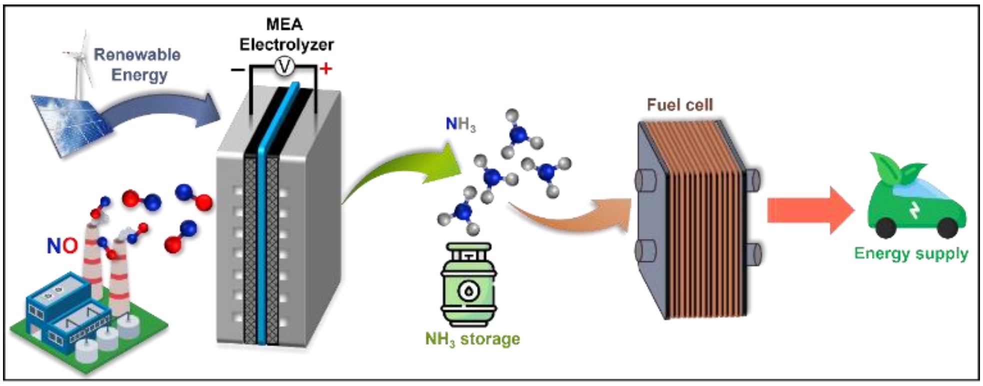

**Fig. 1** Schematic of $NH_3$ economy that contains carbon-free fuel generation from the air pollutant NO utilized by the sustainable energy-driven electrolyzer and the produced $NH_3$ is used as energy supply.

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## EIHE 2025: IT 29

# Intrinsically Microporous Polymers inElectrochemistry

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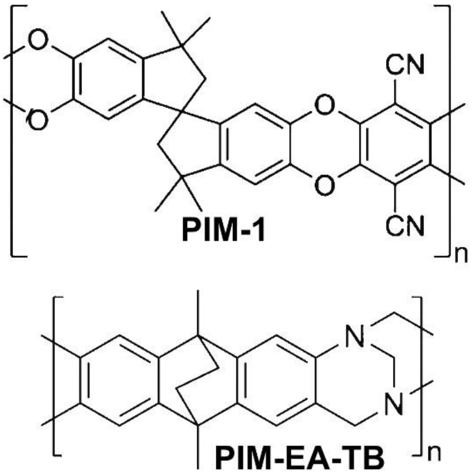
## Abstract:

Polymers of intrinsic microporosity (or PIMs) have been developed over the past decade as molecularly rigid and highly processable materials that are readily applied to electrode surfaces or employed as free-standing membranes. Two prototypical PIMs are PIM-1 [1] and PIM-EA-TB [2] (see Figure). Both possess rigid molecular backbones and pack into porous solid/glassy films with high surface area and with typically 1 nm pore size [3]. Both are of interest in electrochemistry [4].



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EIHE 2025: IT 30

# Electrochemical studies of Biological Interactions at Soft Interfaces

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**Abstract:**

Biological interfaces are ‘soft’ and ‘electrified’.  Soft biomimetic interfaces can applied for studying both fundamental aspects and practical applications of biological interactions. The following areas of research will be discussed:

1. Interactions of drugs:
   a. The interaction of a drug with acute phase proteins in serum can influence their bioavailability and modify the function of biomolecules. Furthermore, the chiral purity of a drug plays an important role, since different isomers have distinctive clinical effects.A micro liquid-liquid interface was effectively used, for quantifying drug-protein interactions.
   b. Several neurodegenerative diseases are caused by amyloidogenesis, which occurs through the accumulation of amyloid beta (Aβ) peptide and its aggregates at lipid interfaces. Beta amyloid aggregation and interactions of $Cu^{2+}$have been investigated and modelled. The effects of a multifunctional peptidomimetic inhibitor ($P_6$) ,based on a naturally occurring, metal chelating, tripeptide and an  inhibitor of Aβ aggregation is studied.

2. Free-standing bilayer membranes
   a. A lipid bilayer representing a cell wall is of fundamental biological significance. Techniques for studying the interactions of important mitochondrial membrane associated molecules, such as Ubiquinone-10 (UQ10) and α-tocopherol (Vitamin E), are presented.
   b. Resonance Enhanced Impedance Spectroscopy, a relatively new technique, is shown to be suitable for probing nanoparticle effects on lipid membranes, in real time.

3. Biofilms

   The formation of biofilms on solid, abiotic surfaces and the implicit electron transfer cascades is of significance across a range of applications including microbial fouling, microbial fuel cells, bioremediation, antibiotic resistance, and biosynthesis. This work shows discuss how biofilms can be detected and destroyed on soft surfaces such as wounds and on hard surfaces such as stainless steel and copper.

**References:**

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**EIHE 2025: IT 31**

# Metal Air Batteries: Alternatives to Li-ion Batteries

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## Abstract:

In view of the increasing energy consumption in the current world, scientific community has shown great interest in different rechargeable battery systems like different metal-ion and metal-air batteries. Transition metal dichalcogenides (TMDs) have emerged as highly effective electrocatalysts, offering exceptional performance due to their unique electronic properties, abundant active sites, and high surface area [1]. Here, we show TMDs nanostructures specifically $MoSe_2$ and its nanocomposites with bimetal oxides as cathode material in metal-air batteries likeZn-air, and Al-air batteries. TMDs-based catalysts exhibit remarkable performance in oxygen reduction reaction (ORR) and oxygen evolution reaction (OER), enhancing the energy density and cycle life of the batteries.The study also addresses the synthesis methods, structural optimization, and potential challenges in the practical application of TMDs in metal-air batteries [2-5].

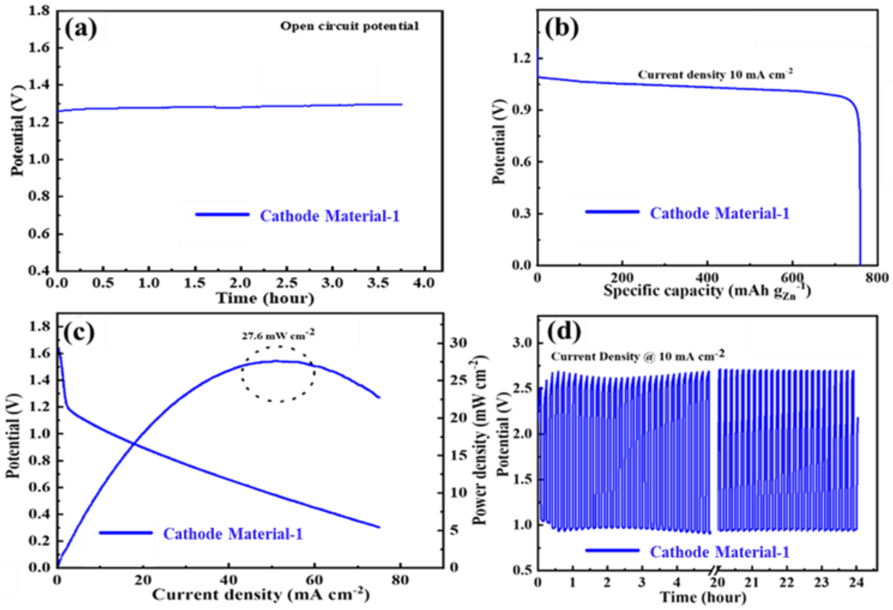

**Figure:** Battery Performance of $MoSe_2$ based Zn-air battery

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## EIHE 2025: IT 32

# Water-Soluble Molecular Vessels

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## Abstract

The properties and functions of chemical entities in confined nanospace are expected to be different from their conventional bulk properties due to restricted translational and rotational motions in the nanospace. Such restricted degree of freedom along with other non-covalent interaction/s may allow to stabilize unusual conformations of compounds in confined nanospace of molecular cavity. My lecture will focus on the synthesis of water-soluble molecular vessels. Unusual photophysical behavior of photochromic compounds in confined nanospace of molecular vessels will be highlighted. Our recent efforts on designing chiral molecular vessels including their chiral recognition properties will be discussed in my lecture. My lecture will also focus on the use ofdifferent molecular vessels for the separation of isomeric polyaromatic hydrocarbons by simple aqueous extraction and for catalytic chemical transformations.

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## EIHE 2025: IT 33

# ReactiveCO$_2$ capture and photo-electrochemical photocurrent polarity switching effect via tuning the electrochemical interfaces

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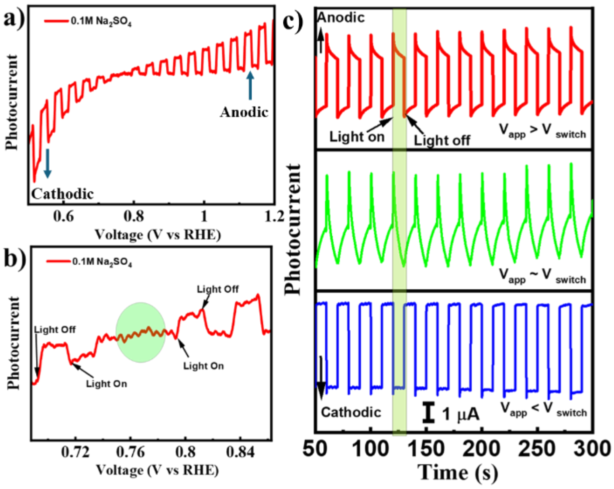
## Abstract:

Today, the energy crisis due to depleting fossil fuel supply and their negative impact on environment like global warming is probably the world's biggest problem. Efforts have been made to develop abundant, inexpensive and environment friendly renewable resources of energy, like water splitting using solar light, as well as to mitigate the exponentially increasing global CO$_2$ atmospheric concentration for carbon-neutral energy sources. However, to develop the highly efficient electrocatalysis systems, the judicious tuning of electrochemical interfaces via strategies such as electronic effects, chemical functionalities, and type and distribution of active sites is essential. In this regard, the catalyst development ensuing the Sabatier principle provides a promising approach. In this talk, I shall discuss a few recent results from our research group at IIT Delhi, India towards the green energy and clean environmental related applications. Particularly, I shall focus on the bifunctional oxygen electrocatalysis, water splitting, and integrated CO$_2$ capture and conversion.



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# Electrochemical Technologies forHydrogen Economy

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## Abstract

Electrochemical engineering plays a critical role in hydrogen economy. Electrochemical technologies have wide applications in green hydrogen production, storage and utilization. Its applications span multiple technologies and industries, offering innovative solutions to global energy and environmental challenges.In hydrogen production, electrochemical processes such as water electrolysis, including alkaline,Proton Exchange Membrane (PEM), Anion Exchange Membrane (AEM) and solid oxide technologiesprovide high-purity hydrogen with minimal environmental impact.Electrochemicaltechnologies are also used in the hybrid thermochemical cycles for hydrogen production. In hydrogen storage, electrochemical systems such as electrochemical compression addresses the challenges of compactness and energy density. Meanwhile fuel cells, including PEM and solid oxide fuel cells, play a critical role in hydrogen utilization, converting hydrogen into electricity for applications ranging from transportation to stationary power systems. Electrochemical technologies also play an important role in hydrogen safety in terms of its applications in hydrogen sensors. Additionally, advanced electrochemical processes can also be adopted for synthesizing valuable chemicals and materials. The present talk will focus on the various aspects and challenges of the different electrochemical technologies in hydrogen economy.

## References:

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EIHE 2025: IT 35

# Electrochemical Energy Storage and Sensing by Carbon Nanomaterials

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## Abstract

Carbon nanomaterials can have wide range of structures. In our laboratory we have synthesized varieties of macrostructure based on carbon nanomaterials. Carbon nanotube (CNT) fibre and sheet have been synthesized by floating catalyst chemical vapour deposition (FC-CVD). Millimetre-long vertically aligned CNTs have been grown by atmospheric CVD process. Three-dimensional (3D) graphene has been synthesized by templated CVD method. Again, a hybrid structure consisting of 3-D graphene and CNT has been grown using plasma enhanced CVD. All these structures have different porosities and surface areas. Moreover, some of these structures have very high electrical conductivities. These materials are very good for electrochemical energy storage and sensing. In these talk the above aspects will be covered.

## EIHE 2025: IT 36

# Spectro-electrochemical investigations in Characterisation of $BiVO_4$ and Hematite interface

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*[2]Homi Bhabha National Institute, Anushaktinagar, Mumbai 400094*

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## Abstract:

The electrode/electrolyte interfaces of the nano composite electrodes are complex and the investigations of such complex processes are important in developing catalysts substrates for energy harvesting and storage, development of sensors and gas storing devices and investigating the interactions of drugs and biomolecules. The interfacial processes have been investigated for noble metal doped 3D-graphene, metal organic framework derived Ni-Co oxide, $MoS_2$ $MoS_2$/C-dots composite for their electrocatalytic and supercapacitor properties. Photoelectrochemical (PEC) investigations are carried out for splitting of water using solar radiation on $BiVO_4$, Hematite and their modifications through doping and hetero junction formation. The results on the hematite photoanode is shown in Fig.1 The intensity modulated photocurrent spectroscopy measurements indicated the reduction of the charge recombination

Process.

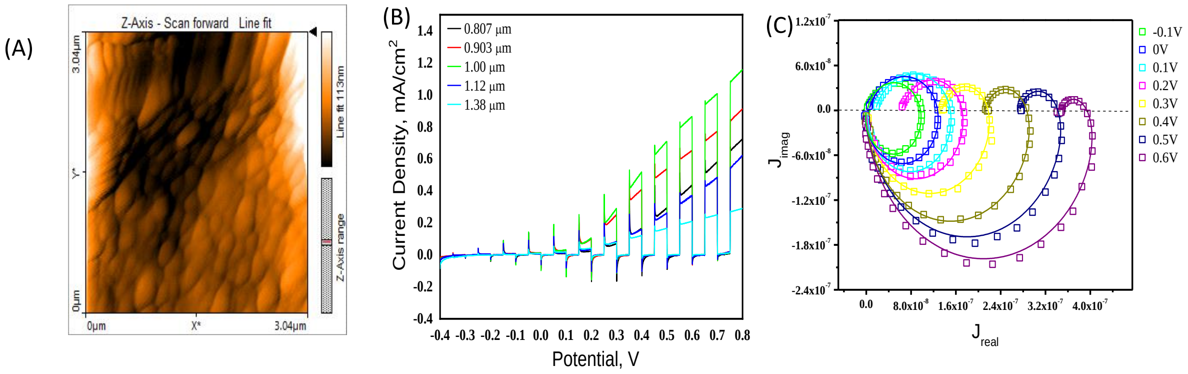

Fig.1 (A) AFM mage of the hematite (B) The chopped light voltammetry (C) IMPS plot

EIHE 2025: IT 37

# Catalysing Nuclear Reactions & Channelizing its energy

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## Abstract

The distinguished electrochemist, Martin Fleischmann along with Stanley Pons, announced (in March 1989) that nuclear fusion can be implemented in a table-top electrochemical cell. “Cold fusion” with its glamorous introduction (via a press conference!), uncertain scientific foundations, and formidable issues of reproducibility, rapidly became associated with pathological science (~July 1989). History of science typically relies on one set of scientists establishing empirical facts and another proposing an underlying theory. Unfortunately, Fleischmann-Pons not only burgeoned the experimental results but also proposed a rather untenable theory, which proved to be a straw man, vitiating the usual cycles of evolution of a scientific field in peer-reviewed literature. Being outliers of the mainstream, a band of scientists continued to pursue the work courageously developing their sub-culture.

This seminar is aimed at a general scientific audience and not necessarily at expert nuclear scientists. We will first unfold the field historically, then present the efforts led by Google, the US-DOE, the European Union and the Japanese government industry consortium to buttress the fact-finding aspirations and pollution-free energy generation. Following this, we will present the results from the “Electrochemically Activated-Nuclear-Reactions” group at IIT-Kanpur, wherein the focus has been on heavy element nuclear transmutations and signatures of nuclear reactions. Finally, the wanderings in this less chartered territory will include the possibilities at the frontiers of science and consequential engineering.

# Molybdenum basedElectrocatalysts for Efficient and Low-cost Green Hydrogen Production

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**Abstract**:

Electrochemical water splitting is a promising approach for large-scale and sustainable hydrogen production with zero carbon emission. However, its kinetics is slow and requires precious metal catalysts for efficient operation. To address this challenge, significant efforts are focused on designing and developing low-cost, highly efficient catalysts to enhance both the hydrogen evolution reaction (HER) and oxygen evolution reaction (OER). In our research, we have developed various noble-metal-free materials as effective catalysts for HER, OER, and full water splitting. Efficient electrocatalysts requires (1) highly active intrinsic sites, (2) abundant accessible active sites, (3) effective electron and mass transfer, (4) high chemical and structural durability, and (5) low-cost and scalable synthesis. It is essential that all these requirements are fulfilled simultaneously for a truly practicable electrocatalyst. While much progress has been made, efforts have often focused on addressing one or a few of these aspects, with particular emphasis on improving electrocatalytic activity through electronic modulation of active sites for water splitting.

In this presentation, I will discuss recent advancements in the synthesis of low-cost, earth-abundant electrocatalysts for the Hydrogen Evolution Reaction (HER). While precious metal-based electrocatalysts remain widely used, emerging molybdenum (Mo)-based materials, such as $MoO_2$, $MoS_2$, and $Mo_2C$, have garnered significant attention due to their high HER activity and cost-effectiveness.The discussion will also cover state-of-the-art strategies to enhance the performance and durability of these materials. These strategies include the development of Mo-based carbon composites, heteroatom doping, and the construction of heterostructures.Finally, I will address the challenges and explore future directions in the rapidly evolving field of Mo-based electrocatalysts for HER.

EIHE 2025: IT 39

# New Materials for New Batteries: Formation of Solar Rechargeable Batteries

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*Materials Chemistry Group, Department of Chemical Sciences, Tata Institute of Fundamental Research Colaba, Mumbai India*

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## Abstract

Over the years, various strategies have been employed to address the intermittency issue associated with solar energy. Conventional approaches involve either coupling a photovoltaic device with a battery (but that inevitably leads to losses due to presence of multiple interfaces), or synthesizing solar fuels, converting solar energy into chemical energy for subsequent use. This has normally been achieved through photocatalysis or photo-electrocatalysis. In a tangential approach, research efforts have instead targeted direct capture and storage of solar energy in a single device. This approach focuses on formation of a 'solar battery' which is capable of storing solar energy and subsequently releasing it as an electrical impulse. Efforts to enable PV devices for storage have been made but face challenges. Integrated bifunctional devices offer a promising solution, and these have been categorized into traditional, multilayer, and advanced photoelectrode fabrication approaches, each with distinct advantages and complexities. Presented in this talk will be our approach which is focused on evaluating a non-trivial polymeric structure of ionic form of carbon nitride. Details and insight into the material will be presented that showcase how a single semi-conductor is able to leverage its unique chemical structure and photophysical behaviour to display persistent photo charge accumulation post light exposure.

## EIHE 2025: IT 40

# Strategies to improve electrochemical performance of Li-S batteries

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## Abstract:

Lithium-sulfur battery technology is probably the front runner among the energy storage devices due to its high energy density, higher safety and lower cost. However, there are several daunting problems in this technology like low conductivity of sulfur, high solubility of lithium polysulfides and migration of lithium polysulfides to anode side. This results in shuttling of lithium polysulfide which is the main reason for reduced capacity and low cycle life. Different methods have been adopted to synthesize sulfur nanoparticle to reduce the dissolution of lithium polysulfide. In addition to that electrolyte modification is also needed for longer cycle. In other attempts the separators have been modified using graphene oxide, MXene and it has been found that the capacity as well as cycle life increases. In thesecases a stable SEI layer also formed which protect lithium anode. The composite cathode exhibits an initial discharge capacity of ~1000mAh/g with very low capacity decay. Post mortem analysis has also been done to investigate the improved capacity of the cells.

EIHE 2025: IT 41

# Advancing Electrochemical Sensing for Healthcare and Environmental Applications

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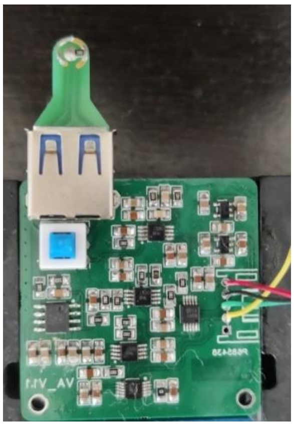
**Abstract:**

At *Asoli Scientific Research*, we are developing a portable electrochemical Potentiostat designed for seamless integration into healthcare and environmental monitoring platforms. This device exemplifies the next generation of sensing technologies by combining miniaturization with screen-printing methods to produce versatile, highly sensitive, and application-specific sensors.Our efforts focus on leveraging these innovations to address critical challenges in diagnostics and monitoring. For instance, we are designing sensors capable of detecting electrolytes from as little as 30 µL of blood obtained through a finger prick. Additionally, we are pioneering non-invasive glucose detection using saliva, paving the way for more comfortable and accessible diagnostics.To achieve these advancements, our team is committed to the entire lifecycle of sensor development: from creating miniaturized electrodes to optimizing chemical interactions with standards and validating performance through rigorous preclinical testing. Our contributions align with emerging trends in electrochemical sensing, such as flexible electronics, real-time monitoring, and wearable platforms, ensuring our technology is future-ready and adaptable to diverse applications.This work represents a step forward in redefining diagnostics and environmental sensing, offering tools that are not only portable and cost-effective but also transformative in improving global health and sustainability outcomes.



*First Prototype of DC based Electrochemical Analyzer*

**References:**

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## EIHE 2025: IT 42

# Electrochemical Conversion of $CO_2$ to value-added chemicals

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## Abstract:

Transforming carbon dioxide ($CO_2$) into valuable chemicals *via* electroreduction presents a sustainable and viable approach to mitigating excess $CO_2$ in the atmosphere.[1,2] Currently, our group is working on the development of MOF, POP and MXene based electrocatalysts for the efficient conversion of $CO_2$ to value-added products in aqueous/organic media. $CO_2$ reduction in 0.1 M $KHCO_3$ produces products such as Syngas, formate, methane, etc. While indirect $CO_2$ reduction in the presence of benzylbromides or alkenes, aldehydes or ketones produces their corresponding carboxylic acid derivatives in organic media. It is observed that the product selectivity in both aqueous as well as organic medium is governed by various factors such as applied potential/current density, electrolyte, solvent and the electrode.

## References:

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EIHE 2025: IT 43

# Engineering Nano Composites for Electrochemical Sensing Applications

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## Abstract:

The development of affordable, marketable electrochemical sensors has been demanded significantly due to their potential applications in clinical diagnostics, pharmaceutical analysis, food safety, water quality, and environmental monitoring etc. Continuous efforts are being made to address societal challenges by monitoring organic and inorganic pollutants, as well as toxic metal ions, which pose risks to both ecological systems and human health. With advancements in nanoscience and nanotechnology, 2D nanomaterials have emerged as superior alternatives to conventional composites, offering enhanced electrochemical properties such as high surface area, excellent catalytic activity, electrical conductivity, mechanical stability, and biocompatibility. To overcome the challenges of generating stable electrochemical signals for critical analytes, the study utilizes composite-modified electrodes to produce enriched signals with minimal interference. Electroanalytical methods have been developed for the determination of toxic metal ions, including As(III), Cr(VI), Hg(II), Pb(II), and Cd(II), as well as important nuclear materials such as Uranium and Europium, using modified electrodes. Additionally, comprehensive investigations have been conducted to understand the pre-concentration processes, redox behavior, electron-transfer kinetics, and underlying mechanisms of some biomolecules, antioxidants, drugs, and other significant organic compounds etc. The methods developed have been validated using other techniques and also analysing the SRM. The techniques are successfully applied to real-world samples, demonstrating their effectiveness in on-site electro-analytical applications.

**Key words**: 2D nanomaterial, sensor, modified electrodes, pollutants etc.

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## EIHE 2025: IT 44

# Electrochemical Point of Care device for profiling of vWFA2 for Systemic Inflammatory State Detection

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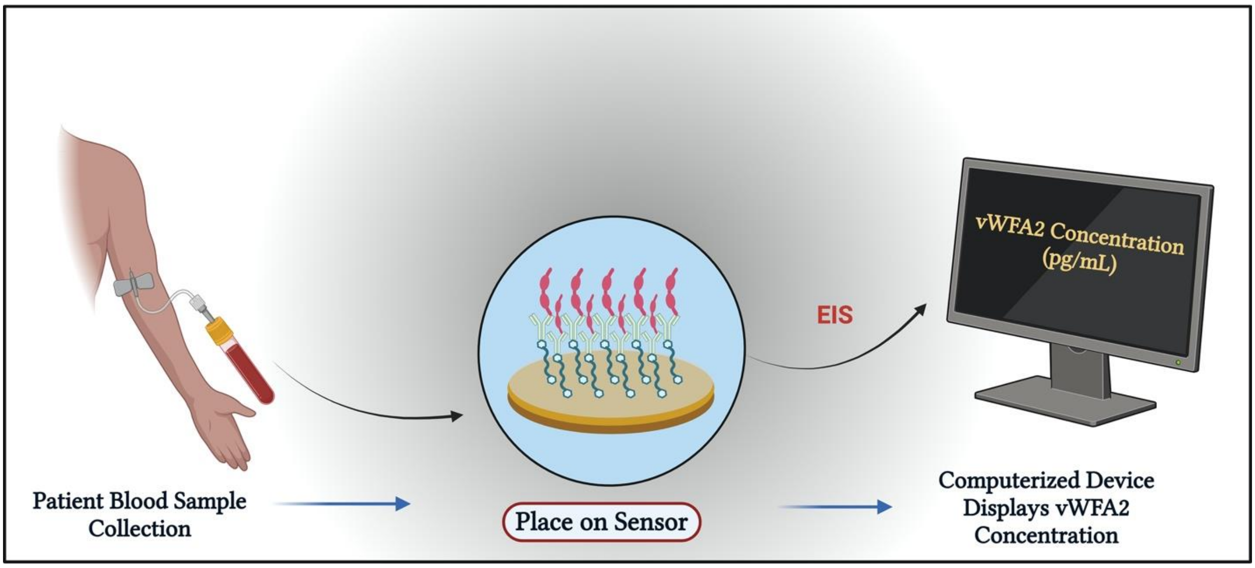
## Abstract

This research aims to develop a portable biosensor device for quickly detecting vWFA2, a biomarker for inflammatory conditions. This type of sensor has the potential to revolutionize detection methods, leading us to improve our assay sensitivity to overcome the limitations of traditional detection methods. Our label-free biomolecular assay is constructed on an Au-ZnO electrode surface and uses electrochemical impedance spectroscopy (EIS) to measure the capacitive change in impedance, revealing the binding effects of the target vWFA2, to the capture probe. Our developed biosensor platform exhibits exceptional sensitivity and specificity, covering a wide dynamic range of 750-24,000 pg/mL and showing a strong correlation with inflammatory conditions. This sensor exhibited a greater accuracy ranging from 86%-110% for the known spiked concentrations in plasma buffer. This electrochemical sensor has the potential to revolutionize point-of-care diagnostic methods due to its high sensitivity, and rapid response time. The vision behind this research is to develop an electrochemical sensor that can rapidly and accurately detect disease states, thus creating a pivotal prognostic tool in inflammatory state treatment, and ultimately mitigating severe mortality and morbidity.



## EIHE 2025: IT 45

# Designing electrochemical biosensors for affordable healthcare

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## Abstract

Sensors have immense potential for application in healthcare monitoring.With the advent of personal monitoring devices and wearable devices, this field is rapidly growing. Electrochemical biosensors offer a promising platform for development of sensors for detection of various physiological analytes.Cancer is one of the major health challenges worldwide. One of the conventional technique for detection of cancer is based on estimation of cancer biomarkers, which are basically biological molecules found in blood, other body fluids, or tissues that is a sign of a normal or abnormal condition or disease.As some of the cancer biomarkers often lack specificity and sensitivity, simultaneous detection of multiple biomarkers can make the diagnosis more accurate. To address this, mediator and substrate-free amperometric biosensor has been developed for simultaneous detection of cancer biomarkers carcinoembryonic antigen and alpha-fetoprotein by designing two different redox-labelled detection probes. In another work, carbon dots were synthesized by the hydrothermal method and bioconjugated with an antibody to design a nanoprobe for the detection of prostate specific antigen (PSA), an important serum based prostate cancer biomarker. The detection probe enabled biomodal assay of PSA via fluorescence and electrochemical sandwich immunoassay. The talk will present an overview of various strategies adopted for efficient tapping of the analyte recognition signals, and ourefforts towards development of sensor technologies with potential for commercial application.

## EIHE 2025: IT 46

# Best Practices in the Evaluation of Electrochemical Kinetic Parameters for Reversible and Irreversible Redox Couples Utilizing Cyclic Voltammetry.

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## Abstract

Cyclic Voltammetry is a widely employed electroanalytical method that serves researchers across diverse scientific fields in the assessment of various kinetic parameters associated with redox-active species. These parameters include the reversibility of redox reactions, charge transfer coefficient, diffusion coefficient, formal electrode potential, dimensionless kinetic parameter, and standard rate constant. However, there is a notable absence of systematic guidelines and best practices for the precise estimation of these parameters through the characteristic peak parameter expressions (such as peak potential, half-peak potential, and peak current) of both reversible and irreversible couples. This gap often leads to confusion for novices, who may find themselves misled by the conflicting interpretations of reversible and irreversible couples presented in numerous textbooks and scholarly articles. The insufficient foundational understanding of voltammetry among researchers from various disciplines contributes to the proliferation of misinterpreted kinetic data in the literature. This perspective aims to examine the theoretical underpinnings, limitations, and challenges associated with current voltammetric methodologies for kinetic parameter determination. It includes corrections to the contentious ψ and $k^0$ values related to reversible and irreversible couples and introduce a new reference scale for the accurate differentiation of irreversible couples. Furthermore, the determination of kinetic parameters using various peak parameter expressions has been revised in light of the ΔE$_P$ values. Comprehensive guidelines for conducting precise kinetic analyses of reversible and irreversible pairs are also provided, detailing best practices and common pitfalls. This article seeks to clarify the concepts of cyclic voltammetry for beginners, thereby alleviating the confusion prevalent in existing literature and offering a clear framework for the application of peak parameter expressions in the accurate estimation of kinetic parameters.

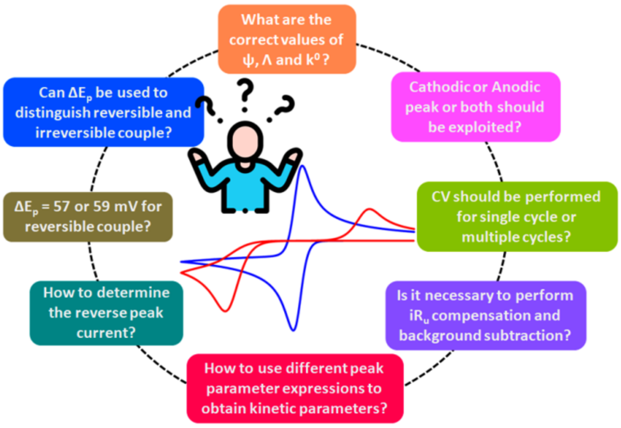

**Figure:** Different Queries regarding Cyclic Voltammetry.

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# EIHE 2025: IT 47

# Beyond Single-Atom Catalysts in Green Energy Transition

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## Abstract

In today's era of renewable and green energy advancements, the single-atom catalyst stands out with significant potential for converting solar energy into chemical energy. This is due to its exceptional atomic efficiency and its ability to blend the benefits of both heterogeneous and homogeneous catalysts. In the recent studies from our research group, we highlights that traditional semiconductors in solar photocatalytic energy conversion suffer from poor photon absorption and fast electron-hole recombination, reducing their efficiency. Additionally, the metal cocatalyst's dimension and the exposure of active sites significantly influence catalytic activity and selectivity, with improvements achievable by reducing particle size and optimizing the metal sites' electronic structure (Fig 1).

In this talk, we introduced our newly developed nanoalloy-single atom catalyst for superior photocatalytic hydrogen evolution reaction under visible light. The catalyst was synthesized at 900 °C, RuNi nanoalloys partially exchanged atoms with Zn from ZIF-8 on a carbon–nitrogen framework, forming RuZn nanoparticles and single nickel atoms (Ni-CN). This catalyst demonstrated enhanced photocatalytic hydrogen production.

**Key words:** Photocatalytic water splitting, Hydrogen generation, Nanoalloy, Single Atom Catalyst (SAC)

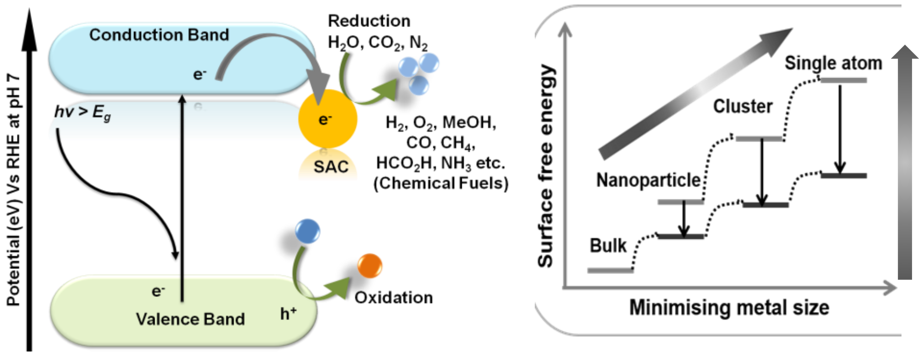

**Fig.1** Representation of semiconductor's electronic and catalytic activity with their geometric structures for solar to chemical fuels

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## EIHE 2025: IT 48

# Designing green erenergy conversion system for a sustainable future

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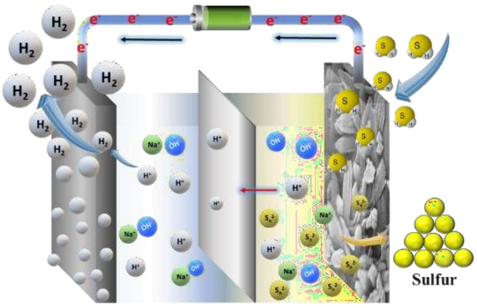
## Abstract

Highly efficient and cost-effective hydrogen production ($H_2$) promises to play a vital role in green energy production due to its high energy density, low-pollution, and renewable nature. The electrocatalytic decomposition of $H_2O$ to $H_2$ and $O_2$ considered to be the most sustainable method for pure $H_2$ production, unfortunately, it stumbles due to potentially uphill and energy-consuming sluggish anodic oxygen evolution reaction (OER).[1] Contrary to $H_2O$ isostructural hydrogen sulfide ($H_2S$) possesses lower bond dissociation energy. Therefore, anodic sulfide oxidation reaction (SOR) will be moreenergy-efficient than OER. Presently, the Claus process is the most popular industrial technology for removing $H_2S$, but energy wasted in the form of steam. Therefore, electrochemical conversion of environment pollutant $H_2S$ into $H_2$ and S provide a way to remove pollutant $H_2S$ and also emerges as new energy source.[2] However, the industrialization of such energy-efficient technology never meets the expectation in reality in the absence of cost-effective and robust electrocatalyst. My talk addresses the approach towards $H_2S$ electrocatalysis and noble-metal free based catalyst that exhibited lower onset potential of 0.23 V *vs.* RHE towards SOR, which is 1.25 V lower than OER. Notably, only a 1.2 V commercial battery easily derives $H_2S$ electrolysis, which is impossible for $H_2O$ splitting demonstrating the tremendous future prospective of $H_2S$ forcost effective hydrogen production as well as sulfur which can be utilized as a cathode/anode catalyst for sulfur based battery for a sustainable economy.[3,4]



**Scheme1.** Schematic representation of $H_2S$ electrolysis into cathodic $H_2$ and anodic SOR.

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# Abstract Presented
# as
# Oral and Poster

EIHE 2025: CP 2

# Synthesis and Characterization of High-Performance Functionalized Polymeric Carbon Nitride for Solar Energy Capture and Storage

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## **Abstract**:

There has been a continuous development of renewable energy-capturing technologies to address humanity's energy demands in an environmentally friendly manner. Along with harvesting energy, the simultaneous storage of that energy has gradually gained importance simply because of the erratic nature of renewable sources. Generally, coupling a photovoltaic (PV) device (silicon solar cell) with a conventional device, such as a battery or capacitor, is used for solar energy capturing and storing. However, there are potential disadvantages including efficiency, higher initial cost, system complexity, space requirements, etc. In 2018, a research paper from Bettina Lotsch's group highlighted a unique property of Functionalized Polymeric Carbon Nitride (F-PCN) which can absorb and store solar energy simultaneously.[1] Following this work, numerous studies have been done exploring the properties of F-PCN.[2,3] However, this material's charge retention times are minimal (*ca.* 3 to 4 hrs) compared to commercially available batteries. To address the above-mentioned issues, I have attempted to synthesize F-PCN with long retention times compared to those already reported in the literature. The details of the synthesis and characterization of the synthesized materials will be discussed in my presentation.

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**EIHE 2025: CP 3**

# Metal Oxide based Carbon Nanocomposite as Sensing Platform for Electrochemical Detection of Cadmium- Computational and Experimental Approach

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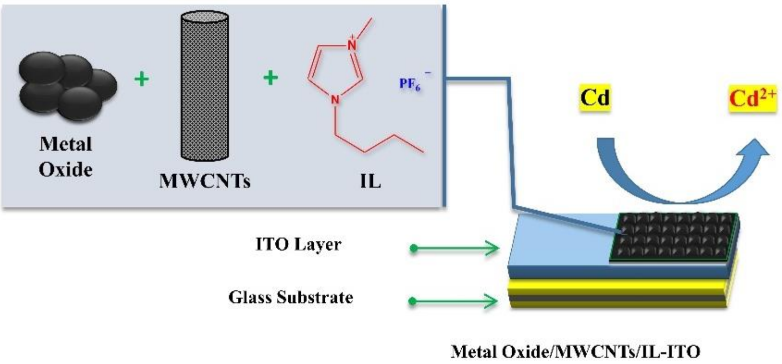
## Abstract:

Cadmium is considered as one of the heavy toxic metals whose compounds are carcinogenic in nature. Its harmful effects are not limited to humans; aquatic and other terrestrial creatures are also at risk. As a result, determining cadmium in the environment is crucial using eco-friendly means to favor sustainable development. In this work, Cadmium is detected using an electrochemical sensor prepared by fabricating ITO substrate with metal oxide based carbon nanocomposite ($SnO_2$, $MnO_2$, MWCNTs and ionic liquid (IL)). The computational studies showed that the interaction of metal oxide based nanocomposites with cadmium is thermodynamically favorable. Metal oxide shows good conductivity and provide structural stability to the redox process at the surface. The fabricated sensor, $SnO_2$/MWCNTs/IL-ITO and $MnO_2$/MWCNTs/IL-ITO showed good sensitivity towards cadmium with linearity range of 20 - 200 and 300 - 2000 ppb with limit of detection 3.61 and 41.34 ppb respectively. The sensor showed good reproducibility and repeatability at optimized conditions. The recovery response to check the stability and resistance to interfering ions showed good results which is credited to the chemical stability and selective sites of nanocomposite. The sensor showed good performance in real water samples analysis by showing efficient recovery through spike recovery test.

**Keywords:** Cadmium, Electrochemical sensor, Ionic Liquid, Metal oxide, MWCNTs.



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EIHE 2025: CP 4

# Electrochemical Energy Conversion and Storage for Demand Responsive Nuclear Power Reactor Operation: An Optimization Study

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## Abstract:

Nuclear power reactors are expected to play a significant role in the clean energy transition as providers of low carbon electricity. However, reactors mostly operate as baseload generators; their flexible operation by power ramp up or ramp down in response to time varying demand and to accommodate intermittent supply from variable renewable generators is not technically or economically feasible. In this context, a combination of electrochemical energy conversion and storage technologies like water electrolyzers, grid scale batteries and fuel cells can play animportant role in providing flexibility to reactor operation without actual power modulation [1,2]. An optimization scheme has been developed for sizing electrolysers and batteries to make use of excess energy available as shown in Fig. 1. Under optimal conditions, up to 96% of excess energy can be used by electrolysers to produce hydrogen, while minimizing the capital investment required. Fuel cells can convert part of the hydrogen to electricity to supply back to the grid during high demand phases but it is less economically favourable based on current techno-commercial maturity level; batteries are the more suitable alternative in this case.

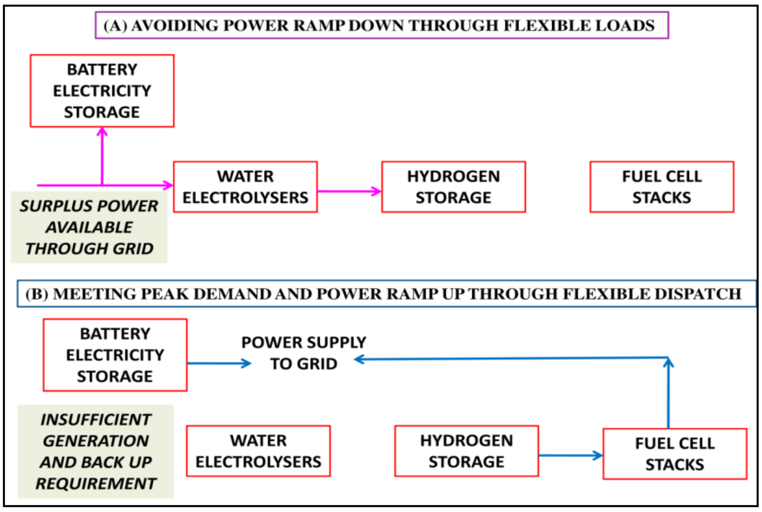

**Fig. 1:** Electrochemical energy conversion and storage systems for enabling demand responsive operation of a nuclear reactor

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**EIHE 2025: CP 5**

# An Assessment of Fuel Cell Performance- Network Theory and Matrix Method Approach

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## Abstract:

The latest research in fuel cell technology (FCT) and hydrogen-based solutionsis progressing rapidly and systematically due to the global push (especially in developed countries) for cleaner energy. In 2024, the fuel cell market is projected to reach \$6.6 billion, with a significant annual growth rate of 29.2% and expected to further expand to \$17.32 billion, by the end of 2028. Over 8,000 research publications and 25,000 patents were filed in the last year alone in this research area. With about 4330 companies involved globally and over 644,000 individuals employed in the sector, the industry is poised for continued growth, supported by both public and private investments. Recent data indicates significant progress in the efficiency, reliability, and maintainability of fuel cell performance. Fuel cell system alone can achieve efficiency up to 60%. In combined cycle mode it can even surpass 85% when accounting for heat recovery. Proton exchange membrane (PEM) fuel cells have weight-to-power ratio typically around 2 to 3 kW/kg and ongoing research aims to achieve it closer to 5 kW/kg to compete with traditional internal combustion engines. The current, with SOFCs usually have a weight-to-power ratio of around 1 to 2 kW/kg. The research focuses on creating more durable and efficient materials for fuel cells, such as new electrocatalysts and membranes, to improve longevity and efficiency while reducing the need for costly precious metals like platinum. Efforts are also being made to make hydrogen production more sustainable and cost-effective, exploring green hydrogen technologies and using machine learning techniques to enhance design and manufacturing processes. Additionally, research is focused on improving the long-term durability of fuel cell stacks, particularly for high-temperature PEM fuel cells, and evaluating system performance under different operating conditions. In the present work, an effort is made to develop a methodology based on network theory and matrix method along with stanine to evaluate the performance of a fuel cell. Fuzzy Logic, Likert Scale, Delphi Method, Analytic Hierarchy Process (AHP), Expert Elicitation, Ordinal Scales, Semantic Differential, Quality Function Deployment (QFD), Bayesian Belief Networks, Pairwise Comparison, Nominal Group Technique (NGT), Q-Methodology, Guttman Scale (Cumulative Scaling), Kansei Engineering are some of the qualitative quantification methods are approaches that enable the translation of qualitative insights (such as observations, descriptions, or expert opinions) into quantitative metrics. In the present work network analysis is used for qualitative analysis. The fuel cell system (FCS) is divided into four interdependent subsystems, and numerous interdependent parameters affect these subsystems. The developed methodology includes steps such as digraphicalillustration, systematic matrix development, and permanent function depiction. A performance index is a numerical value created by quantitatively evaluating a mathematical model, and the proposed method is explained with an illustration. The index values calculated with the mentioned methodology for the best and worst scenarios range from 2533470 to 1261870. A computer program developed in C++ with some modifications is used to calculate the index worth. Real-life situations will fall between these two extreme values.

EIHE 2025: CP 6

# One-Pot Synthesis of the bimetallic chalcogenideswith highly Conducting Carbon Nanotubes for Hybrid Supercapacitor

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## Abstract:

Due to the high energy demand today world supercapacitors play a significant role and fill the gap between batteries andcapacitors in terms of power density and energy density. So, an electrochemical cost-effective Hybrid supercapacitor has been developed by employing bimetallic $CuNiSe_2$ with highly conducting carbon nanotubes.CNT/$CuNiSe_2$ was created by a simple in-situ approach with the mixing of the $NaBH_4$, $Na_2Se_2O_3$& functionalized CNts in an inert atmosphere followed by the addition of the Cu and Ni salt in one pot and stirring for 2 hr. at 90°C. The hybrid composite was characterized by XRD, SEM, HRTEM &IR and fabricated by drop-cast on the glassy carbon electrode and exhibited a good redox couple peak in cyclic voltammetry in the region -0.2-0.65 V vs. Hg/HgO. The specific capacitance of the electrode showed 801.68 F/g at 1A/g in galvanostatic charge and discharge analysis (GCD). The hybrid supercapacitor exhibits maximum energy density of 62.62 Wh. $Kg^{-1}$ and maximum power density with 11.11 kW $kg^{-1}$.

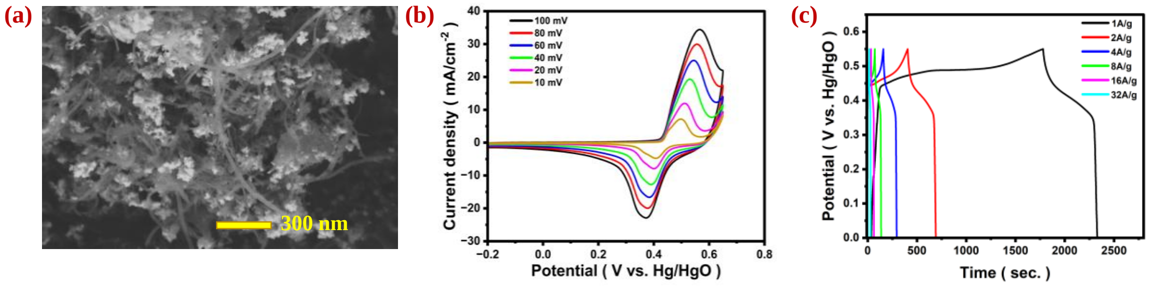

Figure-1 (a) SEM image of CNT-$CuNiSe_2$ composite. (b) CVs and (c) GCD curve of the nanocomposite as working electrode recorded in 6M KOH solution.

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EIHE 2025: CP 7

# Fine scalloped petal-like $Co_3O_4$ for electro-oxidation of glucose

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## Abstract :

A simple hydrothermal synthesis of petal like cobalt oxide is presented as part of our attempt to improve the characteristic properties of the novel structured metal oxide for its responsive behaviour towards glucose in electrochemical non-enzymatic glucose sensing. The structure and morphology of the synthesized material was characterized by powder X-ray diffraction, thermogravimetric analysis, scanning electron microscopy and transmission electron microscopy. The cyclic voltammetry and chronoamperometry measurements showed good sensitivity of 732 $\mu A\ mM^{-1}\ cm^{-2}$, linear range within 5.1 mM , detection limit of 2.0 μM and a quick response time of 7 s under a wide dynamic concentration range of glucose during the sensing studies.[1-4] The novel $Co_3O_4$ electrode material showed strong catalytic activity towards glucose and is a promising platform for glucose oxidation and sensitive detection of glucose moieties with potential applications in clinical diagnosis and healthcare monitoring.

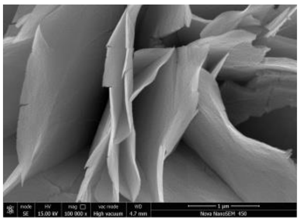

*Fig. 1 Scalloped petal-like $Co_3O_4$*

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**EIHE 2025: CP 8**

# Atomically dispersed Cobalt Single Atom as an Efficient Bifunctional Oxygen Electrocatalyst

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## Abstract:

The overexploitation of reserved natural fuels driven by the urge of ever-increasing energy demand eventually causes severe emission of greenhouse gases leading to environmental pollution along with scarcity of fuel.Definitely, in near future "sustainable energy", which heavily relies onfuel cell and water electrolyzer technologies consider as the saviour of the modern society.However, large scale application of these technologies mainly hindered by sluggish $4e^-$ transfer electrochemical oxygen conversion reaction by oxygen evolution reaction (OER)and oxygen reduction reaction (ORR). As a result, exploration of a highly efficient and cost effective electrocatalyst with long lifespan is urgently required to address these issues. Meantime, single-atom electrocatalysts (SACs) came into limelight owing to their monodisperse metal atoms and utilization of maximal metal centers which often outperform their respective metal cluster based counterparts. Herein, we have fabricated highly dense cobalt atoms disperse on N-rich carbonaceous matrix (Co-NGC) by a hazardless way, polymerization reaction followed by thermal annealing process. Optimized Co-NGC showed impressive performance towards ORR ($E_{onset}$ =1.03 V, $E_{1/2}$ = 0.9V) and OER ($E_{onset}$ =1.6V) with benefits of long 24h sustainability in alkaline electrolyte. Henceforth, our proposed work offers a facile and cost effective way to develop a bifunctional oxygen electrocatalyst.

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**EIHE 2025: CP 9**

# Interfacing Transition Dichalcogenide and Metal Oxide Layered Nanomaterials for Symmetric Supercapacitor Applications

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## Abstract:

Two-dimensional (2D) nanomaterials have garnered significant attention in energy storage applications due to their unique physical and chemical properties. Among these, tungsten diselenide ($WSe_2$) and nickel oxide (NiO) are promising candidates for supercapacitor applications owing to high surface area of $WSe_2$ and galvanostatic stability of NiO. $WSe_2$is a member of the transition metal dichalcogenides (TMDs) family, which exhibitsunique electrical, optical, and catalytic properties. It has a layered structure similar to graphene, which allows for efficient ion intercalation and charge storage.NiO is a widely studied metal oxide known for its high theoretical capacitance and good electrochemical performance. It can enhance the pseudocapacitive behavior of supercapacitors. Combining$WSe_2$ with NiO leverages the advantages of both materials, resulting in a composite with superior electrochemical properties. The synergy between $WSe_2$ and NiO can lead to improved capacitance, stability over 1500 cycles, and higher charge/discharge rates.In this study, the engineering of $WSe_2$/NiO composites have the specific capacitance value of 822 F/g at 1A/g, energy density of 103 Wh/Kg and power density of 905 W/Kg. This valuerepresents a significant advancement in the field of energy storage and also their superior electrochemical properties make them ideal candidates for supercapacitors.

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**EIHE 2025: CP 10**

# MoS$_2$ quantum dots decorated MWCNTs-based electrochemical sensor for dopamine in the presence of uric acid and ascorbic acid and integration with machine learning

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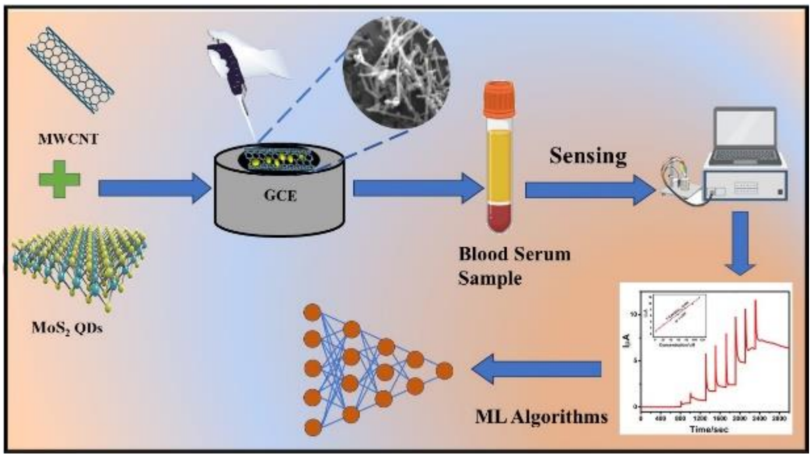
## Abstract:

Dopamine (DA) is a crucial neurotransmitter that plays a significant role in diagnosing, preventing, and treating neurological diseases associated with its levels in various brain functions, including mood, motivation, and motor control. Herein, a novel electrochemical sensing platform based on combining molybdenum disulfide quantum dots (MSQD) with multi-walled carbon nanotubes (MWCNTs) is developed to detect DA in human blood sera samples.The MSQDs were synthesized using the high-shear exfoliation method. The linearity of the newly developed MWCNT/MSQD sensor detectsDA in the presence of ascorbic acid (50 µmol.L$^{-1}$) and uric acid (200 µmol.L$^{-1}$) and the results were also implemented using machine learning (ML) algorithms. The sensor exhibits linearity from 2 µmol.L$^{-1}$ to 966 µmol.L$^{-1}$ of DA, with a sensitivity of 0.097 µA.µmol$^{-1}$.Land a low LOD of 0.6 µmol.L$^{-1}$(S/N=3).Furthermore, the characteristics of sensitivity and selectivity of the sensor were analyzed using chronoamperometry. Furthermore, the average recovery percentage of DA from human blood sera samples is in the range of 100-104 indicating the promising analytical application of the MWCNT/MSQD sensor.The ML algorithms support the discerning and quantifying of DA in the presence of coexisting interferents encountered in biological matrices.



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**EIHE 2025: CP 11**

# Post-synthetic modifications enabled Zinc-Cobalt-MOF derivatives as efficient electrocatalysts for water-splitting

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## Abstract:

Electrocatalytic splitting of water to generatehydrogen through intermittent energy sources presents a lucrative alternative to the problems of greenhouse gas emissions and energy shortage in the future due to its zero-carbon emissions and high gravimetric energy density of hydrogen. However, the large-scale adoption of the technology is hampered by the lack of low cost, sustainable, and effective electrocatalysts that can replace the state-of-the-art electrocatalysts like Pt for hydrogen evolution reaction (HER) at the cathode and $RuO_2$/ $IrO_2$ for oxygen evolution reaction (OER) at the anode. Consequently, designing advanced functional materials with suitable physicochemical properties is crucial for developing sustainable bifunctional electrocatalysts, especially in alkaline media. The present work explores the development of a bimetallic Zn-Co-MOF grown directly on carbon fiber paper (Zn-Co-MOF/CFP) and its post-synthetic modifications (PSMs) for obtaining highly efficient electrocatalysts. The PSM,not only,enhances the surface morphology, but also introduces heteroatoms into the framework skeleton of the parent MOF.Zn-Co-MOF/CFP after the PSM can be further annealed in different gas atmospheres with precursors to convert into corresponding metal phosphides or nitrides thus tuning their electronic properties. Consequently,the developednanomaterialsdemonstrate low overpotentials at high-current density and long-term stability, indicating their effectiveness for electrocatalytic water-splitting.

EIHE 2025: CP 12

# Next-Generation Zinc-Sulfur Batteries: Enhanced Stability and Efficiency with Innovative Cathode and Electrolyte Design

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## Abstract:

Several critical issues, including unstable discharge products, slow cathode reactions, expansion of the sulfur cathode, limited interaction with the electrolyte, and the insulating nature of sulfur and zinc sulfide have hindered the development of high-performance Zinc-sulfur batteries (ZSBs). In this study, a sulfur-functionalized mesoporous silica (SMPS) was synthesized using the sol-gel method in an acidic medium. Functionalized silica was extensively characterized by FT-IR, TGA, SEM, XRD, SAXS, and XPS. SMPS was utilized as the cathode material for a zinc-sulfur battery, with a novel gel electrolyte system (SP-127 gels) based on amphiphilic block copolymer and $ZnSO_4$ solution. The gel electrolyte was prepared by varying polymer concentrations (10-35%), with the SP-20 gel offering the best performance in terms of conductivity and stability.The zinc-sulfur battery demonstrated promising electrochemical performance. A specific discharge capacity of 892mAh $g^{-1}$ was achieved at 50 mA $g^{-1}$. Over 1000 charge-discharge cycles, the battery exhibited excellent stability, with a consistent coulombic efficiency near 99%.Furthermore, the successful demonstration of powering an LED highlights the practical viability of the system. These findings suggest that the SMPS-zinc battery, coupled with the SP-20 gel electrolyte, offers a stable and efficient platform for next-generation energy storage systems.

EIHE 2025: CP 13

# Eco-friendly Synthesis of Porous Reduced Graphene Oxide-Polypyrrole-Gold Nanoparticles Hybrid Nanocomposite for Electrochemical Detection of Methotrexate Using a Strip Sensor

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## Abstract:

Chemotherapy is a crucial cancer treatment, but its effectiveness requires precise monitoring of drug concentrations in patients.[1] This study introduces an innovative electrochemical strip sensor design to detect and continuously monitor methotrexate (MTX), a key chemotherapeutic drug.[2]The sensor is crafted through an eco-friendly synthesis process that produces porous reduced graphene oxide (PrGO), which is then integrated with gold nanocomposites and polypyrrole (PPy) to boost the performance of a screen-printed carbon electrode (SPCE).[3]The enhanced sensor exhibited a notable increase in the electrochemical oxidation signals of MTX, attributed to the improved electron transfer at the SPCE/PrGO-PPy-Au electrode interface. Electrochemical interfacial properties were characterized with cyclic voltammetry, electrochemical impedance spectroscopy, and square wave voltammetry. The sensor demonstrates an efficient electrochemical response toward detection of MTX with a detection range from 130 nM to 1 µM, an impressively low detection limit of 0.4 nM in human serum, and a sensitivity of 24.1 µAµM□1. The sensor exhibited a long-term continuous monitoring stability response to monitor the MTX drug in human serum for 4 hours. The sensor's high sensitivity, selectivity, reproducibility, and stability over time emphasize its potential as a valuable tool for on-site testing of anticancer drug in clinical and environmental settings.

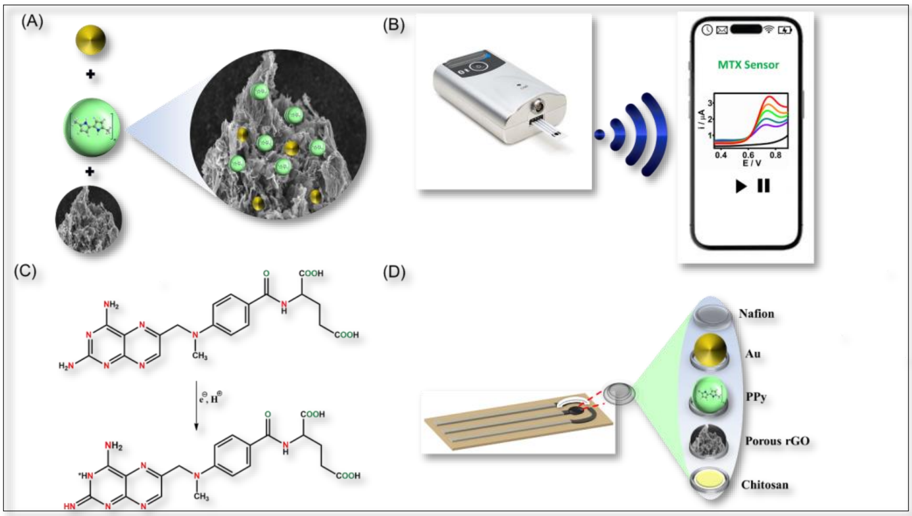

*Figure: Diagrams showing the synthesis and sensing process: **(A)** The PrGO-PPy-Au nanocomposite. **(B)** Recording Voltammograms of Methotrexate with a Bluetooth-Enabled Handheld Potentiostat and Tablet **(C)** Potential electrochemical oxidation of methotrexate. **(D)** Schematic representation of layers of the enhanced SPCE sensor.*

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**EIHE 2025: CP 14**

# Electrodeposition of PDHA with Simultaneous Demethylation resulted in a Quinone-Rich High-Charge Capacity polymer

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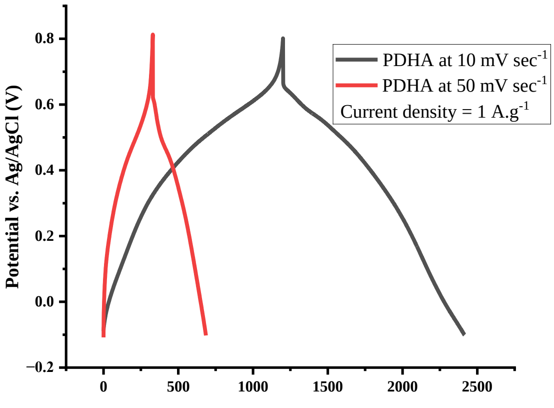
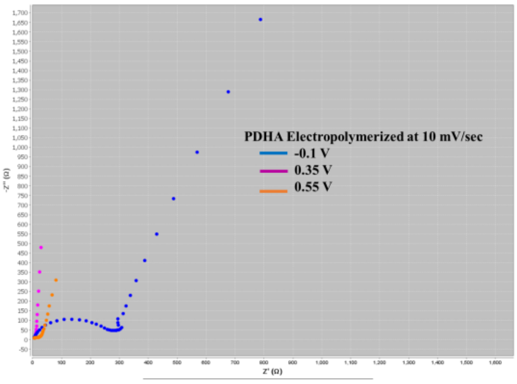
## Abstract:

This paper delves into the electrodeposition of poly 2,5-dihydroxy aniline (PDHA) with simultaneous demethylation of2,5-dimethoxy aniline monomer at various scan rates.[1]PDHA is a polymer comprised of polyaniline molecules as a conducting backbone and a redox-active quinone as a pendant group. During the electropolymerization of PDHA, simultaneous electrochemical demethylation was done. The discharge curve showed that PDHA deposited at 10 mV sec$^{-1}$ has the highest charge capacity of around 227mAhg$^{-1}$ which is 50% of its theoretical energy storage capacity of 443 mAhg$^{-1}$.[2] To explore further electrochemical polymerization and demethylation of the methoxy group, polymerization was done from the lower concentration of monomer at different scan rates 5, 10, 20, and 50 mV sec$^{-1}$. The PDHA was characterized by electrochemical and physicochemical characterizations such as CV, GCD, EIS, FEG-SEM, FTIR, and UV−vis spectroscopic techniques.[1,2]





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EIHE 2025: CP 15

# Harnessing the Distinctive Characteristics of the Transition Metal Chalcogenides for Biosensing and Supercapacitor Applications

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## Abstract

After the discovery of graphene, two-dimensional (2D) nanomaterials have attracted significant attention [1]. In the transition metal dichalcogenides (TMDs) family, molybdenum disulfide ($MoS_2$) and tungsten diselenide($WSe_2$) possessa unique layered structure and large surfaceareas, as well as outstanding physicochemical and optoelectronic properties,which graspthe great potential forapplications in energy storage and biosensing[2, 3]. In the present study. The present study reports,$MoS_2$ QDs with multi-walled carbon nanotubes (MWCNTs) to detect of dopamine in human blood sera samples while $WSe_2$-NiO heterostructures for the supercapacitor applications. The linearity of the newly developed MWCNT/MSQD sensor detectsDA in the presence of ascorbic acid (50 μmol.$L^{-1}$) and uric acid (200 μmol.$L^{-1}$) and the results were also implemented using machine learning (ML) algorithms. The sensor exhibits linearity from 2 μmol.$L^{-1}$ to 966 μmol.$L^{-1}$ of DA, with a sensitivity of 0.097 μA.μ$mol^{-1}$.Land a low LOD of 0.6 μmol.$L^{-1}$(S/N=3).The engineered $WSe_2$/NiO composites have a specific capacitance value of 822 F/g at 1A/g, energy density of 103 Wh/Kg, and power density of 905 W/Kg. The outcomes derived from these two case studies indicate a significant advancement in the biosensing and energy storage capabilities attributed to the TMDs.

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**EIHE 2025: CP 17**

# FDTD Simulation of Evanescent Wave Based SERS Substratefor the Detection of Electrochemical Intermediates

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## Abstract:

Understanding electrochemical intermediate events is crucial for elucidating reaction mechanisms. Surface-enhanced Raman spectroscopy (SERS) is frequently employed to study these intermediates due to its significant signal enhancement capabilities. However, photochemical and photo-electrochemical interferences can often distort the information obtained. In this study, we designed and simulated an evanescent wave-based SERS substrate to mitigate these challenges. Utilizing the Finite-Difference Time-Domain (FDTD) method, we developed a plasmonic nano-antenna array with inverted silver (Ag) nano-wells. This design resulted in a 300-fold increase in the electromagnetic (EM) field strength at the resonance angle[1]. The simulations, performed using Ansys Lumerical FDTD, investigated how structural parameters like nano-well diameter, Ag film thickness, and prism height affect the EM field distribution. Results demonstrated substantial enhancement of the EM field near the nano-well rims, which is critical for achieving high sensitivity in SERS. Through systematic fine-tuning of these parameters, we aim to optimize the SERS substrate for detecting electrochemical intermediates across applications in chemistry, biology, and materials science.Further optimization of the substrate and its performance will be discussed during the presentation, along with potential advancements in nano-photonics and sensor technologies.

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EIHE 2025: CP 18

# Electrochemical quantification of 2, 4-dinitrophenol employing a modified glassy carbon electrode with Zinc sulphide nanoparticles-calix-4-arene-reduced graphene oxide

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## Abstract:

The selective and sensitive detection of 2, 4-dinitrophenol was achieved by developing a glassy carbon electrode (GCE) using zinc sulphide nanoparticles/calix-4-arene/reduced graphene oxide. The ZnS nanoparticles were synthesized and then various analytical techniques like UV-Visible spectroscopy, X-ray diffraction (XRD), FT-IR, transmission electron microscopy (TEM), high-resolution transmission electron microscopy (HR-TEM) were used to characterize them. Selected area electron diffraction (SAED) pattern were taken to confirm the purity and morphology of the synthesized nanoparticles. The surface of the glassy carbon electrode was electrochemically modified with the rGO and calix-4-arene and the electrode fabrication steps were monitored and confirmed by using Cyclic Voltammetry (CV) studies. The electrochemical sensing of 2, 4-dinitrophenol has been done using Cyclic Voltammetry (CV) and Differential Pulse Voltammetry (DPV). The results showed that the peak current is linear with increasing concentration in the range of 1 to 23 µM (with a correlation coefficient of 0.999) and shows a very low detection limit of 13.9 nM (s/n =3). This developed sensor gives good reproducibility and high sensitivity towards 2, 4-dinitrophenol and have anti-interference properties and long-term stability. The real sample analysis results indicated that this sensor electrode is reliable, effective and efficient for the detection of 2,4-DNP in river water sample.

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# Polymer Mediated Selective Oxidation of Hydroquinone Induced Self Charging in Aqueous Rechargeable Zn-Quinhydrone Batteries

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## Abstract:

In the realm of energy technologies, self-charging batteries are gaining significant attention. However, current technologies are highly dependent on available oxygen sources, have lengthy self-charging times, and involve complex designs. This study introduces a novel ultrafast chemical self-charging Zn-quinhydrone polymer gel (QPG) battery, utilizing acid/base-free quinhydrone as the cathode material. The developed Zn–QPG battery demonstrates a specific capacity of 209.7 mAh $g^{-1}$ at a 10C rate and retains 86.4% of its initial discharge capacity after 3000 cycles, with a high coulombic efficiency of 99.4%. The chemical self-charging is driven by the selective oxidation of hydroquinone (HQ) to benzoquinone (BQ) via an aqueous amphiphilic block copolymer, enabling the device to reach approximately 1.1 V within ten minutes after full discharge. This self-charging process produces a high specific capacity of 197.8 mAh $g^{-1}$ at 10C, with 91.2% capacity retention over 100 cycles. Additionally, a flexible Zn–QPG battery demonstrates excellent rechargeability and power delivery capabilities, even under wrist-bend conditions. This work opens new possibilities for ultrafast energy storage systems that do not require external power sources and expands the scope of aqueous zinc-organic batteries.

**EIHE 2025: CP 20**

# Mo Incorporated Bimetallic Metal Organic Framework for Electrochemical Detection of Hydrogen Peroxide

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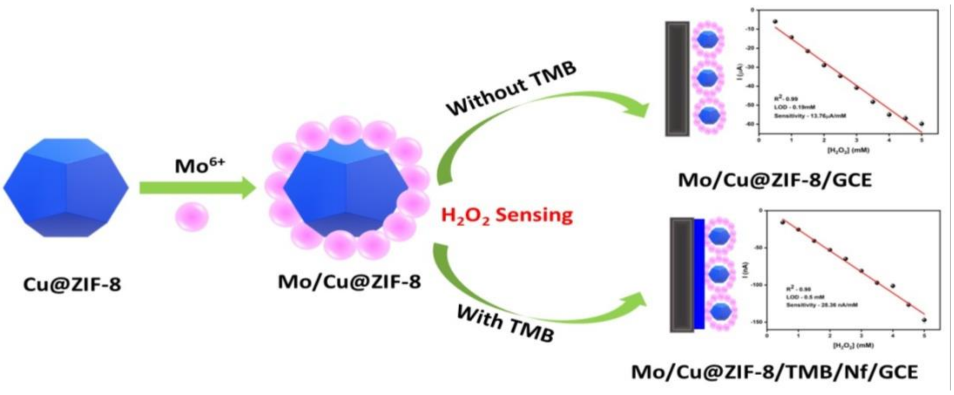
## Abstract:

In this work, peroxidase enzyme mimicking activity of Mo incorporated Cu@ZIF-8is investigatedand co-catalytic effect of Mo on the electrochemical detection of hydrogen peroxidase using this biomimicsystem is demonstrated.Initially, bimetallic metal organic framework (MOF) namely, Cu@ZIF-8 is synthesized and further modified by incorporating Mo ions into its framework. The effect of introduction of Mo on the peroxidase mimicking activity is evaluated using electrochemical methods. Moreover, a chromogenic substrate, tetramethyl benzidine (TMB) is also introduced to shuttle the electron transfer reaction across the modified interface and its role on modulating the electron transfer rate subsequently the performance of sensor is also investigated. Basically, two different modified electrodes namely, Mo/Cu@ZIF-8/GCE and Mo/Cu@ZIF-8/TMB/Nf/GCE, prepared in the absence and presence of TMB are studied for the selective detection of hydrogen peroxide. Among the two, Mo/Cu@ZIF-8/GCE showed a limit of detection (LOD) value of 0.19 Mm with sensitivity of 13.76µA mM$^{-1}$ and Michaelis-Menten constant ($K_M$) value of 0.019 M at an applied potential of -0.4V in PBS (pH-7.2), whereas Mo/Cu@ZIF-8/TMB/Nf/GCE exhibited LOD value of 0.5 mM with sensitivity 28.36 Na Mm$^{-1}$ and $K_M$ value of 0.013 M at an applied potential of -0.2V in PBS (pH-7.2). Here, the successful immobilization of TMB on the electrode surface resulted in 0.2 V positive gain in the overpotential value and enhancing the affinity of peroxide towards the enzyme-mimic system by displaying a lower $K_M$value. Thus, Mo/Cu@ZIF-8 is found to possess a good peroxidase mimicking behavior and demonstrated the utility of such biomimic material for the electrochemical detection of $H_2O_2$.



**Scheme 1:** Pictorial representation of the preparation of Mo incorporated Cu@ZIF-8 and its electrochemical detection of peroxide carried out in the presence and absence of TMB.

EIHE 2025: CP 21

# Electrochemical detection of dopamine using NiCo layered double hydroxide and polypyrrole modified glassy carbon electrode

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## Abstract:

A novel selective electrochemical sensor was fabricated for the determination of dopamine (DA) using a glassy carbon electrode modified with polypyrrole and NiCo-layered double hydroxide(LDH). The modified sensor was characterized by cyclic voltammetry (CV) and electrochemical impedance spectroscopy. UV-vis, FT-IR, high-resolution transmission electron microscopy, selected area electron diffraction pattern, SEM, and X-ray diffraction analysis confirmed the formation of highly pure NiCo-LDH. The electrochemical activity of modified GCE towards DA oxidation was studied using CV whereas differential pulse voltammetry was used for the quantitative determination of DA. The NiCo-LDH/ppy/GCE showed a better electrochemical response towards the detection of dopamine (DA). Under the optimized conditions, the anodic peak current displayed a good linear relationship to concentration in the range of 1-100 µM with a very low detection limit of 2.50 nM.

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EIHE 2025: CP 22

# Environmentally benign Hierarchical Porous Carbon (eHPC) supported Nickel-Cobalt Selenides

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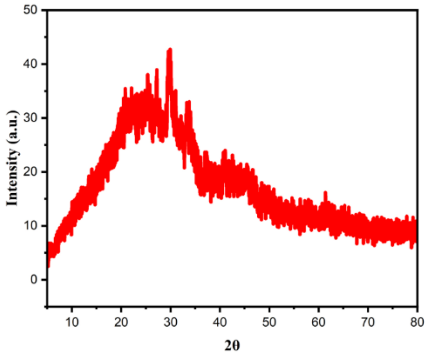
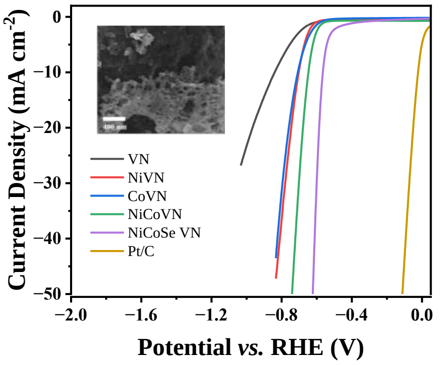
## Abstract:

Energy plays an integral role inenhancing the quality of life. But approximately 2 out of 10 people in the world still live without access to electricity [1]. To meet energy demands, the consumption of fossil fuels is rising, however, it has resulted in severe environmental pollution, particularly the excessive accumulation of carbon in the atmosphere, causing global warming [2]. Thus, the generation of energy with zero carbon emissions, addressing both energy demand and environmental issues, is a vital need of the hour [3].In this context, water electrolyzers, can solve the problem, thanks to their ubiquity, high energy current density,and zero emission of harmful byproducts [4]. To address the sluggish kinetics of water electrocatalysis, it is also essential to produce carbon materials featuring superior porous structures, graphitic configurations, and suitable heteroatom and transition metal doping through effective methodologies.We have successfully synthesized environmentally benign hierarchically porous, graphitic, and heteroatom-doped carbon (eHPC) from the leaves of a medicinal plant which is widely distributed in subtropical regions. This eHPC was doped with a bimetallic selenide, consisting of Nickel and Cobalt. The synthesized electrocatalyst demonstrated commendable performance in overall water splitting processes, HER and OER catalysis with a high current density, low overpotential and Tafel slope.These results suggest a concept of exploring more such biomass-derived carbon materials that could induce the efficient electrocatalytic water splitting for sustainable energy conversion.





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EIHE 2025: CP 23

# Synthesis, Performance analysis, and Investigation of $NdBaCo_2O_{5+\delta}$ as an advanced oxygen electrode material for reversible solid oxide fuel cells.

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## Abstract:

The reversible solid oxide fuel cells (RSOFC) can operate in electrolyzer and power generation modes. To have better durability and cell performance, an efficient material should be developed. The $NdBaCo_2O_{5+\delta}$ oxygen electrode shows lower delamination in the hydrogen, oxygen, and water atmosphere when compared to the other conventional oxygen electrode materials [1]. Recently, double perovskites such as $LnBaCo_2O_{5+\delta}$ (Ln= Nd, Pr, Sm) have been developed as promising oxygen electrode materials for proton-conducting ceramic fuel cells owing to their better cell performance [1]. In the present work, the double perovskite oxygen electrode has been utilized for oxygen ion conducting electrolyte 8 mol percent yttria-stabilized zirconia (8YSZ). $NdBaCo_2O_{5+\delta}$(NBCO) has been synthesized using the combustion synthesis method, and the cell was fabricated with a Fuel electrode (Nickel oxide – 8YSZ), Electrolyte (8YSZ), and Oxygen electrode (NBCO) with a thickness of 23.06 µm, 529.9µm, and 20.12 µm respectively. The prepared cell was studied systematically for its Electrochemical performance. The power density achieved was 73.5 mW $cm^{-2}$ and 48 mW $cm^{-2}$ at 845°C and 789°C, respectively. The ohmic resistance of the cell decreases with temperature, and it is 3.004 $\Omega cm^2$, 2.744 $\Omega cm^2$, 2.852 $\Omega cm^2$ at 775°C, 794, and 840°C, the same trend was observed for the polarization resistance as well. A $Gd_{0.1}Ce_{0.9}O_{1.95}$ (GDC) interlayer was introduced along with the $NdBaCo_2O_{5+\delta}$ oxygen electrode to decrease the interfacial resistance of the electrode-electrolyte interface. It is expected that the interface can match the Thermal Expansion Coefficient (TEC) and reduce the delamination issue. Based on the encouraging results reported on NBCO for proton-conducting fuel cells, [2,5] the oxygen ion conducting fuel cells with double perovskite Electrode are expected to have improved performance. The preliminary results show that the maximum current density, at 0.57V, is 135 mA $cm^{-2}$ at 789°C. The cell microstructure, after cell testing, showed an intact electrode-electrolyte interface without any kind of delamination issues.

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**EIHE 2025: CP 25**

# Development of Bismuth and Lithium Co-doped GDC Electrolyte based Solid Oxide Fuel Cell

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## Abstract:

Electrolyte material is a crucial component of Solid Oxide Fuel Cells (SOFC). Developing an electrolyte material with excellent ionic conductivity and negligible electronic conductivity without any chemical or physical interaction with the porous electrodes is the main challenge. Consequently, the selection of the electrolyte influences the SOFC operating temperature as well as the cell performance. An co-doped (Gd, Li and Bi) cerium oxide electrolyte with the chemical formula $Ce_{0.8(1-x-y)}Gd_{0.2(1-x-y)}Li_xBi_yO_{[1.9(1-x-y)+x/2+3y/2]}$ (x = 0.02 or 0.03 and y = 0.03 or 0.02 and x + y = 0.05) (CGLBO) was synthesized by solution combustion method and characterized by particle size analysis, X-ray diffractometry and field emission scanning electron microscopy (FE-SEM). The microstructural and electrochemical investigations of the sintered electrolyte were carried out. The ions were well distributed into the lattice and formed a complex network of defects that can trap the oxygen vacancies, and the mobile ions promoted ionic transport. As compared to gadolinia-doped ceria (GDC) or bi-doped CGO systems (BiCGO and LiCGO), the Bi and Li-doped GDC showed an improvement in the total conductivity of $0.5\times10^{-3}$ -$0.33\times10^{-1}$ S $cm^{-1}$ in the temperature range of 400–700 °C where the maximum value was $0.33\times10^{-1}$ S $cm^{-1}$ at 700 °C. A button cell SOFC was fabricated with the developed $Gd_{0.76}Ce_{0.19}Li_{0.03}Bi_{0.02}O_{1.85}$ (CGLBO) electrolyte, and its performance is compared with a button cell fabricated from the conventional 8YSZ electrolyte. The ohmic resistance was found to be lower for the cell with CGLBO electrolyte.

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EIHE 2025: CP 26

# Utilization of Tertiary SAM for Enhanced Detection of Chikungunya E1 Protein in an Electrochemical Aptasensor

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## Abstract:

The development of sensitive, specific, and rapid diagnostic tools for chikungunya virus (CHIKV) is essential for timely detection and outbreak control. In this study, we present an electrochemical aptasensor designed to detect the CHIKV E1 protein, utilizing a tertiary self-assembled monolayer that incorporates hexane dithiol (HDT) co-immobilized with a thiolated capture probe (SHCP) on gold PCB (printed circuit board) electrode surfaces, followed by the incorporation of 6-mercapto-1-hexanol (MCH). A thiol-functionalized aptamer serves as the biorecognition element, immobilized onto the gold surface via the SAM. The affinity of this thiol-functionalized aptamer is assessed through electrochemical methods and Quartz Crystal Microbalance-Dissipation (QCM-D), while the protein and aptamer interaction are analysed by using Circular Dichroism (CD) spectroscopy.

The PCB electrode provides advantages such as low cost, scalability, and high conductivity, making it well-suited for point-of-care diagnostics. The detection mechanism is based on square wave voltammetry, where the binding of the CHIKV E1 protein to the aptamer results in measurable changes in the electrochemical signal. Surface characterization of the electrode is performed using FTIR technique. Hexamine ruthenium chloride redox couple was used to assess the binding of CHIKV E1 protein to the aptamer. Solutions with various concentrations of CHIKV E1 protein were analysed, and the results show that the aptasensor can be used to detect the concentration of CHIKV E1 protein.

**Key words:** Electrochemical aptasensor, CHIKV E1 protein, PCB electrode, Square Wave Voltammetry.

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EIHE 2025: CP 27

# Mechanistic Pathways of Electrochemical Carbon Dioxide Reduction on Silver

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## Abstract:

The electrochemical reduction of carbon dioxide to value-added chemicals and fuels provides a platform to utilize $CO_2$. Metal electrodes in aqueous electrolytes are widely used for this reduction process. Noble metals such as gold and silver are highly active and selective electrocatalysts to produce CO. In the present work, the electrochemical $CO_2$ reduction using silver in aqueous electrolyte is studied with more emphasis on its reaction mechanism. The main advantage of this process is that the primary byproducts, CO and $H_2$, can be easily separated from the electrolyte. The resulting mixture, called synthesis gas, can be transformed into fuels like methanol, dimethyl ether, or a combination of hydrocarbons. CO is produced on the silver electrode surfaces via a few adsorbed species; $CO_{2ads}^{-}$, $COOH_{ads}$ and $CO_{ads}$. The experiment involves chronoamperometric studies using a three-electrode setup, with Pt mesh as a counter electrode and Ag/AgCl (3.5M KCl) as a reference electrode. 0.1M $KHCO_3$ is used as the electrolyte. The gaseous products are quantified using a gas chromatograph and faradic efficiencies at different potentials are evaluated. The resulting data are used to get insights into the reaction pathway, the competition between $CO_2$reduction and hydrogen evolution reaction, and mass transport effects.

**Keywords:** Electrochemical $CO_2$ reduction, CO, Silver electrode, Mechanistic analysis

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**EIHE 2025: CP 28**

# Prussian Blue Anchored Carbon black forCancer Biomarker Detection

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## Abstract:

Quantification of cancer biomarkers assists early cancer diagnosis, improves the survival rate and decreases the economic burden of the patients [1, 2]. In view of this, Prussian blue anchored carbon black (PB-CB) was synthesized and used as a probe for electrochemical detection of prostate specific antigen (PSA), a prostate cancer biomarker. PB-CB was characterized by XRD, FTIR, UV Vis spectroscopy, FESEM analysis and confirmed the presence of PB on CB surface [3, 4]. Electrochemical sandwich biosensor was constructed with polyaniline as sensing matrix and PSA antibody modified PB-CB as detection probe. Differential pulse voltammetry (DPV) was carried out for sensors, where the DPV current increased linearly with concentration of PSA in physiological concentration range. Sensor displayed good sensitivity, selectivity, stability and reproducibility. Due to the redox property of PB-CB, addition of mediator, substrate and enzyme were avoided in the proposed biosensor. Real blood serum was tested with proposed sensor and the values are consistent with the values obtained by conventional ELISA approach.

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EIHE 2025: CP 29

# Supporting Role of Galvanostatically Deposited Bi Nanoparticles as the Substrate for Photoelectrochemical Application of Bi-W-Oxide-based Photoanode

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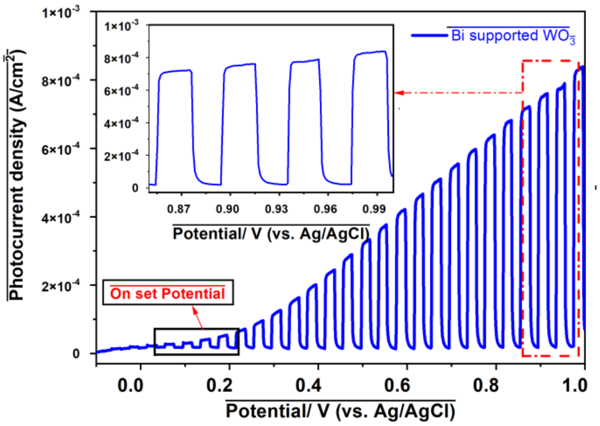
## Abstract:

Solar energy is the most enchanting renewable successor for fossil fuels because it is adequate, inexhaustible, and widely distributed. However, due to the diffuse and intermittent nature of solar irradiation, energy harvested from the sun must be efficiently converted into chemical fuels that are storable, transportable, and usable upon demand [1]. This requirement has motivated the development of sustainable artificial photosynthetic processes, with the aim of mimicking natural photosynthesis to generate fuels from water and carbon dioxide utilizing solar energy. Tungsten-based oxides are enchanting materials due to their paramount characteristics, such as palpable small band gap energy with suitable band edge position & less prone to photo corrosion in different media inclusion with the low hole diffusion length [2]. This work describes the photoelectrochemical and electrode/ electrolyte interfacial behaviour of photoelectrode fabricated via drop-casted W-based thin film over the pre-electrodeposited Bi nano-particles onto the FTO substrate. The reflection spectrum measures the band gap of the semiconductors, which is 2.8 eV and 2.6 eV for pure and electrodeposited bi-supported thin film. The prepared Bi-supported semiconductor films exhibit significant photoelectrochemical activity and long-term durability regarding oxygen evolution reaction from water ($H_2O \rightarrow O_2$). The highest photo-current of 850 μA/cm$^2$ at an applied bias of +1.0 V vs. Ag/AgCl under the illumination of 100 mW/cm$^2$, which is more than 4.0 fold compared to the pure tungsten oxide (200 μA/cm$^2$) thin-film under similar condition. Electrochemical impedance spectroscopy was carried out to study the electrolyte/electrode interfacial charge transfer kinetics and the nature of the semiconductor. The smaller semicircle obtained in Nyquist analysis confirms the better charge transfer resistance for modified thin film over the pure matrix. The positive slope of the Mott-Schottky plot revealed the n-type semi-conductivity of both pure and Bi-supported thin films.



**Acknowledgment:** D.R. gratefully acknowledges the Department of Chemistry, Indian Institute of Engineering Science & Technology, (IIEST), Shibpur, for the financial support.

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**EIHE 2025: CP 30**

# Enhanced Photoelectrochemical Performance of Indium Doped Wurtzite Zinc Oxide Thin Films for Water Splitting Applications

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## Abstract:

Photoelectrochemical (PEC) water splitting technology enables solar energy conversion into green fuels as hydrogen and oxygen gas by utilizing sunlight and specialized semiconductors known as photoelectrochemical technologies [1]. Developing suitable materials is crucial for creating efficient and viable PEC systems. Among the various materials explored, zinc oxide (ZnO), have gained significant interest towards PEC water oxidation due to its non-toxic, high abundance, environmental friendliness, cheap synthetic methods, better photosensitivity and n-type semiconductor with direct band-gap energy of ~3.25 eV along with its unique physical and chemical properties [2]. It has a wide range of applications in quantum dot-sensitized solar cells, as a photoanode in PEC devices and degradation of organic pollutants [3]. The present report describes the drop-cast synthesis of wurtzite zinc oxide thin films with hexagonal structure and its modification through the addition of an optimized amount of the neutral surfactant, triton-X – 100 (TX-100) and later by incorporation of Indium. XRD, SEM, UV-vis absorbance spectra were employed to study their structural, morphological and optical properties, whereas the electrochemical impedance and linear sweep voltammetry were carried out to evaluate their efficacy towards photoelectrochemical water splitting applications. Although the pure ZnO film exhibits the water photocurrent of ~ 40 µA/cm$^2$ under UV-vis illumination, the indium doped ZnO thin films with 3% TX-100 modified sample shows more than four times enhancement in the PEC performance.

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## EIHE 2025: CP 31

# Study of Stacked Layer Formation of BiVO4 and C3N4 for Photoelectrochemical Water Splitting

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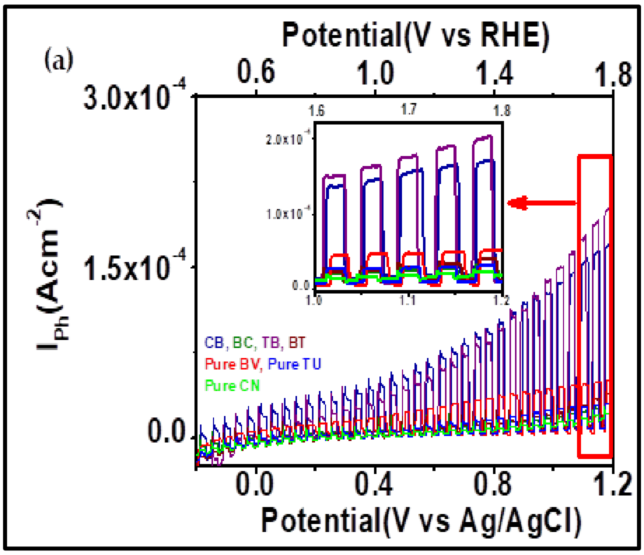
## Abstract:

The photoelectrochemical (PEC) water-splitting process is a solar-driven reaction where water molecules split into hydrogen and oxygen molecules. The hydrogen generated can be stored and used as green fuels for future energy crisis demands. In 1972, Fujishima and Honda first conducted the water-splitting reaction with $TiO_2$ semiconductor [1]. Various metal oxides have gained attention in terms of PEC water splitting afterward. $BiVO_4$ is one of the most promising photocatalysts and a best-fit candidate for the PEC water-splitting reaction[2]. Monoclinic Bismuth Vanadate ($BiVO_4$) has a suitable band gap of 2.45 eV for visible light absorption. This semiconductor is also non-toxic and cheap. In this study, a simple drop-casting technique has been implemented. $BiVO_4$ has been modified using graphitic carbon nitride (g-$C_3N_4$).

Thiourea was also used as a carbon nitride precursor to enhance the PEC performance of pristine $BiVO_4$. There have been different substrate variations BT (Thiourea over $BiVO_4$), TB ($BiVO_4$ over Thiourea), CB ($BiVO_4$ over g- $C_3N_4$), BC (g- $C_3N_4$ over $BiVO_4$). The front illumination of all the substrates has been studied along with other EIS analyses, Mott-Schottky, and DRS analyses. The sample TB showed the maximum photocurrent in the water oxidation process, generating0.19 mA $cm^{-2}$.



**Acknowledgment:** Mr. Aditya Poddar gratefully acknowledges the financial support of the Department of Chemistry, Indian Institute of Engineering Science & Technology (IIEST), Shibpur.

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EIHE 2025: CP 32

# Effect of Dopants & Co-Catalyst in Enhancement of Photoelectrochemical Applications for Microwave-assisted Synthesis of $BiVO_4$ Semiconductor

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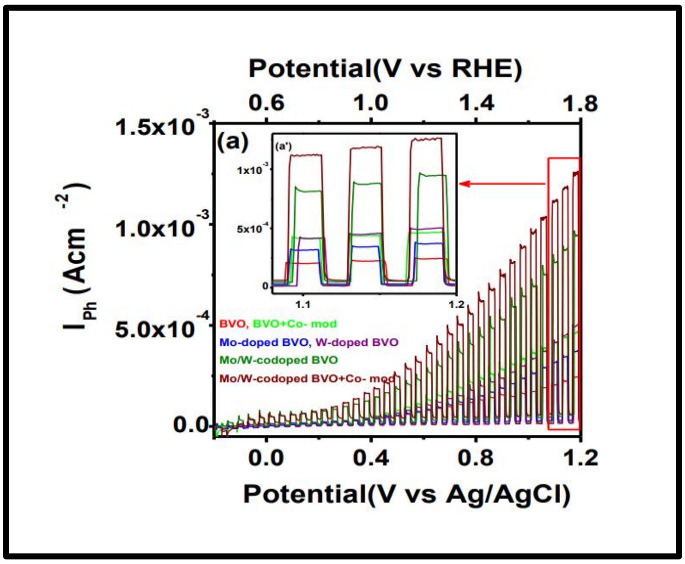
## Abstract:

Pure $BiVO_4$, an n-type semiconductor with excellent chemical and photostability, having band gap energy of ~2.4 eV, is a potential candidate for solar energy harvesting, but it suffers from slower water oxidation reaction kinetics and poor electron mobility. The PEC performance of $BiVO_4$ (BVO) can be enhanced by doping with metals (Mo, W, etc.). Microwave synthesis offers several advantages over other photocatalyst synthesis methods, such as a swift rise in temperature, shorter reaction time, highly controllable and energy efficient process, requirement of minimum amounts of solvents, etc. The simple microwave synthesis in the presence of UV light of Mo-doped, W-doped, and Mo/W-co-doped BVO for enhancing the PEC activity of the photocatalyst is reported. The Mo/W-co-doped BVO exhibits the best PEC performance among the prepared photocatalysts at optimized conditions, i.e., temperature (T) 100ºC, power (P) 300 W, time (t) 15 min and exposure of UV light for 2 min achieves maximum photocurrent of ~0.9 mA $cm^{-2}$ vs. Ag/AgCl in water oxidation reaction. The addition of an optimized amount of oxygen evolution catalysts, i.e., Co (II), over the $BiVO_4$ surface boosts the PEC performance of the photocatalyst. The catalytic property improves by ~75% with minimum charge transfer resistance towards water oxidation reaction. The dual modification strategy, i.e., metal doping and adsorption of OEC materials with BiVO4 surface strikingly improves the performance, in towards oxygen evolution reaction and Co (II) modified Mo/W-co-doped $BiVO_4$ had exhibited the maximum photocurrent, 1.2 mA $cm^{-2}$, during the photoelectrochemical water oxidation reaction.



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## EIHE 2025: CP 33

# Augmentation in corrosion inhibition efficiency in gram-negative bacterial strains influenced the adsorption of plantextract at the interphase of copper metal and a mild corrosive environment

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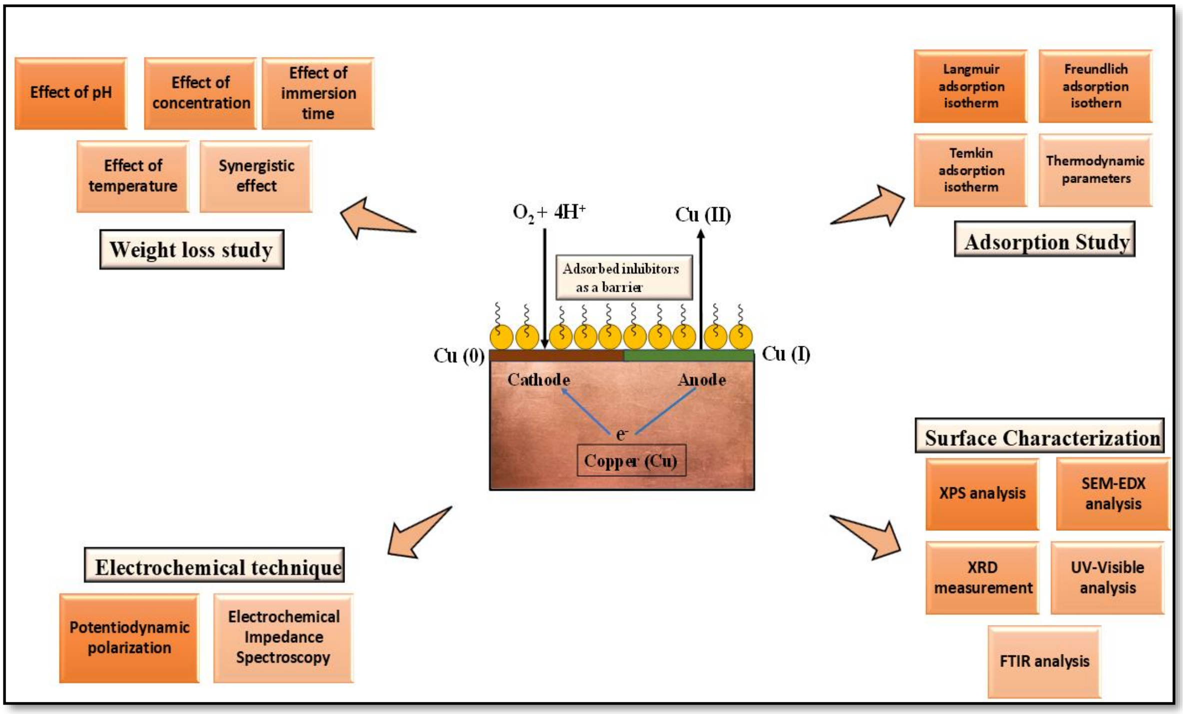
## Abstract:

In the present study corrosion inhibition efficiency of plantextract, bacterial strainsand collaboration of plant wasteextract with bacterial strains on copper sheets in different acidic solutions of pH 5.5 and at three different temperatures were investigated. The weight loss and electrochemical measurements were employed to evaluate the inhibitors' corrosion rate and inhibition efficiencies. For, alteration in the surface morphology on the test samples, Fourier Transform Infra-Red spectroscopy, UV visible spectroscopy, Scanning Electron Microscope, X-ray diffraction, Energy Dispersive X-ray and X-ray Photoelectron Spectroscopy were employed. In collaboration with bacterial strain, plant extract shows excellent inhibition efficiency among the inhibitors. Weight loss studies at 300 K demonstrate that, the corrosion rate significantly decreased to 11.90 % with the highest inhibition efficiency of 88.09%. Potentiodynamic Polarization, and Electrochemical Impedance Spectroscopy techniques show corrosion current density significantly decreased from 29.260 μA/cm$^2$ to 4.356 μA/cm$^2$ for the solution containing 500 μL of plant extract along with bacterial strain. The synergistic parameter, $S_\Theta$ indicatesthat the inhibitors do not interact mutually. $\Delta G^\circ_{ads}$ values suggested the physisorption of inhibitors on the test sample that supports Langmuir adsorption isotherm. XPS spectra support the presence of heteroatoms as Cu-N and Cu-S formed on the surface.



**EIHE 2025: CP 34**

# Novel ZeoliticTetrazole Framework (ZTF-8) Based MOF as Corrosion Inhibitor for X65 Steel in CO2 Saturated Brine: Experimental and Conceptualization of Molecules–Surface Bonding viaMachine learning

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## Abstract:

Recently, there has been an increase in worry over metal corrosion which affects both industrial and local production. This has necessitated the emergence of nanomaterial based corrosion inhibitors. Herein, we report for the first time the mechanochemical synthesis of ZeoliticTetrazole Framework (ZTF-8) and its application as anticorrosion agent for sweet corrosion. The ZTF-8 product was characterized using professional analytical methods. The inhibition efficiency was further evaluated using combine electrochemical and surface probe approaches. The outcome of the electrochemical studies revealed a decline in the corrosion current densities of the inhibited curves compared to the blank curve. The observed shift in corrosion potential was within ± 85mV compared to the blank system, thus suggesting a mixed-type inhibition mechanism. Maximum inhibition efficiency of 94 % at 0.1_ZTF-8 was achieved which reflects on the radius of the inhibited semicircles compared to the blank. The molecules-surface bonding interaction ZTF-8 was appraised using multi-level quantum chemical computation. The ZTF-8 exhibited a flat adsorption orientation. The flat adsorption orientation was confirmed using surface probe approaches *via* FESEM, AFM and XPS analysis. All surface related observation prove the presence of ZTF-8 barrier film layer on the X65 steel, thus impeding the ingress of the corrodent.

EIHE 2025: CP 35

# Improved Electrochemical Reduction of $CO_2$ to Syn gas with Highly Exfoliated $Ti_3C_2T_x$MXene-Gold Composite

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## Abstract:

Transforming carbon dioxide ($CO_2$) into valuable chemicals through electroreduction offers a sustainable and effective solution to address the excess $CO_2$ in the atmosphere. This report presents new insights into the development of a titanium-based MXene composite designed as a catalyst for the efficient conversion of $CO_2$ in a safe, aqueous medium. Although the composite exhibits excellent electrocatalytic activity for $CO_2$ reduction and high selectivity for CO production, its large-scale application is hindered by the high cost of gold and a decrease in catalytic efficiency on a larger scale. In this study, we successfully synthesized an $Au/Ti_3C_2T_x$ composite and evaluated its catalytic performance in the electrochemical $CO_2$ reduction reaction (ECRR). The synthesized composite shows strong interactions between gold atoms and the MXene support, facilitated by the formation of metal-oxygen/carbon bonds. The $Au/Ti_3C_2T_x$ electrode achieved a notable current density of 17.3 mA $cm^{-2}$ at a potential of -0.42 V vs. RHE in a $CO_2$-saturated environment, with a Faradaic efficiency of 48.3% for CO and 25.6% for $H_2$. Nyquist plots revealed a reduction in charge-transfer resistance within the $Au/Ti_3C_2T_x$ layer, indicating efficient charge transfer between the gold and MXene. Additionally, the crossover of liquid through the Gas Diffusion Electrode (GDE) was shown to significantly enhance $CO_2$ diffusion to the active sites of the catalyst, thereby improving $CO_2$ conversion efficiency. The aim of this research is to engineer an interface between metal and MXene that enables the selective electroreduction of $CO_2$ into fuels and other valuable chemical compounds.

**Keywords:** MXene, electrochemical $CO_2$ reduction, Gas Diffusion Electrode

## References:

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# Impact of Carbonization Temperature on the Structural and Electrochemical Properties of $LiFePO_4$/Soft Carbon Composites for High-Performance Lithium-Ion Batteries

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## Abstract:

In this study, $LiFePO_4$ (LFP) was synthesized using a hydrothermal process and composited with soft carbon carbonized at different temperatures (1000°C, 1300°C, 1400°C). The physical and electrochemical performance of these LFP/C composites was investigated for potential battery applications. To study the physical property X-ray diffraction (XRD) to analyze the crystal structure, scanning electron microscopy (SEM) to observe particle morphology, and Brunauer-Emmett-Teller (BET) surface area measurements to assess porosity and surface area were taken. For electrochemical performance, cyclic voltammetry (CV), galvanostatic charge/discharge tests, and electrochemical impedance spectroscopy (EIS) were employed. CV analyzed redox behavior, galvanostatic tests assessed specific capacity and cycling stability, while EIS provided insights into charge transfer resistance and impedance. Higher carbonization temperatures improve both physical and electrochemical properties, enhancing conductivity, crystallinity, and overall battery performance. This study emphasizes the importance of optimizing carbonization temperature in electrode material synthesis for lithium-ion batteries.

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**EIHE 2025: CP 37**

# Synthesis and Electrochemical Characterization of Single-Crystal P2-Type Layered Oxides for Sodium-IonBatteries

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## Abstract:

Sodium-ion batteries (SIBs) are emerging as a promising alternative to lithium-ion batteries for electric vehicles, offering benefits such as cost-effectiveness and abundant material resources. To meet the increasing demands for high energy density and long cycle life in electric vehicles, the development of advanced cathode materials is crucial. In this work, single-crystal P2-type layered oxide cathodes are synthesized using a solution combustion method. These P2-type materials are considered one of the most promising candidates for next-generation sodium-ion battery cathodes due to their high capacity and structural stability. The structural and morphological characterizations of prepared sample were done by XRD, Raman, FE-SEM, and HR-TEM (EDX). The electrochemical performance of electrode materials has been performed by cyclic voltammetry (CV), and Galvanostatic charge and discharge (GCD), and Electrochemical impedance spectrum analysis.

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5. J.-M. Tarascon, Nat. Chem., 2010, 2, 510.

EIHE 2025: CP 38

# Exploring peanut shell-derived Hard Carbon as a High-Performance Anode Material for Sodium-Ion Batteries

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**Abstract:**

The Biomass derived Hard Carbon with the advantage of Green, Sustainable, eco-friendly and High reversible capacity has received much attention and it is a most promising anode material for Sodium ion Batteries. The Peanut Shell derived Hard Carbon (PDHC) is synthesized by Hydrothermal Pre-treatment Technique and Carbonized at different Temperature. The obtained samples were characterised by XRD. Morphology(SEM, XRD, RAMAN) and Structural characterization have proved by the hydrothermal pretreatment has a great influence on morphology transformation, thelayer spacing, as well as the defect concentration which can enhance the adsorption sites of Na+ and shorten thetransport route of sodium ions.The electrochemical characterization was employed byCyclic voltammetry(CV), Galvanostatic charge/discharge (GCD) and Electrochemical Impedance Spectroscopy (EIS). This Study highlights the potential of Biomass derived Hard carbon as an anode material for Sodium ion Batteries.

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EIHE 2025: CP 39

# Synthesis and Electrochemical characteristics of $SnO_2$ /GO nanocompositeas anode for lithium-ion battery

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## Abstract:

In recent times, $SnO_2$ has emerged as a highly promising electrode for the anode material of lithium-ion batteries (LIBs). However, its low electrical conductivity and significant volume effect restrict its wide range of applications. Graphene oxide GO is composited with $SnO_2$ nanoparticles using a wet chemical approach. Structure analysis using X-ray diffraction (XRD) reveals the tetragonal rutile structure of $SnO_2$. In addition, X-ray photoelectron spectroscopy (XPS) and Raman detection provide evidence of the presence of $SnO_2$ along with GO. Scanning electron microscopy (SEM) and Transmission Electron Microscopy (TEM) demonstrate the shape of $SnO_2$ and $SnO_2$@GO. The electrochemical performance of the prepared electrode was investigated using a series of Cyclic Voltammetry (CV), Galvanostatic charge-discharge (GCD)and Electrochemical impedance Spectroscopy (EIS). A pristine $SnO_2$ material exhibits a coulombic efficiency of 92% and the composite material $SnO_2$@graphene oxide(GO)shows a remarkable coulombic efficiency of 98%. This study demonstrates the impact of graphene oxide (GO) composition on the $SnO_{2.}$ The stable electrode structure of the $SnO_2$@GO nanocomposite anode improves cycling stability. Due to its good specific capacity and cycling stability, our electrode material is a promising anode material for rechargeable Li-ion batteries.

**Keywords:** $SnO_2$, graphene oxide, Lithium-ion battery.

## References:

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## Graphical abstract :

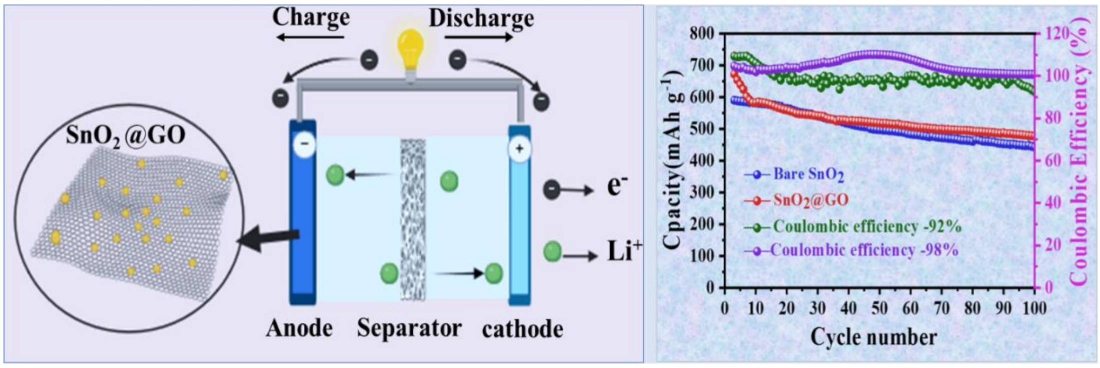

**Figure 1.** Graphical representation for $SnO_2$@GO anode material for lithium-ion Batteries exhibit superior cycling stability and rate capability.

## EIHE 2025: CP 40

# AGreen Solvent-free Approach for Rational Designing of NiFe-Layered Double Hydroxide [NiFe-LDH] Electrocatalyst for Efficient Water Splitting

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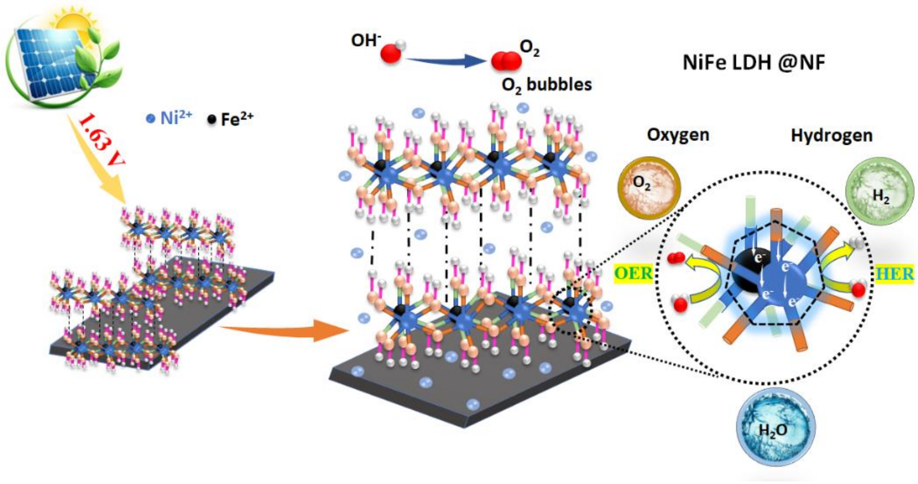
## Abstract:

Creating cost-effective, chemically stable electrocatalysts to improve the hydrogen evolution reaction (HER) and oxygen evolution reaction (OER) remains a major challenge in electrocatalytic water splitting. We have synthesized a highly efficient NiFe-layered double hydroxide (LDH) electrocatalyst using a solvent-free method. The formation of well-interconnected metal ions with nano-spherical architectures created an extensive electrochemical active surface area enriched with catalytic active sites, demonstrating synergistic effects. Preserving the suitable stoichiometric ratio, such as $Ni_6Fe_4$LDH, was crucial in enhancing catalytic performance for both the HER and OER. The optimal $Ni_6Fe_4$-LDH ratio established overpotentials of 167 mV (112 mV $dec^{-1}$) for HER and 280 mV (116 mV $dec^{-1}$) for OER, attaining a 10mA $cm^{-2}$ current density in 1 M KOH. Moreover, $Ni_6Fe_4$LDH demonstrated impressive robustness, stable up to 90 h with a minor decrease of 4.1% and 4.6 % in current density for HER and OER. Notably, in the bifunctional two-electrode arrangement of $Ni_6Fe_4$LDH/NF||$Ni_6Fe_4$LDH/NF, effective water electrolysis was accomplished, preserving a stable 10 mA $cm^{-2}$ at a bias of 1.64 V for over 140 hours, with a slight current loss of 3.9% of current density.



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EIHE 2025: CP 41

# Conversion of medical waste to medical sensor: Probingthe electrochemical activity of 1T SnS2-MXene heterostructure for the stress biomarker detection

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## Abstract:

Steadfast approaches have been made to develop layered 2D materials-based electrodes for various biosensor applications. In this study,an electrochemical sensor was designed by employing 1T $SnS_2$–$Nb_2CT_x$ heterostructure-modified carbon yarn (CY) electrode for detecting serotonin (5-HT) in biological fluids. The nano hexagonal morphology of 1T-$SnS_2$ provides a heterojunction with $Nb_2CT_x$enabling a conductive electron transfer network, leading to enhanced electrochemical response and improved sensing capabilities. An elaborative study was conducted to elucidate the mechanism behind the heterostructure formation with the help of ultraviolet photoelectron spectroscopy (UPS) analysis. The developed 1T $SnS_2$–$Nb_2CT_x$ nanocomposite-based electrochemical sensor demonstrated a wide detection range of 1 to 100 µM for 5-HT, with a limit of detection value of 81 nM. The sensor measured 5-HT levels in human serum, cerebrospinal fluid, interstitial fluid, and human sweat samples, confirming its practical applicationin real sample analysis. Finally, a “lab on a syringe” prototype model was fabricated by placing thread electrodes on a commonly available syringe barrel and validated.To sum up, we came up with the idea of recycling medical waste materials for fabricating the next generation "point of care (POC)" devices for the real-time monitoring of biomarkers.

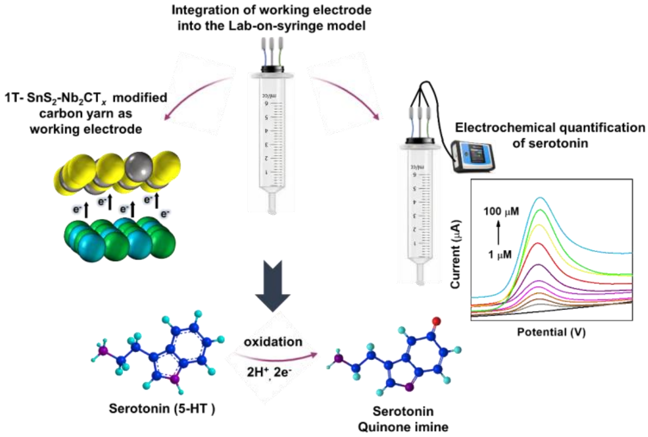

Figure 1: Schematic representation of1T $SnS_2$–$Nb_2CT_x$ heterostructure-modified carbon yarn integrated “lab on a syringe” model and its serotonin sensing application.

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EIHE 2025: CP 42

# Liquid/Liquid Interface Assisted Synthesis of α-Cobalt Hydroxides and its Application in Electrochemical Detection of Ascorbic Acid

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## Abstract:

An interface is an efficient soft-template for the controlled synthesis of nanostructures with distinct morphologies. It can offer a unique quasi-2D interface with higher surface energy for precursor assembly to start the nucleation process, which then spurs intermediate growth to build the desired final structure. The air/liquid, air/solid, liquid/liquid, and liquid/solid interfaces are frequently used for the fabrication of various innovative materials. Among these, synthesis employing a liquid/liquid interface offers a scalable way to create hybrid materials. Here we synthesized α-cobalt hydroxide using an n-butanol/water system. The controlled alteration of the solvent ratio leads to a distinct difference in the crystal nucleation and the morphology of the final product. The formation of a non-aggregated flower structure with an increased active surface area and least charge transfer resistance at the electrode-electrolyte interface was exhibited by the CH samples generated at the interface of a 1:1 solvent ratio (BW2). Inspired by its superior properties, BW2 has been employed for electrochemical sensing applications with minimal addition of conductive multi-walled carbon nanotubes (MWCNTs) The CH/MWCNT composite displayed exceptional performance in detecting ascorbic acid (AA) with a limit of detection (LOD) of 0.32 µM.

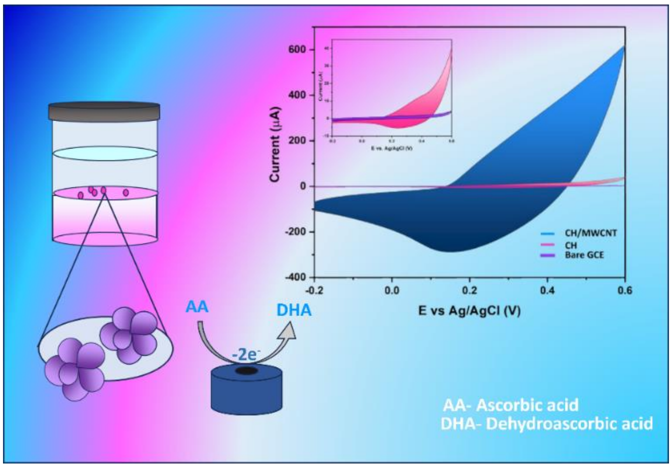

Figure: Schematics of liquid/liquid interface assisted synthesis of α-cobalt hydroxide for electrochemical ascorbic acid detection.

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EIHE 2025: CP 43

# $Ti_3C_2$MXene Modified Screen Printed Electrode for Diagnosis of Cirrhosis Using Whole Blood

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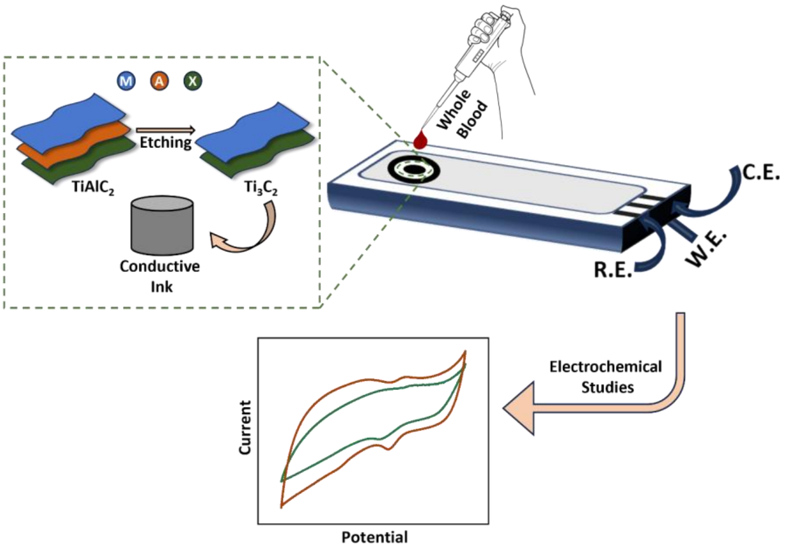
## Abstract:

Cirrhosis is a chronic liver disease condition that is one of the leading causes of human mortality. The early diagnosis of cirrhosis is crucial for effective treatment, as many cases remain unidentified in their early stages, leading to an underestimation of the disease's severity.The conventional method for Cirrhosis diagnosisusing whole blood includes techniques such as High-Performance Liquid Chromatography (HPLC), Enzyme-Linked Immunosorbent Assay (ELISA), and other immunoassay techniques present few limitations such as intricacy and time consumption. Recent studies on electrochemical biosensors offer a more practical approach characterized by their affordability, compact size, and ease of use. Screen-printed electrodes (SPEs) used for measuring electrochemical sensing have made significant advancements, surpassing traditional electrodes in terms of surface area, longevity, disposabilityand detection capabilities. The sensing element in the working electrode of the SPE,plays a vital role in determining the sensitivity and selectivity of the biosensor. This work presents a novel approach utilizing $Ti_3C_2$ MXene, a 2D metal carbide as a working electrode in the SPEs for the detection of cirrhosis using alpha fetoprotein (AFP) as a biomarker.Levels of AFP are elevated in cirrhotic samples when compared to normal samples. It can be detected using $Ti_3C_2$ MXenesmodified working electrode in the SPE, which has good conductivity, hydrophilicityand favourable surface functional groups.The performance of the electrode in the presence of blood plasma of cirrhosis patients compared to normal was evaluated based on Cyclic Voltammetry, Chronoamperometry, and Electrochemical Impedance Spectroscopic methods.



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EIHE 2025: CP 44

# NiCo-LDH nanocages, a powerful electrode material for electronanalysis of silver ions

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**Abstract:**

Cholera, typhoid fever and dysentery are waterborne diseases usually caused by inadequate drinking water [1, 2]. Given that these diseases are due to the presence of bacteria in water, various disinfection methods enabling the bacteria eradication during water treatment process are utilized [1, 2]. Because of the good antibacterial properties of silver ions ($Ag^+$), the incorporation of silver nanoparticles (AgNPs) into membrane matrix is one of the most used approaches nowadays, especially in reverse osmosis (RO) water treatment technology [2, 3]. However, the release of $Ag^+$ in water during treatment must be monitored, given that a concentration of $Ag^+$ higher than 0.93 µM in drinking water exposes consumers to serious health risks [4]. The present work is in line with this objective and proposes a cost-effective electrochemical sensor for ultrasensitive detection of $Ag^+$ and their efficient quantification in drinking water. The successful synthesis of nickel cobalt-layered double hydroxide (NiCo-LDH), used as the electrode material in this work was evidenced by XRD, TGA, XPS, FE-SEM and HR-TEM. The prepared sensor (NiCO-LDH/GCE) showed high sensitivity and selectivity towards $Ag^+$. Furthermore, real sampleanalysis highlighted the better sensitivity of the prepared sensor compared to AAS, revealing the great potential of NiCo-LDH /GCE for real life applications.

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## EIHE 2025: CP 45

# Nickel phthalocyanine modified sensor for the electrochemical detection of 2-amino adenine in the urine sample

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## Abstract:

2-amino adenine is a derivative of pyridine used as the precursor in synthesizing pharmaceutical compounds, and its derivatives are used in developing drugs that target the central nervous system. 2-amino adenine is not inherently highly toxic, but it is associated with carcinogenic effects in some cases when it is left untreated for a longer time in the pharmaceutical samples. In this study, 2-amino adenine was examined electrochemically using square wave voltammetry (SWV) and Cyclic voltammetry (CV). The electrochemical detection was done using a Nickel phthalocyanine integrated carbon paste electrode. The developed sensor exhibits a highly active surface area with commendable repeatability and reproducibility, able to detect the 2-amino adenine in the urine sample. The modified carbon paste electrode exhibits a lower detection limit at $0.165\times10^{-8}$ M. The accumulation time, scan rate, impact of metal ions, and electrochemical impedance spectroscopy (EIS) were also examined in addition to the pH and concentration variation.

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# Extrinsic Pseudocapacitance of $Ti_3C_2T_x$ MXenes in Divalent Metal-ion Electrolytes after Assembly with Perylenediimide

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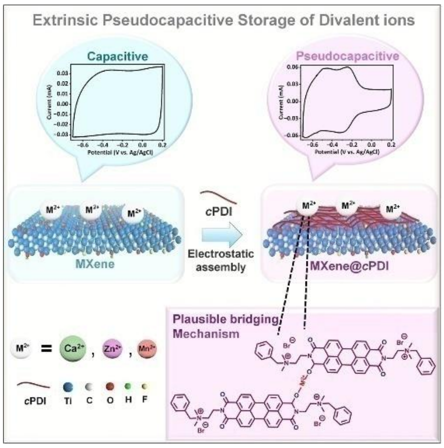
## Abstract:

Organic materials are an emerging class of charge hosts for the development of sustainable multivalent metal-ion-based electrochemical energy storage devices in the era of post-lithium-ion batteries. We developed a strategy for spontaneous electrostatic assembly of perylene diimides (PDIs) onto $Ti_3C_2T_x$ MXene via a solution-processable route. Non-covalent interactions are the driving force in the formation of binder-free organic-inorganic hybrid electrodes. Due to the nanoscale distribution of PDIs across $Ti_3C_2T_x$, extrinsic pseudocapacitive characteristics are observed in divalent metalions. $Ti_3C_2T_x$-PDI hybrid electrode demonstrated storage of $Mn^{2+}$, $Zn^{2+}$,and $Ca^{2+}$ with three-fold enhancement in charge storage capacities over pristine $Ti_3C_2T_x$. This research paves the way for developing MXene-organic hybrid structures aimed at creating high-capacity, high-rate multivalent metal-ion storage devices.



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EIHE 2025: CP 47

# Facile co-precipitation synthesis of Cu-Fe PBAs for Excellent Electrocatalytic Activity towards Overall water splitting

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## Abstract:

Hydrogen generation by electrocatalytic water splitting is considered a clean, green, and renewable approach for sustainable energy demands and environmental management. The effective use of earth-abundant transition metal catalysts is cost-effective and limits the usage of noble metal catalysts like $IrO_2$, $RuO_2$, and Pt/C. The Prussian blue analogs (PBAs) are a class of transition metal hexacyanoferrates that can be tailored for specific electrochemical reactions.Both iron and copper are well-proven transition metals for catalytic activities due to their ability to achieve much-pronounced reactant transformations under mild circumstances, as well as their environmental friendliness, cyclability, and long-term stability.At 10 mA cm$^{-2}$ in 1.0 M KOH, the greenly synthesized $Fe_8Cu_2CN$ (PBAs) on NF (Nickel foam) exhibits a small overpotential of 170 mV (148 mVdec$^{-1}$) for HER and 310 mV (130 mVdec$^{-1}$) for OER. $Fe_8Cu_2CN$ displays ultra-stable behavior (150 hours) with a slight current loss of 4.2% for OER (Oxygen Evolution Reaction) and 3.4% for HER (Hydrogen Evolution Reaction), respectively. The interaction of Fe, Cu, and CN (cyanide) enhances the rate of reaction kinetics. The development of a water electrolyzer that delivers 10 mAcm$^{-2}$ at 1.67 V is made possible with the help of the improved bifunctional catalyst $Fe_8Cu_2CN$/NF. The $Fe_8Cu_2CN$/NF//$Fe_8Cu_2CN$/NF exhibit ultra-durability (over 180 h) with a negligible current loss of 5.4%. The improved effectiveness of the synthesized catalyst is demonstrated by the solar-assisted water electrolysis at 1.66 V.These findings suggest that $Fe_8Cu_2CN$/NF//$Fe_8Cu_2CN$/NF can be used to generate large quantities of hydrogen at very affordable prices.

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EIHE 2025: CP 48

# N-doped activated carbon derived from sweet potato for the Electrochemical detection of Bisphenol A in water and soil samples

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## Abstract:

Bisphenol A (BPA) is an endocrine disruptor widely employed in food and beverage packaging, necessitating monitoring due to its potential to leach into food and water sources. In this study, we introduce a straightforward, cost-effective, and highly sensitive electrochemical sensor derived from N-doped activated carbon sweet potato biowaste designed to detect BPA in water, and soil samples. The electrochemical detection of BPA was facilitated by this sensor electrode system, which combines the high surface area properties of optimized catalyst N-doped activated carbon NSC-600 with the enhanced host-guest interaction capability. This detection process was achieved through a diffusion-controlled oxidation reaction, involving an equal number of protons and electrons. With a detection limit of 9.2 nM, the sensor demonstrated a two-step linear response within the ranges of 1.2 µM to 18.0 µM. Additionally, the sensor showed good recovery with real water and soil samples, delivering a repeatable and stable response for one month, with minimal interference from common inorganic and organic species. The proposed electrochemical sensor has the potential to contribute to the development of a simple and cost-effective water quality monitoring system for BPA detection in soil and water sources.

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EIHE 2025: CP 49

# Fabrication of environmentally benign metallosurfactants coatings for biocorrosion resistance

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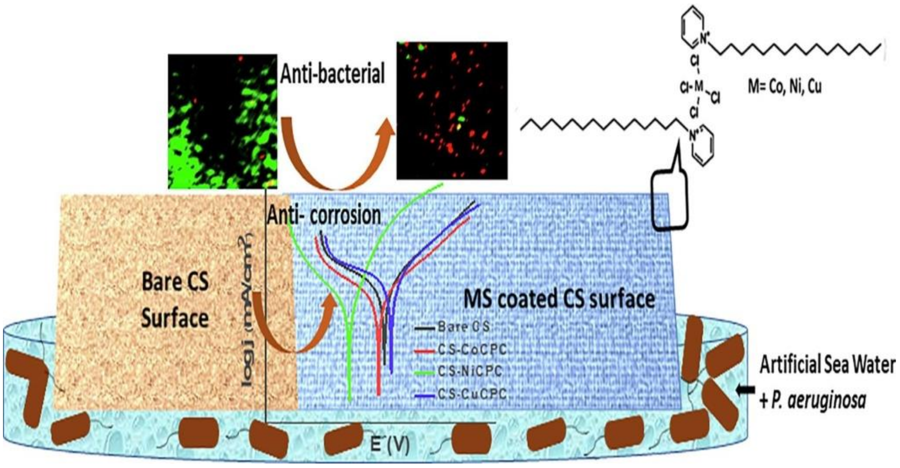
## Abstract:

Biofouling is the biggest issue that impairs success of marine infrastructure. Biofilm forming aerobic bacteria Pseudomonas aeruginosa present in sea water causes considerable environmental and economic losses by initiating microbially induced corrosion[1]. Concerning the importance of biocorrosion inhibition, we are aimed to fabricate non-toxic metallosurfactants (MS) coating on carbon steel to mitigate growth and adhesion of biofilm and consequent corrosive reactions on its surface[2]. As the toxic ion release from fouling-release metallic coatings have deleterious effect on the aquatic eco-system therefore the MS coatings with slow release of metal ions can be a greener approach in this field[3]. Here, we report the surface modification of CS with self-assembly of a series of MS viz. $MC_{42}H_{76}N_2Cl_4$, where M = Co, Ni and Cu. The MS under study is a complex of an anti-corrosive surfactant ligand cetyl pyridinium chloride (CPC) and transition metal salts in a stoichiometry of 2:1 (CPC: M). The corrosion activities of sea water salts and marine bacteria Pseudomonas aeruginosa on bare and modified CS substrates was extensively studied by employing standard electrochemical tests like potentiodynamic polarisation, EIS. The results obtained from various corrosion tests reveal this strategy can be used to develop long term and eco-friendly anti-fouling coatings.



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EIHE 2025: CP 50

# Impedimetric Detection of Pathogenic E. coli O157:H7 Using Green-Synthesized Amino Carbon Nanoparticles

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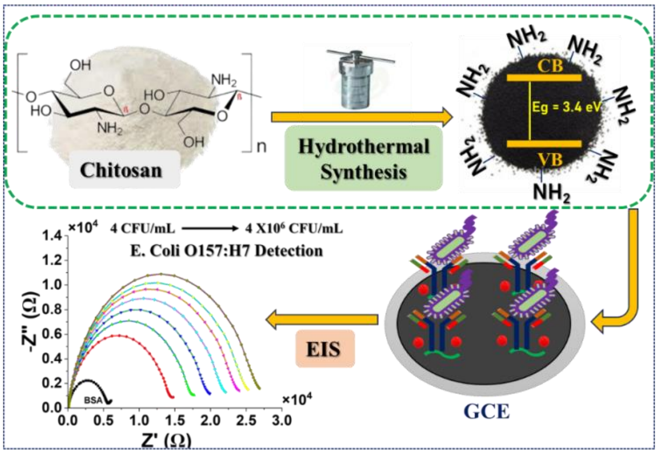
## Abstract:

The global health risk posed by pathogenic contamination of water bodies, especially the extremelylethal*Escherichia coli O157:H7* (*E. coli O157:H7*)[1], underscores the urgent need for enhanced detectionmethods[2]. Traditional approaches like bacterial culture and polymerase chain reaction (PCR) are cumbersome and time-intensive[3]. To overcome these challenges, we propose an electrochemical immunosensor utilizing the semiconductingcarbon dots with amine groups,derived fromnatural polymer chitosan via a green synthesis approach. The prepared carbon nanomaterial was thoroughly characterized using various characterization techniques. The fabricated biosensor exhibits outstanding performance in the precise detection of *E. coli O157:H7*over a wide range of antigen concentrations, utilizing electrochemical impedance spectroscopy (EIS). Additionally, the biosensor excels in real-time analysis of live bacterial samples, achieving an impressive detection limit (LOD) and sensitivity of 0.74 CFU/mL and 5.7 (($\Delta R_{ct}/R_{ct}$)/(CFU/mL))/cm²,respectively. furthermore, the biosensor demonstrates significant selectivity to the target even in the presence of interfering species, enhancing its suitability for real-time application and highlighting its significant potential as a sensor for *E. coli*detection.



Graphical abstract of Impedimetric detection of pathogenic E. coli O157:H7using green-synthesized amino carbon nanoparticles

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EIHE 2025: CP 51

# S-doped Activated Carbon derived from Banana Peel for trace-level detection of Thymol in Water and soil samples

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## Abstract:

Carbon paste electrodes (CPEs) are widely utilized in electroanalytical applications due to their chemical stability, extensive electrochemical window, low capacitive current, straightforward fabrication, and surface renewability. Electro-catalysts can be readily integrated into CPEs, enhancing their suitability for various applications. Ineffective biowaste management poses a significant challenge in the Agroindustry and agriculture, as the rapid decomposition of biowaste-driven by its highwater content and limited biological stability attracts pests and contributes to greenhouse gas emissions. As a result, this organic waste can be repurposed for the development of electrocatalysts. Activated carbon (AC) has been employed in advanced electrochemical applications owing to its high conductivity and porosity, which significantly enhance electrocatalytic activity. In this study, activated carbon derived from banana peels (BPC) is used as the sensing material for determining the pesticide Thymol (THY). The synthesized material was characterized using SEM, FT-IR, XRD, EDX, AFM, CV, and EIS approaches which indicates the developed sensor has effective features concerning structural morphology, topography, bonding nature, and charge transfer conductivity. The fabricated electrode displays the lower detection limit (LOD) with a good linearity range and higher recovery values in the presence of other foreign interferents.

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EIHE 2025: CP 52

# Investigation of Piezochromism Effect of $CoMoO_4$in Electrochemical Performance and $CoMoO_4/CuMoO_4$Nanocomposite's Application in Battery Type or Pseudocapacitors

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## Abstract:

In this study, pure $CoMoO_4$ (COA) was synthesized using a coprecipitation method with constant temperature bath and was subjected to grinding in mortar and pestle during which the colour of the compound was observed to change from purple to green (COB) causing piezochromism. Followed by this $CoMoO_4/CuMoO_4$ composite (COC) was prepared using the same method. The three prepared materials (COA, COB, COC) were characterised using X-ray diffraction (XRD), Fourier transformed IR spectroscopy (FTIR), X-ray photoelectron spectroscopy (XPS), Scanning electron microscopy SEM and Energy dispersive X-ray spectroscopy (EDX). These were done to reveal the crystal structure, functional groups, oxidation states, surface morphology and elemental composition respectively. The working electrodes prepared from the samples were tested for electrochemical performance in a three-electrode system with 1M KOH as electrolyte. The electrochemical examination of the composites was done through the techniques Cyclic voltammetry (CV)to evaluate charge storage capability, Electrochemical impedancespectroscopy (EIS)to study charge transfer resistanceand Galvanostaticcharge-discharge analysis (GCD)to measure specific capacity, energy density and power density. Thus, the Faradaic redox reactions of the sample were examined using CV, EIS and GCD.

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**EIHE 2025: CP 53**

# Differential pulse voltammetry based detection of 4-ethylphenyl sulfate using $MoS_2$ nanosheet@molecularly imprinted polydopamine: A bioinspired approach

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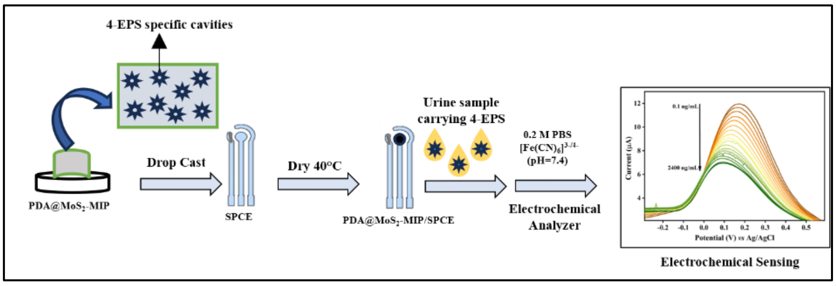
## Abstract

4-ethylphenyl sulfate (4-EPS), a metabolite produced by gut microbiota, is implicated in various diseases, including chronic kidney disease, cardiovascular diseases, and autism. Traditionally, 4-EPS has been detected using chromatographic methods, but these techniques are costly, labour-intensive, and time-consuming. Electrochemical sensors, offering high sensitivity, low detection limits, and fast response times, have emerged as promising alternatives for detecting small molecules like 4-EPS[2,3]. In this study, we developed an electrochemical sensor using differential pulse voltammetry based on polydopamine and $MoS_2$ nanosheets, integrated onto screen-printed carbon electrodes for 4-EPS detection[1]. A molecularly imprinted polymer (MIP) technique was employed to create a specific binding site for 4-EPS within a polymer matrix of polydopamine, reinforced with $MoS_2$ nanosheets. Polydopamine was synthesized via self-polymerization, while $MoS_2$ nanosheets were prepared using a hydrothermal method. This polymer matrix contains molecular cavities uniquely selective for 4-EPS, showing negligible electrochemical response to common interfering molecules in urine, such as urea, uric acid, glucose, and fructose. We also evaluated the recovery percentage of 4-EPS in spiked urine samples from a healthy individual, achieving an acceptable recovery range of 92.44% to 104.81%. Furthermore, the sensor's performance demonstrated a good correlation with results obtained from ultra-performance liquid chromatography-mass spectrometry/mass spectrometry (UPLC-MS/MS).



**Scheme 1:** Electrochemical sensing of 4-EPS using MIP technique

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EIHE 2025: CP 54

# Liquid/Liquid Interface-Assisted Synthesis of PEDOT/$Ag_2SeO_3$ Nanohybrids: A Novel Pathway for Photodegradation of Organic Dyes

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## Abstract:

Liquid-liquid interfacial synthesis presents a more energy-efficient alternative to traditional solid-state reactions due to its lower thermal requirements. This study aimed to utilize this innovative method to synthesize silver selenite ($Ag_2SeO_3$) within a conducting polymer matrix. A hexane/water interface was utilized for the synthesis on a PEDOT support under ambient temperature and pressure conditions. The polymerization of EDOT was initiated by adding concentrated $H_2SO_4$, with the acid concentration significantly influencing both the yield and formation of the nanohybrid. To evaluate this influence, two distinct mole ratios of the nanohybrid were prepared by varying the volume of acid. PXRD analysis confirmed the highly crystalline nature of the nanohybrids, with intense peaks corresponding to crystalline $Ag_2SeO_3$ integrated into the PEDOT matrix. The successful formation of the PEDOT/$Ag_2SeO_3$ nanohybrid was further validated through Raman spectroscopy and FT-IR techniques. Additionally, SEM imaging and elemental composition studies demonstrated the morphology and uniform distribution of nanoparticles within the polymer matrix. The optimized nanohybrid exhibited enhanced photocatalytic activity for the degradation of Rhodamine B (RhB) and Methylene Blue (MB) under incandescent light. This work underscores the potential of liquid-liquid interfacial synthesis in developing nanohybrids for advanced photocatalytic applications.

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EIHE 2025: CP 56

# Evaluating the Efficacy of Co-Precipitation Method for Synthesizing $CuMoO_4$ and $CuMoO_4$/$NiMoO_4$ Nanocomposites:A Comprehensive Study of Their Energy Storage Properties in Supercapacitor Applications

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## Abstract:

$CuMoO_4$ and $CuMoO_4$/$NiMoO_4$ nanocomposite (CNM) functioned as energy storage materials because of their high specific resistance, stability, and pseudocapacitive properties, especially in supercapacitor applications. $CuMoO_4$ and composite were synthesized via the co-precipitation method, a cost-effective method and scalable approach for exact control over particle size and shape. $CuMoO_4$ and composite were reacted under controlled conditions as a part of their synthesis process. $CuMoO_4$ nanoparticles were characterized to study the physical property using X-ray diffraction (XRD) for phase identification, scanning electron microscopy (SEM) for morphological analysis, Fourier-transform infrared spectroscopy(FTIR) for identification of functional groups, UV visible spectroscopy for electronic transitions, X-ray photoelectrons spectroscopy for the determination of elemental composition, vibrating sample magnetometers(VSM) for measurement of magnetic properties, Raman for molecular structure and also we have implied electrochemical studies such as cyclic voltammetry(CV) analyzed for redox behavior, galvanostatic charge/discharge tests(GCD) assessed specific capacity and cycling stability, and electrochemical impedance spectroscopy(EIS) provided insights into charge transfer resistance and impedance. This work demonstrates the effectiveness of the co-precipitation technique in producing desired properties, offering a scalable alternative for practical materials in environmental and energy storage applications.

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EIHE 2025: CP 57

# Bio-Waste-Derived Activated Carbon-Based Sensor for the Electrochemical Analysis of Hesperetin and Co-existing Flavonoids inthe Presence of Triton X-100

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## Abstract:

The feasibility of utilizing dried orange peel, a byproduct from the juice industry, as a cost-effective precursor for producing activated carbon using $H_3PO_4$ as an activating agent was evaluated. The synthesis process involved carbonization followed by chemical activation, aiming to provide an eco-friendly and sustainable approach to managing agricultural waste. The morphology of the carbon sample was analysed usingSEM, while X-ray Diffraction (XRD) was employed to examine the formation of carbon crystallites during the activation process. Applying the prepared activated carbon was investigated for the electrochemical detection of hesperetin; a bioactive flavonoid found in citrus fruits.The sensor exhibited a lower detection limit of 45nM and two linear dynamic ranges of 50 nM-1µM and 1µM-10µMfor hesperetin detection using square wave voltammetry. Minimal interference from co-existing molecules, including flavonoids, makes it suitable for detecting hesperetin in complex biological matrices, including human urine and orange peel extraction, with enhanced recovery rates. The sensor was stable and provided reproducible results, demonstrating all the characteristics of a potential commercial sensor.

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EIHE 2025: CP 58

# Voltammetric Detection of Pesticides Using Modified Pencil Graphite Electrode as a Sensor

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## Abstract

The widespread and extensive use of pesticides in agriculture has raised significant concerns regarding their adverse environmental impacts and associated health risks. Monitoring pesticide residues in environmental samples, such as water and soil, is crucial for public safety. The present study aims to develop, and application of a carbon nanotube (CNT)-modified pencil graphite electrode (PGE) as a sensitive electrochemical sensor for the voltammetric detection of pesticides.The modification of the PGE with CNTs significantly enhances the electrode's surface area, conductivity, and electrocatalytic properties, allowing for improved sensitivity and selectivity in detecting trace amounts of pesticides.The electrochemical performance of the modified electrode has been evaluated using cyclic voltammetry (CV) and differential pulse voltammetry (DPV), focusing on detecting commonly used pesticides. The CNT-modified PGE demonstrated excellent stability, reproducibility, and a low detection limit, making it a promising tool for environmental monitoring.This work highlights the potential of CNT-modified electrodes in pesticide detection, offering a cost-effective and portable solution for environmental analysis.

Keywords: CNTs, Pencil graphite electrode, Pesticides, DPV.

EIHE 2025: CP 59

# Microwave-Assisted Synthesis of Ni-Doped Carbon from Bio-Waste as a cost Effective Electrocatalyst for Effective and Sustainable Water Electrolysis

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## Abstract:

Developing low-cost easily synthesisable electrocatalysts for the oxygen evolution reaction (OER) and hydrogen evolution reaction (HER) is crucial for transitioning from nonrenewable energy sources to hydrogen fuel generation. This study presents a facile and straightforward microwave-assisted method for synthesising nickel-doped carbon derived from bio-waste, aimed at creating an effective electrocatalyst for electrochemical water splitting. The characterisation of synthesised Ni-doped carbon confirms the successful incorporation of nickel into the carbon matrix and the effective bonding of nitrogen to carbon atoms. The electrochemical performance was evaluated in a 1 M KOH electrolyte, revealing overpotential of 280 mV for OER and 180 mV for HER at 10 mA/cm² current density. The full cell potential reached 1.65 V, demonstrating promising performance for practical applications in water splitting. Stability tests conducted via amperometric I-t curves indicated excellent stability, with consistent performance maintained for up to 50 hours. Ni-doped carbon derived from bio-waste is forecasted as a viable and sustainable electrocatalyst for efficient hydrogen production through water splitting. Integrating electrocatalysts with solar energy systems leads to sustainable hydrogen production, enhancing the overall viability of renewable energy technologies.

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EIHE 2025: CP 60

# Enhanced Electrocatalytic Performance of Synthesized $Fe_2O_3$ Incorporated into Nitrogen-Doped Carbon for Sustainable Hydrogen Production via Electrolysis

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## Abstract:

Developing efficient, stable, cost-effective non-noble metal (NNM) catalysts is essential for advancing sustainable hydrogen production technologies via electrolysis. Presently, $Fe_2O_3$@NC (Iron oxide incorporated nitrogen-doped carbon) electrocatalyst is synthesised and investigated for their physical and electrochemical properties. Physical characterisation confirmed the successful incorporation of $Fe_2O_3$ into the nitrogen-doped carbon matrix, leading to enhanced surface area and increased active sites. The $Fe_2O_3$@NC catalyst exhibited remarkable performance, demonstrating the low overpotentials of 302 mV for the oxygen evolution reaction (OER) and 189 mV for the hydrogen evolution reaction (HER) at a current density of 10 mA/cm². The electrode showcased excellent electrocatalytic activity, with small Tafel slopes and outstanding stability. Notably, the turnover frequency (TOF) of $Fe_2O_3$@NC was measured at 0.175 $sec^{-1}$, closely matching the commercial $IrO_2$ catalyst's TOF of 0.173 $sec^{-1}$ at 1.60 V. Electrochemical characterisation revealed that the $Fe_2O_3$@NC catalyst effectively addresses the slow oxidation rate of water, leading to impressive hydrogen and oxygen evolution performance. Furthermore, the sustainability of the water-splitting reaction was evaluated using solar cells operating at 1.57 V, successfully generating $H_2$ at the cathode and $O_2$ at the anode. These findings underscore the potential of the $Fe_2O_3$@NC catalyst in electrolysis applications for renewable hydrogen production.

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EIHE 2025: CP 62

# Voltammetric investigation of antihistamine drug cetirizinedihydrochloride in presence of uric acid using sensitive methyl orange modified pencil graphite electrode

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## Abstract

In the present study, an electrochemical sensor has been developed using methyl orange (MO) reagent, electropolymerized onto a pencil graphite electrode (PGE), for the selectiveand sensitive determination of the antihistamine drug cetirizine dihydrochloride (CTZ). The surface morphology of both the methylorange-modified pencil graphite electrode (PMO/PGE) and the bare pencil graphite electrode (BPGE) were examined through scanning electronmicroscopy (SEM) with energy-dispersive X-ray analysis (EDX). The charge transfer behavior has been analyzed using electrochemical impedance spectroscopy (EIS). The voltammetric behavior of CTZ in the presence of uric acid (UA) has been studied in 0.1M PBS of pH 8.0. Various parameters including the effect of pH, scan rate, concentration, simultaneous and selectivity studies for CTZ, were evaluated using cyclic voltammetry (CV), linear sweep voltammetry (LSV), and differential pulse voltammetry (DPV). The limit of detection (LOD) has been determined through the DPV method across different concentrations (1.0–11.0 μM) yielding a value of $1.56 \times 10^{-8}$ M. The applicability of the proposed sensor was validated through real sample analysis of CTZ, achieving sustainable recovery percentages under optimized conditions.

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**EIHE 2025: CP 63**

# Magnetic molecularly imprinted polymer: A sustainable approach for selective sensing and separation of enrofloxacin

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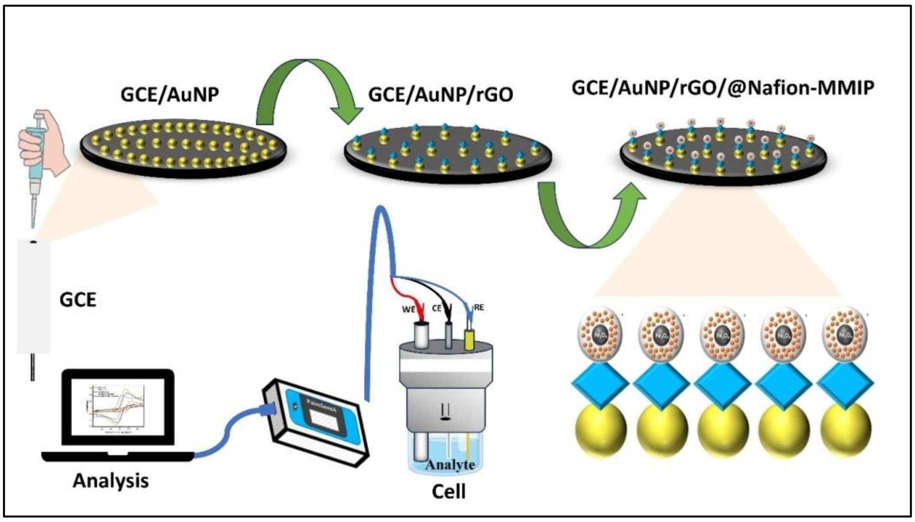
## Abstract:

Enrofloxacin (ENR) is a synthetic fluoroquinolone (FQ) widely utilized as an antibacterial agent in animals. Non-covalent binding of ENR to DNA gyrase/topoisomerase complex IV inhibits DNA replication in bacterial cells[1]. Overuse of ENR causes various adverse health complications like gastrointestinal, nervous, and immune system damage and leakage into the environment which is extremely dangerous for other animals including humans. However, in recent years, overuse of ENR in aquatic animals has become a major concern and exceeded the maximum residual limit of 100μg/kg, which increased the risk of ENR toxicity to humans [2]. Magnetic molecularly imprinted polymer (MMIP) is an emerging material studded with numerous artificial cavities that can be employed as a highly efficient, selective, and sustainable sensing probe, and separation matrices. It opens a plethora of future possibilities for magnetic separation of various target analytes from diverse sources. In this work, we have synthesized MMIP for real-time sensing and separation of ENR in diverse matrices. Synthesized MMIP has been thoroughly characterized both physically and electrochemically. It shows excellent sensing ability with a good detection limit and wide detection range. MMIP can be thus considered as a novel material with effective magnetic separation and specific recognition ability of target analyte.



**Keywords:** Enrofloxacin, Residual limit, Electrochemical sensor, Sustainable, Magnetic separation

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EIHE 2025: CP 64

# Non-Enzymatic Electrochemical Detection of Glucose Using Biowaste-Derived Activated Carbon

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## Abstract:

The study investigated glucose electro-oxidation in an alkaline medium using a modified carbon paste electrode. The modifier used in this study was activated carbon produced from sugarcane bagasse. Sugarcane bagasse activated carbon(SBAC) was produced through a simple, cost-effective, and eco-friendly process involving the carbonization of Sugarcane bagasse at 650 °C with $K_2CO_3$. The produced SBAC characterized using techniques such as Fourier-transform infrared spectroscopy, X-ray diffraction, Scanning electron microscopy, and atomic force microscopy. The SBAC sensor exhibited a high surface area and excellent performance in glucose oxidation, which is evaluated by the parameters including electrochemical impedance spectroscopy, scan rate variation, the effect of temperature, and concentration variations. The impact of halide ions, such as iodide and chloride, on glucose oxidation in alkaline solutions was also studied. The SBAC sensor exhibits a low limit of detection at 8.58 nM. The developed sensor showed high reliability in analyzing human serum, urine, and breast milk samples.

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**EIHE 2025: CP 65**

# Detection of Trichloro Hydroxybenzene Using Copper-Doped Activated Carbon Modified Sensor

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## Abstract:

Pea pods are a major component of agricultural biowaste, rich in cellulose and lignin, making them an excellent carbon source when pyrolyzed. The pyrolyzed pea pods were activated chemically by doping with copper. This was incorporated as a modifier in the carbon paste electrode for the detection of Trichloro hydroxybenzene, which is a chlorinated aromatic compound and a significant environmental contaminant due to its use in pesticides. Its potential toxic effect on humans and the environment underscores the importance of developing technologies to detect this compound at trace levels. The activation process of activated carbon led to an increase in its surface area, thereby increasing the sensor's sensitivity. The performance of the modified electrode was assessed using multiple electrochemical techniques, such as Cyclic Voltammetry, Linear Sweep Voltammetry, and Square Wave Voltammetry. The developed sensor showed reasonable detection limits for Trichlorohydroxybenzene. The developed sensor was further tested for its practical applicability by analyzing spiked real samples, including water, soil, fruit, and vegetable samples. The recovery percentage of the analyte was calculated to evaluate the sensor's accuracy, indicating the sensor's high precision and reliability in detecting Trichlorohydroxybenzene.

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EIHE 2025: CP 66

# Photoelectrochemical evolution of solution-deposited tin-antimony-sulfide thin films for efficient water splitting

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## Abstract:

This study investigates the potential of solution-processed Tin-Antimony-Sulfide (TAS) as a photoelectrode material for water splitting in PEC cells. We synthesized TAS film byspin coatingand annealed at 300ºC temperature for 1 hour in $N_2$ atmosphere, thencharacterized their structural, optical, morphological and photoelectrochemical properties. X-ray diffraction revealed the crystallization of ternary phase $Sn_6Sb_{10}S_{21}$ at 300ºC annealing temperature. Further, surface morphology of annealed TAS film shows the highly porous structure which plays a crucial role in PEC performance. The optical band gaps obtained from the UV-Vis-NIR spectra is 1.38 eV, with absorption coefficients of approximately $10^5$ $cm^1$. This range is optimal for photoelectrochemical water splitting.PEC performance was measured to assess the material's photocurrent response, density, and efficiency under simulated sunlight.

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**EIHE 2025: CP 67**

# Synthesis of bi-dopedmno$_2$ nanoparticles for detection of allura red using electrochemical sensor

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## Abstract

The innovative development and application of a nanosensor to identify dangerous Allura red food dyeare presented in this work. Bismuth-doped Manganese dioxide nanoparticles (Bi-$MnO_2$) weredrop cast on graphite electrode (GE) surface to develop this sensitive platform. Bi-$MnO_2$-GE was used to demonstrate the sensing capabilities of the proposed nanosensor using electrochemical measurement, differential pulse voltammetry, chromoamperometry, and Cyclic voltammetry. The optimal response conditions for the target analyte were optimized through the examination of multiple parameters. In contrast to the unmodified GE, the investigation showed that the Bi-$MnO_2$-GE greatly increased the signals of the Allura red food dye. The linear range of Allura red is 1µM to 5µM.The highest reaction was observed at pH = 8. The electrochemical sensing probe showed a strong linear correlation between Allura red concentration and current, with limits of detection (LOD) and quantification (LOQ) of 0.341µM and 1.139µM, respectively. The correlation coefficient $R^2$ is 0.99. Under optimal circumstances, the Bi-$MnO_2$-GE system can detect Allura red with a low limit of detection and has high sensitivity. Furthermore, the proposed electrochemical platform's remarkable stability, sensitivity, and repeatability point to its possible use in actual sample analysis.

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**EIHE 2025: CP 68**

# Evaluation of anticorrosion property of Zn-$NiFe_2O_4$ nanocomposites in 3.5% NaCl medium.

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## Abstract:

The evaluation of anticorrosion properties of Zn-$NiFe_2O_4$ nanocomposites in a 3.5% NaCl medium addresses the need for advanced corrosion-resistant materials, particularly for applications in marine and harsh environments. In this study, Zn-$NiFe_2O_4$ nanocomposites were synthesized and applied as protective coatings on metallic substrates to examine their effectiveness in inhibiting corrosion. Structural and morphological characterization of the nanocomposites has been conducted using techniques such as X-ray diffraction (XRD) and scanning electron microscopy (SEM), confirming the successful formation of Zn-$NiFe_2O_4$ with desirable particle distribution. The effects of $NiFe_2O_4$nanoparticles on the corrosion resistance of a Zn-coating were studied. The Zn-composite coatings were developed by electrodeposition using a Zn-sulfate plating bath using a new condensation product as a brightener suspended with $NiFe_2O_4$particles under DC conditions. The co-deposition of secondary phase particles in the Zn-metal matrix changed the surface morphology of the metal matrix which has been analyzed by SEM photomicrographs. The Tafel and electrochemical impedance spectroscopy (EIS) corrosion tests were performed to study the corrosion resistance property of the coatings. The corrosion resistivity of the Zn-metal matrix was more improvised by the co-deposition of $NiFe_2O_4$nanoparticles.These findings suggest that Zn-$NiFe_2O_4$nanocomposites provide an effective and durable anti-corrosion solution, with potential applications in marine and industrial settings requiring robust corrosion resistance.

**Keywords:**Zn-$NiFe_2O_4$ nanocomposites, EIS, Polarization studies, Hull-cell.

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EIHE 2025: CP 69

# P-Doped Activated carbon derived from Papaya peel biowaste for the electrochemical detection of Perfluoro nonanoic acid

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## Abstract:

Per- and polyfluoroalkyl substances (PFAS) are of concern because of their high persistence (or that of their degradation products) and their impacts on human health and environmental impact. Therefore, extensive research has been conducted into these chemicals' remediation (i.e., the detection, extraction, and destruction). In this research, we have synthesized a P-doped activated carbon derived from papaya peel waste by using pyrolysis, followed by carbonization methods at different temperatures from 400 to 600°C. The synthesized material was characterized using SEM, HR-TEM, FT-IR, XRD, AFM, CV, and EIS. The fabricated electrode was aimed for the determination of Perfluoro nonanoic acid (PFNA) and displayed enhanced catalytic activity for the determination of PFAS via the electrochemical methods since these are cost-effective, simple, and selective for detecting the PFAS at the trace level. The developed electrochemical sensor PPAC-600 exhibits lower detection limits, enhanced conductivity, with enormous surface area, improved stability, and the highest recovery values towards the detection and degradation of PFAS in water, and soil samples.

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EIHE 2025: CP 70

# Numerical Analyses of Engineering Scale Electro-Refiner to Calculate Limiting Current Density

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**Abstract:**

Pyro-chemical reprocessing is emerging as a promising approach for the reprocessing of metallic nuclear fuel, particularly due to its capability to handle high burn-up, short-cooled fuel, recover minor actinides, and produce desirable waste form—all while being compact & cost-effective. In the context of India’s nuclear energy strategy, this process is crucial for achieving lower fuel doubling times. A central operation in pyro-chemical reprocessing is molten salt electro-refining, which occurs in a high-temperature electro-refiner. In electro-refiner a paddle-type stirrer is introduced into the electrolyte which significantly enhances the transport of ionic species to the electrodes. This arrangement increases the attainable limiting current density in the electrochemical cell.

This study investigates the relationship between stirrer rotational speed and limiting current density in the electro-refiner through computational fluid dynamics (CFD) modeling and simulation. By estimating the diffusion layer thickness at varying rotational speeds, we aim to elucidate the transport phenomena within the electro-refiner—insights that may be challenging to obtain experimentally.

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EIHE 2025: CP 71

# Electrochemical investigation of methocarbamolby using nanoparticle-modified carbon paste electrode

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## Abstract

A simple, low-cost and trouble-free electrochemical sensor has been developed by $ZnFe_2O_4$nanoparticles with carbon paste electrode (CPE) for the sensitive voltammetric investigation of methocarbamol (MET). The synthesized nanoparticles have been characterized by XRD, SEM and EDX techniques.The $ZnFe_2O_4$modified carbon paste electrode ($ZnFe_2O_4$@CPE)shows more electrocatalytic activityover BCPE which was assessed by electron impedance spectroscopy (EIS), cyclic voltammetry (CV), and differential pulse voltammetry (DPV) in 0.1 M phosphate buffer solution (PBS) of pH 7.0.The electrochemical performance of MET was evaluated by different parameters such as the pH of the solution, scan rate and concentration study. The electro-oxidation of MET shows an irreversible behaviour and the electrode response were observed to be a diffusion-controlled reaction. Under optimized conditions, the anodic peak current of the analyte was directly proportional to the concentration of the analyte (10.0-140.0 $\mu$M) with the limit of detection (LOD) $0.66 \times 10^{-8}$M $L^{-1}$. The analytical applicability of the modified sensor wasdetermined by a real sample analysis of MET.The developed electrochemical sensorcould be employed successfully for the analysis of MET present in pharmaceutical sample.

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# Switchable Molecular Electrocatalysis

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## Abstract:

Metal phthalocyanines (MPc), including those with iron (FePc), cobalt (CoPc), zinc (ZnPc), copper (CuPc), and nickel (NiPc), have been extensively studied as electrocatalysts for a range of reactions [1]. Tetraamino-substituted FePc and CoPc, in particular, have been the subject of much research as model electrocatalysts for basic electrochemical substrates including protons ($H^+$) and dioxygen ($O_2$) [2]. It is already been explored that the trend in electrocatalytic ORR is largely determined by ligand geometry, rather than being influenced by the central metal ion or the support material [3]. Here, we demonstrate a switchable electrocatalytic effect on the same catalytic metal center for both the oxygen reduction reaction (ORR) and the hydrogen evolution reaction (HER) by leveraging hydrogen bonding interactions facilitated through ligand geometries (α and β). The geometries are adjusted so that the specific electrochemical process can be selectively turned off or on. While the α-geometry precisely turns ON the catalytic centre during dioxygen electrochemistry, the β-geometry switches on the catalytic Co sites during electrocatalytic HER.

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**EIHE 2025: CP 73**

# Amplification of current generation by *Shewanella oneidensis* using conductive polymer electrodes in bioelectrochemical systems

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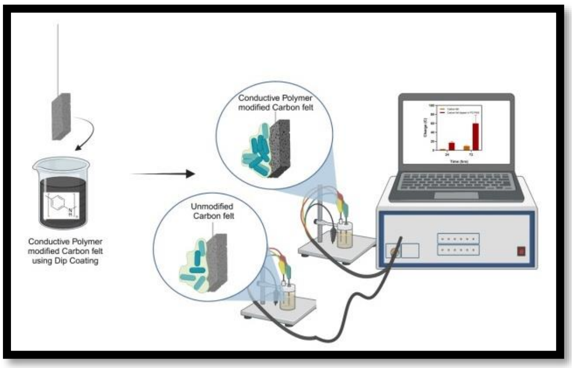
## Abstract:

Bioelectrochemical systems in which electroactive bacteria generate electricity via extracellular electron transfer offer sustainable alternatives to fossil fuels. To address the bottleneck of low current production, the present work aims to fabricate novel electrode materials with favourable characteristics to increase bacterial extracellular electron transfer. Specifically, conductive polymers have been combined with nanoparticles for improved conductivity, increased surface area for biofilm formation and biocompatibility, thereby leading to enhanced performance in a microbial three-electrode set-up containing *Shewanella oneidensis* MR-1 as the model electroactive bacterium. The fabricated electrodes were compared with conventional electrodes using chronoamperometry/chronocoulometry and cyclic voltammetry, showing a significant increase in microbial electricity output. Elemental characterisation of the electrodes was performed using energy-dispersive X-ray spectroscopy, and the biofilm formed on the surface of the working electrode was visualised using scanning electron microscopy. The work advances the potential use of electroactive bacteria insustainable applications.



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EIHE 2025: CP 74

# Evaluation of conductive properties of Additive Manufactured Electrodes from ABS Conductive Filament: Influence of Pre-treatment and structural analysis

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## Abstract:

In this study, we investigated the potential of additive manufacturing (AM) to produce conductive electrodes using ABS-based conductive filament. The aim was to evaluate the effect of pre-treatment on the conductivity of the 3D-printed electrodes and to compare their structural and electrical properties. Conductivity measurements were performed on samples with and without pre-treatment to assess the impact of surface modifications. X-ray diffraction (XRD), Field Emission Scanning Electron Microscopy (FESEM), and Raman spectroscopy were employed to analyze the structural, morphological, and chemical properties of the printed electrodes. The results show that the conductive filament exhibits promising electrical performance, with pre-treatment leading to improved conductivity due to enhanced filament interconnectivity. XRD and FESEM analysis revealed favourablemicrostructural characteristics, while Raman spectra confirmed the presence of conductive carbon networks within the material. The findings suggest that ABS conductive filaments can be effectively utilized in additive manufacturing of electrodes, offering a viable alternative for low-cost, customizable conductive components in various electronic applications. These results provide a positive outlook for the use of such filaments in 3D printing of functional, electrically conductive parts in electrochemistry.

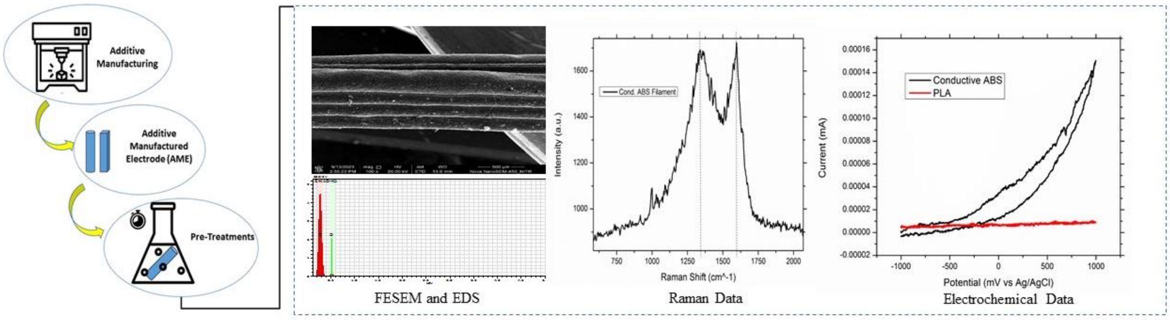

**Fig:** Characterizations of conductive properties of Additive Manufactured Electrodes

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EIHE 2025: CP 75

# Advancing Health and Environmental Safety with a Nickel-Based Electrochemical Sensor for Aspirin Detection

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## Abstract:

The development of a highly sensitive electrochemical sensor for the detection of aspirin has significant implications for both clinical diagnostics and environmental monitoring.This study introduces a sensitive electrochemical sensor for aspirin detection using a nickel (Ni) metal foil (3 mm x 1 mm) as the working electrode, Hg/HgO as the reference electrode, and Pt mesh as the counter electrode. X-ray Diffraction (XRD), Field Emission Scanning Electron Microscopy (FESEM), and Raman spectroscopy confirmed the presence and purity of Ni on the electrode. The developed sensor demonstrated high sensitivity (14,250µAmM$^{-1}$cm$^{-2}$), a low limit of detection (LOD) of 0.67 µM, and a linear range from 0.67 to 3.99 µM, highlighting its potential for precise aspirin monitoring. This Ni-based sensor offers rapid detection, making it valuable for clinical diagnostics and environmental applications to detect aspirin in biological and water samples. Future work will aim to enhance sensor stability and explore compact designs for real-time, on-site aspirin monitoring, facilitating broader applications in healthcare and environmental safety.

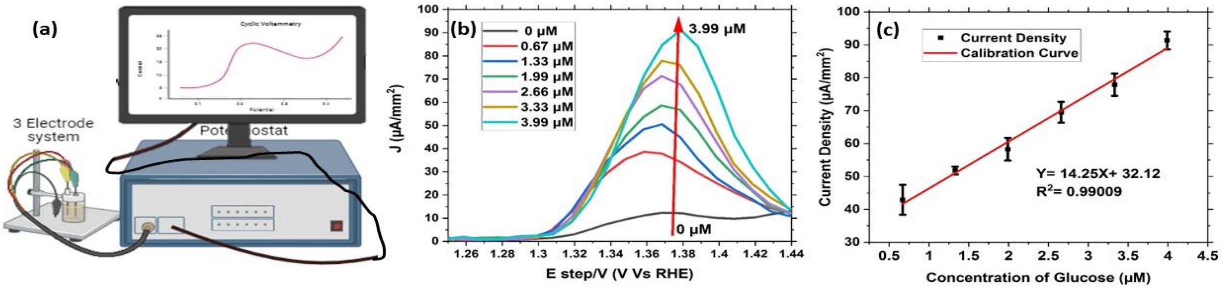

**Figure 1: (a)** Electrochemical workstation**; (b)** DPV of aspirin in 0.5 M NaOH solution at different concentration and **(C)**Peak average values and calibration curve of the obtained DPV curves with increase in aspirin concentration

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**EIHE 2025: CP 76**

# $MnO_2$ Nanorods on Mesoporous Carbon as a Bifunctional Electrocatalyst for Hydrazine Oxidation and Oxygen Reduction Reactions in Alkaline Media

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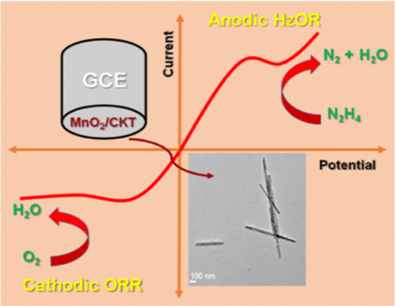
## Abstract:

Hydrogen production through water splitting plays a crucial role in harnessing zero-carbon green energy. The hydrazine oxidation reaction (HzOR) is considered as a viable alternative to theanodic OER. However, HzOR faces challenges due to its high operational potential, necessitating the use of costly precious metal-based electrocatalysts.[1] Additionally, noble metal (Pt)-based catalysts experience slow kinetics for the cathodic ORR and are economically unviable, also suffering from the methanol crossover effect. Therefore, there is a pressing need for a non-precious metal-based bifunctional electrocatalyst, efficientlyperforming both HzOR and ORR. [2]Herein, we've developed a straightforward method to create manganese oxide nanorods incorporated into mesoporous carbon (CKT) as an electrocatalyst for anodic HzOR and cathodic ORR in alkaline conditions. The synthesized $MnO_2$/CKT nanocomposite exhibits impressive performance for HzOR, with a low onset potential of 0.7 V and a working potential of 0.88 V vs RHE, a low Tafel slope of 105 mV decade$^{-1}$, achieving a maximum current density of 25.6 mA cm$^{-2}$ at 1.4 V vs RHE with 50 mM hydrazine hydrate in 1 M KOH. Furthermore, the catalyst effectively performs ORR through a 4-electron pathway, with an improved onset potential of 0.95 V vs RHEin $O_2$-saturated 0.1 M KOH.



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EIHE 2025: CP 77

# $Fe_3C$/Fe Decorated N-doped Carbon Derived from Tetrabutylammonium tetrachloroferrate Complex as Bifunctional Electrocatalysts for ORR, OER and Zn-Air Batteries in Alkaline Medium

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## Abstract:

The emergence of non-precious metal-based *robust* and economic bifunctional oxygen electrocatalysts for both oxygen reduction reaction (ORR) and oxygen evolution reaction (OER) is crucial for the rational design of commercial rechargeable Zn-air batteries (RZAB) with safe energy conversion and storage systems. Herein, a facile strategy to fabricate a cost-efficient, bifunctional oxygen electrocatalyst $Fe_3C$/Fe decorated N doped carbon (FeC-700, the catalyst prepared at carbonization temperature of 700 °C) with a unique structure has been developed by carbonization of a single source precursor, tetrabutylammonium tetrachloroferrate(III) complex. The ORR and OER activity revealed excellent performance ($\Delta E$=0.77 V) of the FeC-700 electrocatalyst, comparable to commercial Pt/C and $RuO_2$, respectively. The designed temperature-tuneable structure provided sufficiently accessible active sites for the continuous passage of electrons by shortening the mass transfer pathway, leading to extremely durable electrocatalysts with high ECSA and amazing charge transfer performance. Remarkably, the assembled Zn-air batteries with the FeC-700 catalyst as the bifunctional air electrode delivers gratifying charging-discharging ability with an impressive power density of 134 mW cm$^{-2}$ with a long lifespan, demonstrating prodigious possibilities for practical application.

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**EIHE 2025: CP 78**

# Electrodeposition of gCN.ZIF-8 composite for Voltammetric sensing application

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## Abstract:

Graphitic carbon nitride (gCN) provides a large number of electron-donor N-sites for chemical interactions with analytes, making it a promising option for detection and sensing applications but issues including agglomeration, poor dispersibility, and inhibited electron transport make it difficult to use effectively in electrochemical systems. Zeolitic imidazolate frameworks (ZIFs) having $Zn^{2+}$ as metal ion and organic linker imidazole such as 2-methylimidazole (Hmim), widely used in electrochemical sensing, water splitting, biomedicine etc. ZIF-8 having tunable chemical compositions, high surface area, high porosity, and controllable crystal structure make them the ideal solution to overcome impeded charge transfer and surface agglomeration.Hence our work investigates the electrodeposition of gCN.ZIF-8 composite to create a novel electrode material for voltammetric sensing applications. The electrochemical response and surface functionalities of the modified electrode have been examined using comprehensive surface, chemical, and electrochemical characterization. The step by step optimization protocol shows the improved peak current of 1.91 times for 1:3 gCN.ZIF-8 modified glassy carbon electrode (GCE) at 15 cycles of electrodeposition at a scan rate of 100 mV/sec. The modified gCN.ZIF-8/GCE provides an increment in electroactive surface area of 1.22 times than the bare electrode thus making it a suitable option for detection of specific analyte.

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# Manganese-Nickel BTC as a Bifunctional Catalyst for Hydrogen Evolution and Urea Oxidation

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## Abstract

The urea oxidation reaction (UOR) presents a promising alternative to the oxygen evolution reaction (OER), enhancing energy conversion efficiency in electrochemical hydrogen generation while simultaneously addressing the widespread issue of urea in wastewater. This study investigates advancements in nickel-based electrocatalysts for both UOR and the hydrogen evolution reaction (HER), particularly emphasizing the performance of manganese nickel benzene tricarboxylic acid (Mn@NiBTC). Results indicate that varying the concentration of $NaBH_4$ in equal proportions of $KMnO_4$ and NiBTC significantly boosts the performance of both UOR and HER. At a concentration of 5 mM $NaBH_4$, the Mn@NiBTC catalyst exhibits exceptional efficacy, achieving a current density of 550 mA $cm^{-2}$ at 1.8 V (RHE) with a low Tafel slope of 15.5 mV $dec^{-1}$ in a 1 M KOH solution containing 0.33 M urea. For HER, this catalyst demonstrates a current density of -750 mA $cm^{-2}$ at a potential of -0.8 V. We evaluated various nickel-based catalysts, including Ni foam, NiBTC, and Mn@NiBTC, for their effectiveness in the electrochemical decomposition of urea into benign nitrogen and fuel-cell-grade hydrogen. Overall, the 5 mM $NaBH_4$ content in the Mn@NiBTC catalysts emerges as highly efficient materials for urea oxidation, showcasing the significant potential for large-scale applications in urea removal from wastewater and sustainable hydrogen production.

EIHE 2025: CP 80

# Fish Scale-Derived Activated Carbon Modified Sensor for the Electrochemical Detection of Cloxifenolum in Real Samples

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## Abstract:

Fish scale biowaste generated during fish processing is often discarded despite their potential value. Repurposing them can contribute to sustainable practices and reduce environmental impact. Fish scale activated carbon was synthesized by one-step carbonization and activated with sodium carbonate. In this study, fish scale activated carbon was incorporated in the working electrode to detect Cloxifenolum, a toxic molecule commonly found in antibacterial products that can disrupt endocrine function and harm aquatic ecosystems if left untreated. Electrochemical analysis of Cloxifenolum was conducted in a 0.2 M phosphate buffer solution (PBS) using cyclic voltammetry (CV) and square wave voltammetric (SWV) techniques. The modified sensor exhibited more significant oxidation currents for Cloxifenolum than an unmodified carbon paste electrode (CPE). The developed sensor demonstrates high sensitivity and selectivity for detecting Cloxifenolum in the presence of surfactant with a lower detection limit. This study demonstrated the real sample analysis of spiked Cloxifenolum in vegetables, fruits, water, and soil samples, including personal hygiene products like toothpaste, hand wash, and Shampoo.

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EIHE 2025: CP 81

# Investigation of Free-Standing fCNT-MXene Superiour Supercapacitor Electrode Performance in Aqueous Electrolyte

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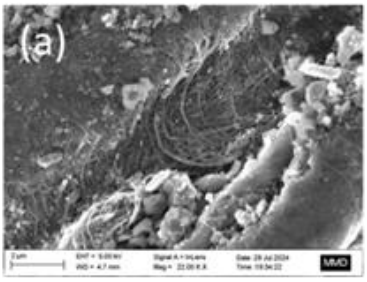
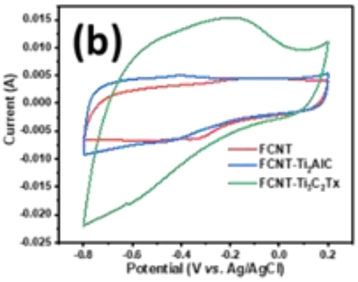
## Abstract:

Supercapacitors hold significant promise for high-power applications due to their ability to store and deliver energy at rapid rates, making them ideal for use in electric vehicles and portable electronics. In this study, we present a high-performance, current-collector-free supercapacitor based on a CNT aerogel-MXene composite. This novel device leverages the exceptional electrical conductivity and large surface area of functionalized CNTs, combined with the superior hydrophilicity of MXene, to achieve enhanced energy storage and power delivery.Present study shows the potential of fCNT-MXene supercapacitors in advancing energy storage technologies, which are essential to meeting the increasing demand for efficient and sustainable energy solutions.





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# Electrochemical characterization of $Al_2O_3$-$SiO_2$ and $SiO_2$barrier coatingon type 430 stainless steel electrode in LiCl-KCleutectic melt

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## Abstract:

Chemical and electrochemical stability of $Al_2O_3$-$SiO_2$ and $SiO_2$ coatings on type 430 stainless steel electrodes were characterized in LiCl-KCl melt employingemf, cyclic voltammetry techniques. $SiO_2$ coating was observed to be reduced, forming $O^{2-}$ ions in the melt. Uranium electrodeposition on coated electrode was checked by potentiostaticmethod and significant deposit was observed, indicating electrical contact through micro-cracks of coating.Suitability of these coatings in chloride melt can be checked by further improvements of coatings.

$Al_2O_3$-$SiO_2$ and $SiO_2$ coatings were prepared on grade 430 stainless steel electrodes using aluminium butoxide, GPTMS, and TEOS as precursors. These coated and bare electrodes were tested in a LiCl-KCl eutectic melt using cyclic voltammetry in the temperature range of 673-773 K (Fig. 1). The $Al_2O_3$-$SiO_2$ coated electrode showed a surge in cathodic current due to lithium reduction, while the $SiO_2$ coated electrode displayed additional peaks related to the electroreduction of $SiO_2$ and formation of $Li_2O$. The $SiO_2$ coating also facilitated oxygen ion formation, but the $Al_2O_3$-$SiO_2$ coating was more stable and non-reactive due to the higher stability of $Al_2O_3$. Both coatings had micro-cracks, allowing the melt to contact the bare electrode, confirmed by similar open-circuit potentials between coated and uncoated electrodes (Fig. 2). Potentiostatic electrolysis in a LiCl-KCl-$UCl_3$ melt demonstrated uranium deposition on the $Al_2O_3$-$SiO_2$ coated electrode (Fig. 3). However, the presence of pores in the coating led to electrical contact. The study suggests that further improvement of the coating's insulation is needed, as $SiO_2$-based coatings may not be ideal due to reactiveness of the material in chloride melt at elevated temperature.

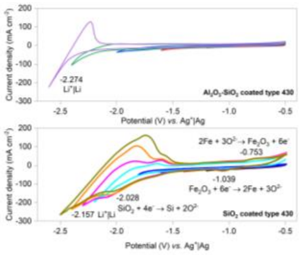

Fig. 1: Cyclic voltammograms of LiCl-KCl eutectic melt at $SiO_2$ and $Al_2O_3$-$SiO_2$ coated SS430 electrodes at 773 K.

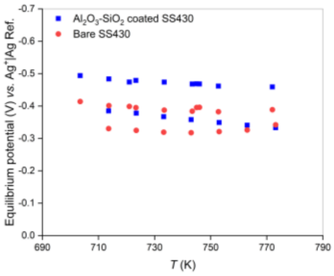

Fig. 2: EMF data of bare and $Al_2O_3$-$SiO_2$ coated SS430 electrodes against $Ag^+|Ag$ reference.

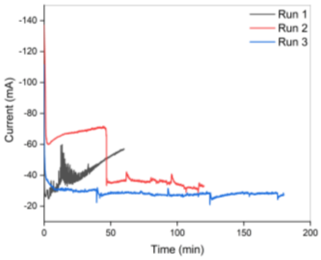

Fig. 3: Cathodic current vs. time during electrodeposition of U at $Al_2O_3$-$SiO_2$ coated SS430 electrode at 773 K.

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**EIHE 2025: CP 83**

# Corrosion Studies on D9 and T91 Steels in LiCl-KCl eutectic melt

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## Abstract:

Corrosion aspect of D9 and T91 steels in a LiCl-KCl eutectic melt at 773 K was comprehensively evaluated employing cyclic voltammetry technique. Both steel types demonstrated pronounced corrosion susceptibility in chloride melt. At 773 K, the equilibrium potential of D9 and T91 steel was determined to be -0.402 and -0.367 V, respectively.Voltammetric studies revealed considerable dissolution of Fe from both D9 and T91 steels following prolonged immersion in the melt. In the present study D9 and T91 steels were immersed in LiCl-KCl eutectic melt and thermally equilibrated for 135 h at 773 K in argon atmosphere. Cyclic voltammograms (CV) of the melt were recorded at tungsten working electrode (WE)before and after immersion of D9 and T91 steels in melt at various time intervals. Voltammograms of the melt, recorded at various switching potentials prior to steel immersion, indicated the presence of $Li^+$ reduction at -2.38 V, with no additional peaks observed (Figure 1). Cyclic voltammograms of the melt recorded at tungsten electrodeafter 98 h immersion of D9 reveals presence of $Fe^{2+}$|Fe redox couple with cathodic and anodic potentials at -0.561 and -0.456 V, respectively.Additional redox couples $Ni^{2+}$|Ni and $Mo^{3+}$|Mo were identified at cathodic potentials of -0.185 and -0.034 V, respectively, beyond 98h immersion. Increasing current densities over time suggest enhanced dissolution of D9. Similar voltammetric features were observed at tungsten electrode following the immersion of T91 steel in the melt, as depicted in Figure 3, with the notable exception of the absence of the $Ni^{2+}$|Ni redox couple. Salt samples were analysed for Fe, Cr, Ni by ICP-OES. Fe and Ni conc. in salt employed for D9 experiment was estimated to be 195 and 13 µg/g of salt, respectively, while Fe concentration was estimated to be 165 µg/g of salt employed in T91 experiment.Voltammetric studies revealed the significant corrosion of these steels in molten chloride medium at 773 K. Dissolved moisture impurity in the melt or oxygen impurity in argon cover gas may be attributed for the corrosion.

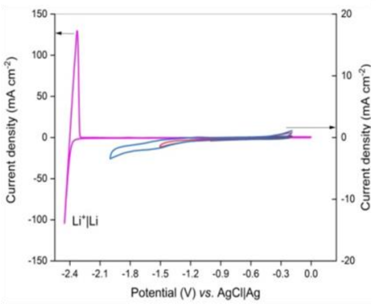

Fig. 1: CV of LiCl-KCl melt at tungsten WE at 773 K before immersion of D9 and T91 steels in the melt

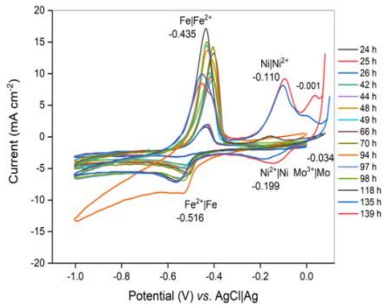

Fig. 2: CV of LiCl-KCl meltat tungsten WE at various time intervals after immersion of D9 in the melt.

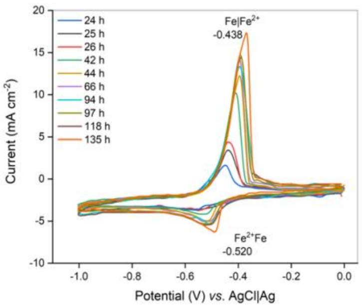

Fig. 3: CV of LiCl-KCl meltat tungsten WE at various time intervals after immersion of T91 in the melt.

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# Boron Nitride Nanosheets modified with Molybdenum disulfide Nanoflowers for the Electrochemical Detection of Azodye–Sunset Yellow from Soft Drinks

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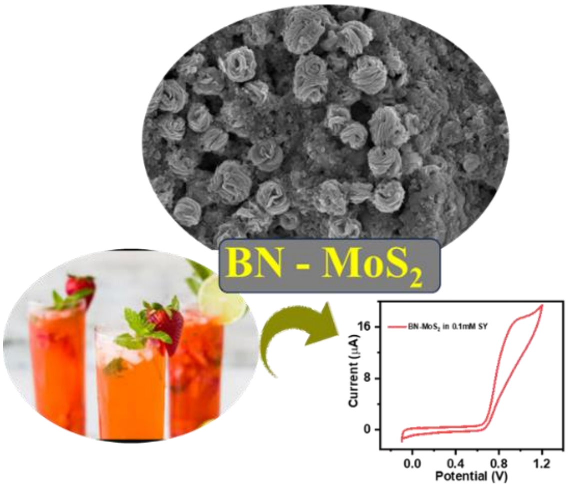
## Abstract:

Azo dyes, particularly illegal additives in food, have been shown to adversely affect human health [1]. Consequently, it is crucial to develop high-sensitivity, simple, and rapid sensors for their monitoring and analysis of food products. In this study, an electrochemical sensor utilizing Boron Nitride nanosheets-molybdenum disulfide nanoflowers (BN-$MoS_2$) compositeas an electrode modification material was developed for the detection of sunset yellow (SY). The prepared BN-$MoS_2$composites demonstrated excellent electrochemical sensing properties for SY due to its electrical conductivity, enhanced surface area, and electroactive sites [2,3]. Under optimal conditions, detection ranges were 1nM–1000 µM for SYwith limits of detection (LOD) of 1nM. The sensor exhibited satisfactory stability and repeatability. This simple and fast electrochemical sensor proved effective in testing SY in soft, achieving good recovery value, indicating its potential for an electrochemical sensor for SY.



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EIHE 2025: CP 85

# Hydrothermal Synthesis and Electrochemical Characterization of a NovelManganese Vanadate Electrode for Improved Performance in Iron Redox Flow Batteries

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## Abstract:

The increasing demand for large-scale energy storage systems has drawn significant attention toward developing efficient, economically viable solutions. Iron redox flow batteries (IRFBs) are emerging as a cost-effective option for large-scale energy storage due to the abundance, environmental sustainability, and low cost of iron.A primary challenge in IRFBs is optimizing electrode materials to improve redox reversibility and electrochemical performance. This study introduces a novel $MnV_2O_4$ (MVO) electrode material, synthesized via a hydrothermal technique and characterized through XRD, Raman, SEM-EDAX, and TEM analyses.The MVO material exhibits a nanopebble structure with a high surface area and porous architecture, both beneficial for redox reactions. Electrochemical investigations, including cyclic voltammetry, electrochemical impedance spectroscopy, and other diagnostic techniques, were conducted to evaluate its performance. Results indicate that the MVO electrode material shows improved conductivity, stability, and reversibility (Ipa/Ipc = 1.02) of the Fe(II)/Fe(III) redox couple in iron electrolyte, with a significant improvement in current density and energy efficiency compared to conventional electrodes. These findings suggest that the synthesized MVO electrode material could contribute to the development of more efficient and durable IRFBs, supporting renewable and scalable energy storage systems.

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EIHE 2025: CP 86

# AnElectrochemical Sensor Based on Bio-derived Graphene Quantum Dots as an Electronic Tongue for Acrolein; a Carcinogen in Foods

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## Abstract

Food is one of the most essential needs of every living being, and good quality food is required for health excellence. Hence the quality of food that we are consuming is highly significant. Unfortunately, the qualities of most of the foods that we consume daily are getting deteriorated through food processing and adulteration and that probably makes them carcinogenic to humans[1]. Cancer is a disease with multifactorial etiology that can result in death if not treated appropriately. Thus, through the detection of carcinogens in food can prevent a large variety of adverse health conditions for the global population[2]. Therefore, herein, we are exploring the electrochemical sensing technique for the detection of acrolein, one of the main carcinogens present in processed foods. Further, the development of an integrated electrochemical screen-printed sensor system can satisfy the need of a hand-held sensor for the real-time monitoring. Graphene quantum dots derived from the seeds of *Gloriosa Superba* is utilized for modifying the working electrode. The sensor exhibited lowest detection limit of 0.1 mM, being the lowest one reported hitherto. Further, the real-time applicability of the sensor also validated successfully.

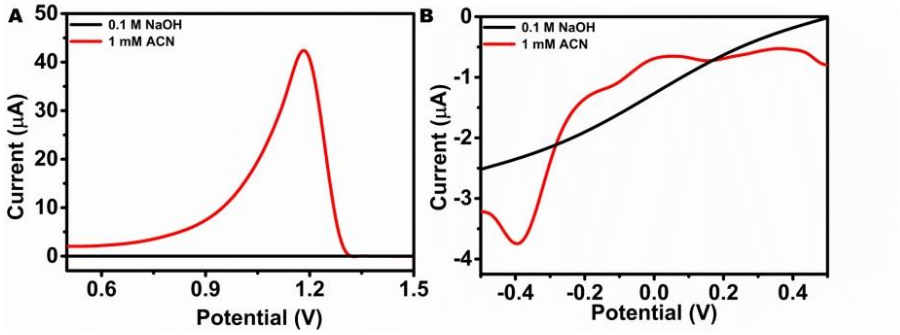

**Figure.** (A) and (B) The DPV responses corresponding to the oxidation and reduction of 1 mM acrolein in 0.1 M NaOH

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# Detection of Trichloro HydroxybenzeneUsing Copper-Doped Activated Carbon Modified Sensor

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## Abstract:

Pea pods are a major component of agricultural biowaste, rich in cellulose and lignin, making them an excellent carbon source when pyrolyzed. The pyrolyzed pea pods were activated chemically by doping with copper. This was incorporated as a modifier in the carbon paste electrode for the detection of Trichloro hydroxybenzene, which is a chlorinated aromatic compound and a significant environmental contaminant due to its use in pesticides. Its potential toxic effect on humans and the environment underscores the importance of developing technologies to detect this compound at trace levels. The activation process of activated carbon led to an increase in its surface area, thereby increasing the sensor's sensitivity. The performance of the modified electrode was assessed using multiple electrochemical techniques, such as Cyclic Voltammetry, Linear Sweep Voltammetry, and Square Wave Voltammetry. The developed sensor showed reasonable detection limits for Trichlorohydroxybenzene. The developed sensor was further tested for its practical applicability by analyzing spiked real samples, including water, soil, fruit, and vegetable samples. The recovery percentage of the analyte was calculated to evaluate the sensor's accuracy, indicating the sensor's high precision and reliability in detecting Trichlorohydroxybenzene.

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EIHE 2025: CP 88

# Study on the Performance Evaluation of 500W Zinc-Bromine Redox Flow Battery Stack

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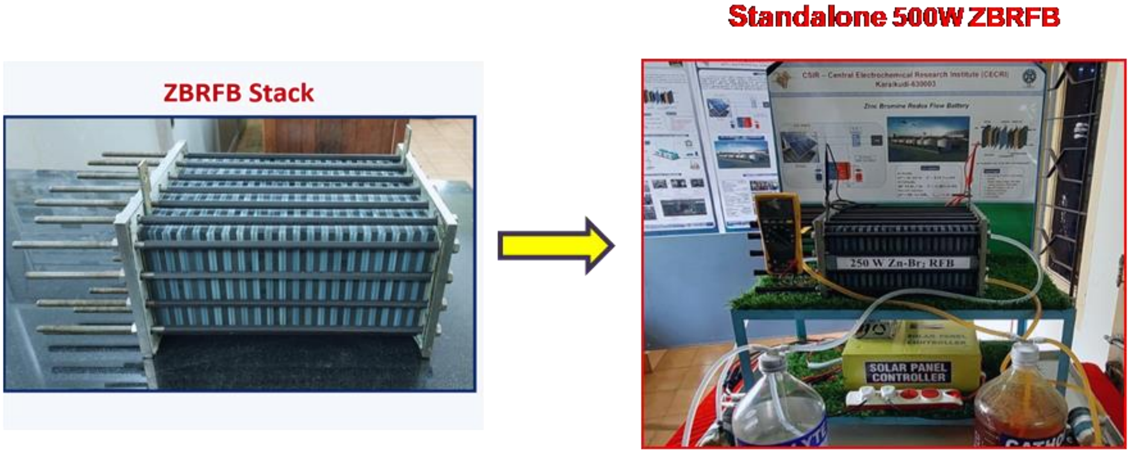
## Abstract:

Electrochemical energy storage and conversion devices are very unique and important for providing solutions to clean, smart, and green energy sectors particularly for stationery and automobile applications. Based on the rechargeability, reduction and oxidation couple of the electrolytic solution, redox flow batteries are one of the energy storage applications for use. Zinc-Bromine redox flow battery (ZBRFB) is the most appealing technology used for storing electrical energy in large-scale owing to its easy scalability, flexibility in cell design, ease of operation, and safety[1,2,3]. Herein, a 500W ZBRFB stack, which was comprised of 20 cells with an active electrode area of 220 $cm^2$ was constructed, and it delivered a power output of 500W at an operational current density of 40 mA $cm^{-2}$, respectively. The performance of the ZBRFB was tested at various time durations and the efficiencies were recorded accordingly. The coulombic efficiency of > 60 % was achieved for the 500W ZBRFB stack performance. Further, a stand-alone ZBRFB integrated with solar panels was also successfully demonstrated for stationary energy storage applications. The systematic process of stack assembly and fabrication along with the testing at different current densities will be presented in detail.



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EIHE 2025: CP 89

# Sensitive Electrochemical Detection of P-Chlorophenol Using $WO_3$ Nanorod and rGO Nanocomposite

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## Abstract:

p-Chlorophenol (PCP), a chlorinated organic compound widely used in industry, poses significant environmental and health risks, including cancer and liver disease, even at low concentrations. This study developed a sensitive PCP detection method using carbon paste electrodes modified with a composite of tungsten oxide ($WO_3$) nanorods and reduced graphene oxide nanoparticles. The sensor achieved optimal performance in alkaline conditions, demonstrating enhanced sensitivity and selectivity due to the catalytic and bulk properties of $WO_3$ nanostructures. Key detection parameters, such as heterogeneous rate constant, accumulation time, temperature effects, scan rate, and PCP concentration, were comprehensively analyzed. $WO_3$ nanostructures were synthesized hydrothermally and characterized to confirm their crystalline and chemical properties, enabling a broad linear response range for PCP detection with a low detection limit of 0.102 nM. The sensor also exhibited excellent recovery rates in both soil and water samples, underscoring its potential for environmental monitoring. These results demonstrate the sensor's high selectivity, sensitivity, and rapid response, making it suitable for analytical applications in PCP detection.

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# Ultrasensitive detection of holoTC for analysis of Vitamin B12 levels using $Ag_2MoO_4$ deposited PEDOT sensing platform

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## Abstract:

Vitamin B12 is an essential micronutrient required for the proper functioning of the human body. However, screening for vitamin B12 insufficiency is hindered by the low sensitivity of the current Total vitamin B12 test. Holotranscobalamin (holoTC) is an early indicator of the negative vitamin B12 balance as it is the first protein to decline in the serum. We report a novel immunosensor based on flower-like poly(3,4-ethylenedioxythiophene) (PEDOT) nanostructural film impregnated with $Ag_2MoO_4$ NPs deposited on fluorine-doped tin oxide electrode. The prepared electrodes were characterized by FE-SEM, FTIR, XRD, and electrochemical studies. The activated anti-holoTC antibody was immobilized and optimized to capture the target in a response time of 15 minutes. The electrochemical performance of the sensor was carried out by using the electrochemical impedance spectroscopy and a good linear relationship between $\Delta R_{ct}$ and holoTC was obtained in the range from 0.1 pg $mL^{-1}$ to 100 ng $mL^{-1}$ with a LOD of 0.093 pg $mL^{-1}$. The proposed sensor was successfully applied in human serum samples for holoTC detection. The experimental results showed that the immunosensor is highly selective towards holoTC and presented an acceptable stability of 20 days with reproducibility RSD ≤4%. To the best of our knowledge, this is the first developed electrochemical immunosensor for holoTC detection.

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EIHE 2025: CP 91

# Advancements and Achievement Attributes of All-Vanadium Redox Flow Battery Stack

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## Abstract:

Redox energy storage systems have received considerable attention as they promise to be inexpensive, possessing long life, flexible design, high reliability, low operation & maintenance cost. Vanadium redox flow batteries (VRFB) are one of the most remarkable technologies for effective large scale energy storage applications, owing to its long cyclability and high energy efficiency. Herein, we have developed a 500 W and 1 kW of VRFB stack with an active area of 230 $cm^2$ and 530 $cm^2$, respectively. The performance of 500W VRFB stack was tested at various rate capabilities from 20 to 80 mA $cm^{-2}$ and could withstand long cyclability for about 700 cycles with about 65 % energy efficiency. Moreover, the VRFB stack was integrated with solar panels and the corresponding charge-discharge was recorded with better efficiencies. Subsequently, we have developed custom design of 1 kW VRFB and has been demonstrated successfully. The detailed performance characteristics of VRFB stack in terms of rate capability and cyclability will be discussed.

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# ZnO interlinked graphene - based sensors for quercetin detection

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## Abstract:

Quercetin (QUR) was studied electrochemically using voltammetry with carbon paste electrodes (CPE) modified by graphene (Gr) and zinc oxide nanoparticles (ZnO). Various pH levels of 0.2 M phosphate buffer solution (PBS) were tested, and pH 6.0 was found to be optimal. The electrochemical analysis of QUR showed a redox reaction, featuring an oxidation peak at 0.356 V and a reduction peak at 0.324 V, with peak currents of 1.05 µA and 0.413 µA, respectively. The modified electrode displayed a higher peak current than the bare CPE, indicating electrocatalytic activity of the Gr-ZnO modifier. Surface characterization of the Gr-ZnO/CPE was performed through X-ray diffraction (XRD), field emission scanning electron microscopy (FESEM), transmission electron microscopy (TEM), and energy-dispersive X-ray spectroscopy (EDS). Sweep rate experiments revealed that the reaction mechanism involves equal electron and proton transfer, with adsorption as the governing factor. The limit of detection (LOD) was calculated to be 18.0 nM. This modified electrode was successfully applied for QUR determination in real samples, showing high recovery and validating the electrode's practical applicability.

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EIHE 2025: CP 93

# Polypyrrole-rGO/Nickel hydroxide nano composite Film for Serotonin Detection in genetically Engineered Drosophila Brain Samples

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## Abstract:

Serotonin (5-HT), a neurotransmitter, plays a key role in regulating many body functions. Abnormal levels of serotonin are associated with various neurological disorders, making it important to have fast, accurate, and affordable ways to detect it. We have developed a new paper-based electrode for detecting serotonin by modifying the paper electrode with a combination of polypyrrole (Ppy), reduced graphene oxide (rGO), and nickel hydroxide($Ni(OH)_2$), that significantly improved its electrochemical properties. The nanocomposite used to modify the electrode was created using a method called cyclicvoltammetry and analyzed with advanced techniques such as FE-SEM, AFM, FTIR, and XPS. Electrochemical testing was done using cyclic voltammetry and electrochemical impedance spectroscopy (EIS). The sensor showed a very low detection limit of 0.015 nM and a wide detection range from 0.007 nM to 500 µM, which is in line with clinically relevant serotonin level. The sensor was also tested for accuracy and reliability through recovery, spike analysis, and interference studies, yielding excellent results. We validated the performance of this disposable sensor by testing it on brain samples from genetically modified fruit flies (Drosophila melanogaster) and comparing the results to thosefrom a standard HPLC-UV method. This sensor is highly sensitive, selective, and stable, offering a cost-effective and reliable solution for detecting serotonin in clinical settings.

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## EIHE 2025: CP 95

# Green Synthesized Bimetallic Nanoparticles Towards Electrochemical Detection of Ampicillin in Milk Samples

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## Abstract:

The prevalence of antibiotic residues in dairy products, particularly milk, poses a significant threat to human health, notary given the potential development of antibiotic resistance and allergic reactions in sensitive individuals, necessitating the development of sensitive and reliable detection methods. For the different antibiotics used in veterinary medicine, ampicillin is one of the most commonly administered antibiotics. In light of this, we report a novel aptasensor based on green synthesized Ag-Au bimetallic nanoparticles deposited on modified FTO electrode. The modified electrodes were characterized using Field Emission Scanning Electron Microscopy (FESEM) with Energy Dispersive X-ray Spectroscopy (EDS), and electrochemical methods. The aptamer was optimized to capture the target within a response time of 15 mins. DPV technique was employed to evaluate the performance of the fabricated aptasensor. The developed aptasensor allowed the detection of ampicillin in a wide concentration range, comprised between 0.01 ng and 100 µg mL$^{-1}$. Further details regarding detection limit, reproducibility and shelf life of the sensor will be explained during poster presentation. The experimental results showed that the aptasensor exhibited greater sensitivity, reproducibility and long- term stability. The outcomes of the study indicate that the developed aptasensor could be effectively useful in detecting ampicillin in milk samples.

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EIHE 2025: CP 96

# Sunlight Assisted Photocatalytic Water Remediation

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## Abstract

Sunlight-assisted photocatalytic water remediation is one of the hot topics to explore in terms of green methodology. Organic pollutants such as organic dyes, antibiotics, pesticides, endocrine disruptors, etc, are piling up in the water resources. This could cause serious health issues in living beings and pollution too. Hence photocatalysis with suitable catalyst active in solar region could effectively degrade these pollutants in a greener way. So herein we have utilised a novel $TiO_2$ nanocomposite for the water remediation.

EIHE 2025: CP 97

# Development of Electrochemical Aptasensor UtilisingMesoporous Silica Supported Au-Cu Bimetallic Nanoparticles forDetection of Ampicillin in the Milk Sample

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## Abstract:

β-lactam antibiotics are commonly used in veterinary medicine to prevent infectious illnesses and increase production efficiency for goods including milk, eggs, and meat. Ampicillin is one of the beta-lactam antibiotics that are extensively used. Consuming milk or milk products with antibiotic concentrations that exceed the maximum residue limit (MRL) value might pose major health risks including resistance to antibioticsand hypersensitivity reactions leading to various health difficulties. Therefore, an electrochemical biosensor based on aptamer recognition was demonstrated that utilizes Apt/GOPS/Au-Cu/MSN fabricated FTO as biosensing platform for ampicillin detection. The successful creation of the sensor probe was confirmed using a variety of physical and electrochemical techniques such as SEM, contact angle, FTIR, XRD, CV, and EIS. The aptamer was immobilized and tuned to detect the target within 20 minutes. The sensor's electrochemical performance was assessed using electrochemical impedance spectroscopy. A linear association was found between $\Delta R_{ct}$ and ampicillin at concentrations ranging from 0.01 to 1000 ng/mL, with a detection limit of 0.01 ng/mL$^{-1}$. The aptasensor demonstrated superior selectivity, repeatability, and long-term stability. The results showed that the developed aptasensor could be a promising alternate method for detecting ampicillin residues in milk samples.

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EIHE 2025: CP 98

# Tailoring Multi-electrolyte Additive-Mediated Electrode-Electrolyte Interphasefor Stable Electrochemical Cycling of Lithium Iron Manganese Phosphate Cathodes

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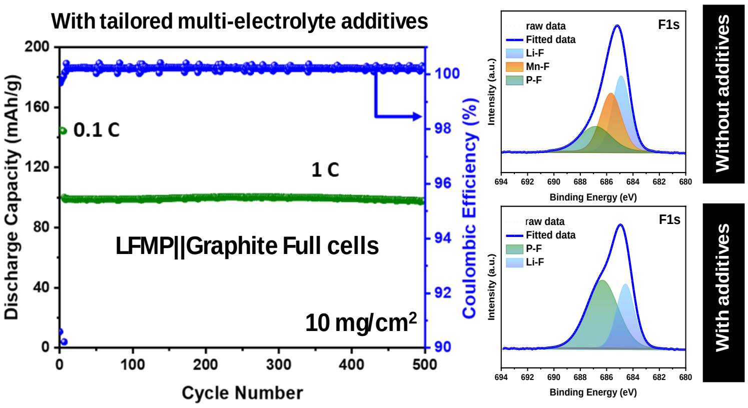
## Abstract:

Lithium Iron Manganese Phosphate (LFMP, $LiFe_xMn_{1-x}PO_4$, $0.1 < x < 0.9$) is a promising phospho-olivine cathode for lithium-ion battery applications offering low cost and safe cycling prospects due to the presence of strong P−O covalent bond.[1]Despite its high energy density (20 % higher than the conventional lithium iron phosphate (LFP) cathode)the low electronic conductivity ($<10^{-9}$ S $cm^{-1}$), lithium-ion diffusivity ($<10^{-16}$-$10^{-14}$ $cm^2$ $s^{-1}$), Jahn-Teller lattice distortion and manganese dissolutioninto the electrolyte leads to capacity fading upon cycling especially withhigh active material loadings.[1,2]

Engineering a stable cathode-electrolyte interphase (CEI) is an effective strategy to enable surface passivation of the cathode and improve the cycling stability.[3,4] The present study reports on a systematic investigation of the role of tailored multi-electrolyte additives in improving the cycle life of LFMP||Li half cells at room temperature and at elevated temperatures with high active loadings(10 mg/$cm^2$).Additionally, the cycling stabilitywith the multi-electrolyte additives is demonstrated in LFMP||Graphite full cells. A detailed investigation of the generated CEI and its role in suppressing Mn dissolutionand enabling long-term cycling stability is carried out with advanced post cycling characterization techniques deciphering the prospects of employing tailored electrolytes for long lasting LFMP-based lithium-ion cells.



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**EIHE 2025: CP 99**

# Synthesis of MSS-Z8 Meso-microporous Template with Enhanced Surface Area for Electrochemical Detection of Vitamin D

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**Abstract:**

Vitamin D deficiency is an emerging pandemic, whose continued persistence could greatly enhance the severity of fatal diseases including cancer and COVID-19. Therefore, the regular monitoring of vitamin D levels is essential to maintain overall health status. With this view, a feasible yet effective electrochemical biosensor has been developed for rapid and cost-effective detection of 25-hydroxyvitamin $D_3$ ($25(OH)D_3$). Herein, exceedingly conductive spiked-Au augmented mesoporous silica sphere-metal organic framework (MSS-Z8) based nanoplatform was constructed. The MSS-Z8 offered improved stability, meso-microporosity with high surface area ($S_{BET(MSS)}$, 49.95 $m^2\ g^{-1} < S_{BET(MSS-Z8)}$, 643.4 $m^2\ g^{-1}$), which illuminates its potential for efficient attachment of Au particles. Further, the bio-recognition element i.e. 5' thiolated aptamer specific to vitamin D was conjugated via Au-SH interactions. After characterization and optimization of Apt/Au/MSS-Z8/FTO electrode, the electrochemical detection of $25(OH)D_3$ was carried out using differential pulse voltammetry technique using $[Fe(CN)_6]^{3-/4-}$ redox couple. The biosensor displayed a concentration dependent decrease in current response upon incubation of $25(OH)D_3$, which formed the basis of $25(OH)D_3$ detection up to 0.084 pg $mL^{-1}$ along with a wide functional linear response range of 0.001-$10^6$ pg $mL^{-1}$. Therefore, the present biosensor holds great prospect for real time quantification of vitamin D.

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**EIHE 2025: CP 100**

# Insights into heterojunction design in $SnO_2/Cu/g\text{-}C_3N_4$ ternary composites for enhanced visible light-driven photoelectrocatalytic water splitting

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## Abstract

The growing population demands increased energy production. To fulfil this need, renewable sources must be utilised. Currently, the energy we use primarily comes from the combustion of non-renewable sources, particularly fossil fuels, a practice that raises many environmental concerns. To address these issues, researchers are focusing on energy production from renewable sources (green energy). In this regard, photocatalysis and photoelectrocatalysis (PEC) contribute tothis field by not only reducing carbon footprints but also by harnessing solar energy in alignment with green chemistry principles. Among energy sources, hydrogen ($H_2$) is promising due to its higher energy density. In this context, our work explores photocatalytic and photoelectrocatalytic $H_2$production throughwater splitting. The main challenge in this domain is developing a visible light-active catalyst with efficient electron-hole separation. To this end, we synthesized a ternary composite system based on $SnO_2/Cu/g\text{-}C_3N_4$ using a simple sonochemical method. The successful construction of the composite was confirmed through various physicochemical characterizations, including XRD, FESEM, BET,UV-visible spectroscopy, FTIR, and EDAX.The observed enhanced catalytic efficiency in $H_2$ production is attributed to the synergistic effect and heterojunction in the composite, which facilitated excellent electrochemical properties, making it highly suitable for photocatalytic and photoelectrocatalytic applications.

Keywords: Photocatalysis, Photoelectrocatalysis, Water splitting, $H_2$gas, Heterojunction, Composite.

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**EIHE 2025: CP 101**

# LDH derived TMD as Electrocatalysts for the Hydrogen Evolution Reaction

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## Abstract

The growing global energy crisis and environmental challenges demand clean and renewable energy solutions. Hydrogen is a promising alternative to fossil fuels due to its high energy density and zero-emission characteristics when used as fuel[1]. However, efficient hydrogen production through electrochemical water splitting, which involves both the hydrogen evolution reaction (HER) and oxygen evolution reaction (OER), requires highly efficient electrocatalysts to lower overpotentials and accelerate reaction kinetics[2]. In this study, we report the transformation of NiMo layered double hydroxide (NiMo LDH) into Mo-doped nickel selenide (Mo@$NiSe_2$) and Mo-doped nickel sulfide (Mo@$NiS_2$)through a simple solvothermal selenization and sulphurization process respectively. The resulting Mo@$NiSe_2$ and Mo@$NiS_2$ catalysts exhibit remarkable improvement in HER performance, with Mo@$NiSe_2$ achieving an overpotential of 118 mV at 10 mA/cm², compared to 602mV required by the pristine NiMo LDH [3, 4].Theoretical DFT studies showed an absolute $\Delta G_H$ value of 0.02 eV for Mo@$NiSe_2$ (210) substantiating the higher electrochemical HER activity.These findings suggest that the transformation of NiMo LDH into its selenide and sulfide forms is a viable strategy for developing low-cost, efficient electrocatalysts for hydrogen production, contributing to the advancement of sustainable energy technologies.

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### EIHE 2025: CP 102

# Highly Active Nickel and Nitrogen-doped Carbon for Enhanced water-splitting reactions

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## Abstract:

Developing earth-abundant and less expensive catalysts with high activity for water splitting is necessary to meet sustainable hydrogen production among the promising alternatives to precious metal catalysts. Nickel and nitrogen-doped carbon present high catalytic activity, stability, and cost-effectiveness. Ni–N–C catalysts were synthesized and assessed for their performance in alkaline (KOH) conditions in both the hydrogen evolution reaction (HER) and oxygen evolution reaction (OER). Along with the synthesized material, graphene oxide was incorporated into the material. The materials' structure can be considered a reason for efficient electron transfer and better catalytic activity due to uniform nickel sites and nitrogen-rich carbon matrix. Such overpotentials for water-splitting are diminished by the synergistic effect between the nickel and nitrogen sites in the carbon matrix,which thus reduces the energy demand for this splitting process. Electrochemical tests have exhibited that these Ni–N–C catalysts reveal remarkable stability and activity compared to Noble metal-based catalysts. It indicates the perspective of these Ni–N–C materials as scalable and economical catalysts, which can render practicality to water-splitting applications in this research study to accelerate renewable hydrogen production technology development. Secondly, wastewater deals with the deficit of fresh water; it dilutes wastewater into better and more sustainable energy.

**Keywords:** Electrochemistry, Water Splitting, Hydrogen evolution Reaction (HER), Oxygen Evolution Reaction, Nickel, Nitrogen and Carbon

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EIHE 2025: CP 103

# In-situ decorated gCN.CuBDC interface for Voltammetric detection

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## Abstract:

Graphitic Carbon Nitride (gCN) ~~is a type of metal~~ free polymer characterized by its semiconducting nature, containing an abundance of electron donor nitrogen sites. The ease of synthesis and availability of precursor material enhances its potential as a material for electrochemical sensing and the detection of various analytes. Nonetheless, certain characteristics that obstruct its effective electrocatalytic performance include inadequate dispersibility in solvent, agglomeration, and restricted electron transfer. To address these constraints,we in-situ modify the electrode surface with gCN and CuBDC. Cu(II)ionsprovide significant advantages in electrochemical sensing due to their high electrocatalytic activity, reversible redox behavior,out standing sensitivity,andcost-effectiveness.The reversible redox behavior of Cu(II)/Cu(I) facilitates reliable cyclic voltammetry, essential for conducting repeated experiments while ensuring optimal responses and reduced electro-dedegradation. The gCN.CuBDC modified interface exhibits enhanced electrocatalytic activity in comparison to its individual component.The enhanced optimization protocol yields nearly double the current response compared to the unmodified interface. The electrochemical surface area of the modified interface was approximately 1.4 times greater than that of the unmodified electrode, indicating that the modified interface provides a greater number of electrochemical sites for analyte interaction.

EIHE 2025: CP 104

# A comparison ofNi-Moand Ni-P alloy coatings as electrocatalyst for overall water splitting in salt water media

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## Abstract:

Water splitting is an effective strategy to produce renewable and sustainable hydrogen energy. Especially, seawater splitting, avoiding use of the limited freshwater resource, is more intriguing. Nowadays, variouselectrocatalysts explored for hydrogen evolution reaction (HER) and oxygen evolution reaction (OER) using natural seawater or saline electrolyte [1]. It is well known that Ni is very much stable in alkaline condition.In this study, Ni foam supported NiMo and NiP electrocatalyst coatings were synthesized by simple electrodeposition method. Electrochemical activity studies of these catalysts were carried out inseawater like system (1M KOH+0.5M NaCl). Both hydrogen evolution reaction (HER) and oxygen evolution reaction (OER) were studied by investigating their CV, LSV and EIS analysis. Ni-Mo and Ni-P both catalysts were found to be active for both HER and OER in seawater like electrolyte. For HER NiMo and NiP catalyst exhibited overpotentialsof 0.31V and 0.29 V respectively for achieving a current density of 10mA/cm$^2$.

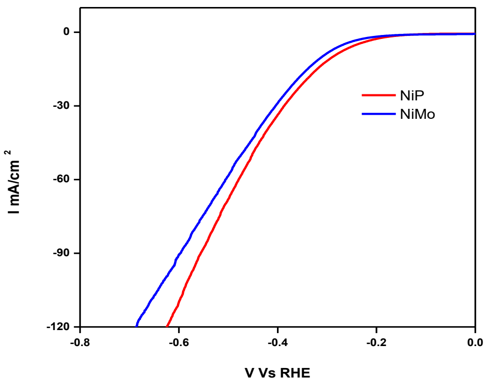

Fig 1. HER activity of NiP and NiMo electrocatalyst in sea water like system

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**EIHE 2025: CP 105**

# Gold-enhanced scribed sensor Intended for the identification of mercury

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## Abstract:

This study presents a highly sensitive gold-coated scribed sensor for detecting mercury (Hg) in environmental samples, addressing the urgent need for effective monitoring of this toxic metal. Mercury contamination poses significant risks to human health and ecosystems, particularly in water and agricultural soils. The sensor employs a novel scribing technique to create precise micro-patterns on its gold-coated surface, increasing its effective surface area and enhancing interactions with mercury ions, which improves sensitivity and selectivity. Gold was chosen for its excellent electrochemical properties, ensuring quick charge transfer and a low detection limit for trace amounts of mercury. With a cost-effective design and ease of use, this sensor is suitable for diverse applications, from industrial waste monitoring to remote field assessments. Its ability for real-time detection can improve environmental safety and regulatory compliance. Future research will focus on enhancing sensor performance and exploring its use across various environmental contexts. Further details will be discussed later during presentation.

**EIHE 2025: CP 106**

# Exploring the supercapacitor performance of binary metal oxidesCuO/MoO$_3$ nanocomposites

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## Abstract:

In this study, pure CuO and MoO$_3$ were prepared bythe Co-precipitation methodand a composite of CuO/MoO$_3$was prepared by hydrothermal process.High-performanceCuO/MoO$_3$ is a considerable low-cost electrode material for supercapacitors.The preparednanomaterials of CuO, MoO$_3$ and CuO/MoO$_3$were subjected to X-ray diffraction (XRD), Fourier transform infrared spectroscopy (FTIR), X-ray photoelectron spectroscopy (XPS), scanning electron microscopy (SEM), and energy dispersive X-ray spectroscopy (EDX). These analytical methodologies were utilized to clarify the crystalline structure, identify functional groups, ascertain oxidation states, analyse surface morphology, and evaluate elemental composition.The electrochemical characterization of the specimen was conducted utilising cyclic voltammetry (CV), galvanostatic charge and discharge (GCD), and electrochemical impedance spectroscopy (EIS). From the findings, the CV curves revealed significant redox peaks, signifying efficient pseudocapacitive behaviour while the EIS data (Nyquist plot) corroborated minimal charge transfer resistance and elevated ionic diffusion rates within the electrode; furthermore, GCD exhibited substantial specific capacitance and consistent charge-discharge cycling.

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**EIHE 2025: CP 107**

# Density Functional Theorystudy of ORR mechanism on zinc oxide doped with a copper vs cobalt nanocluster electrocatalysts

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## Abstract:

A First principle study used Density functional theory (DFT) for the Oxygen Reduction Reaction (ORR) on electrocatalysts simulated as zinc oxide doped with Cobalt and copper nanoclusters. The effectiveness of transition metals and their combinations have been previously shown to exhibit good catalytic activity for the ORR reaction. In this study, a specific kind of surface decoration on zinc oxide was done using an M6 nanocluster to understand the extent of its catalytic activity by the chemisorption of ORR species such as $O_2$, O, OH, OOH, $H_2O$ and $H_2O_2$. Both the $4e^-$ and the $2e^-$pathways have been analysed from the results to find the energetically favourable pathway. A general comparison of the difference in the effectiveness of Cobalt and copper decoration on electrocatalysis of ORR has also been provided, along with an in-depth analysis of the structural and electronic properties of the systems to identify the sites of catalytic activity. Results show that zinc oxide decorated with cobalt nanocluster has higher catalytic activity for ORR. Further future work into this nanocluster as a potential electrocatalyst with relevant changes has also been proposed.

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EIHE 2025: CP 108

# Urchin-like assembled Iron-doped Nickel Cobalt Oxide Nanorods Anchored on Nitrogen and Sulfur co-doped Reduced Graphene Oxide for Electrocatalytic Oxygen Evolution Reaction

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## Abstract

The design of a cost-effective and highly efficient electrocatalyst for oxygen evolution reaction (OER) remains a key factor in the pursuit of developing sustainable energy conversion devices. Nickel cobalt oxide ($NiCo_2O_4$) with its availability of redox couples and stable spinel structure stands out as an effective OER electrocatalyst. However, the low conductivity and limited surface area restrict their use. To resolve the addressed issues, our work focuses on doping Fe in $NiCo_2O_4$ as an effective approach to modulate the electronic structure leading to enhanced electrical conductivity and the incorporation of Nitrogen and sulfur co-doped reduced graphene oxide increases the surface area and durability of nickel cobalt oxide. Herein, we designed an urchin-like assembled Fe doped nickel cobalt oxide nanorods anchored on N,S rGO by a simple hydrothermal method followed by calcination. The prepared electrocatalyst exhibits overpotential of 300 mV to attain a current density of 10mA cm$^{-2}$ in 1M KOH and maintained long-term stability of 12 hours. The enhanced catalytic activity could be attributed to presence of Fe$^{3+}$ sites in nickel cobalt oxide that would improve charge and electron transfer pathways. This doping tends to induce the formation of highly active oxidation states of Ni$^{3+}$ and Co$^{3+}$ thus maximizing the number of Ni-O and Co-O bonds and enhancing the adsorption and desorption of OER intermediates. Therefore, Fe doped nickel cobalt oxide anchored on a heteroatom doped reduced graphene oxide could be a promising, efficient, and durable OER electrocatalyst in alkaline medium.

**Keywords:** Urchin-like assembled-nanorods, N,S rGO, OER electrocatalyst.

EIHE 2025: CP 109

# Design and Development of a Feasibility Prototype for the Non-Invasive Detection of Adultration of honey

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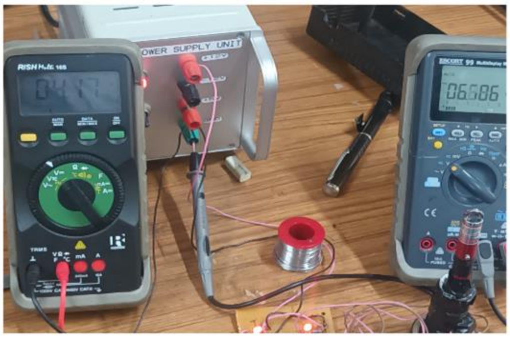
## Abstract:

Honey a primary source of non fruit fructose is typically adultrated with water, causing changes in taste, shelf-life and quality. Non invasive simple methods to detect the extent of this adultration is necessary in the food industry . Presently there is no cost effective commercial of the shelf online non invasive sensor available in the market. In this paper, using spectroscopic methods, a feasibility test for a sensor to perform the above function has been discussed and experimented.The experiment comprises of detecting various levels of water content in honey from various branded products using the effects of scattering and transmission of light from laser source.The result obtained indicates a simple,fast effective non invasive method based portal low cost online sensor can be realised, to detect the amount of water adultration in honey. The honey adultrated with water more that 20 percentage increases the chances of fermentation and decrease the shelf life of honey leading to spoilage of quality especially in health and drug manufacturing industries. This adultration also decreases the nutritional values and impacts on the purity of honey, cheating the customers and affecting their health.

Image:



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EIHE 2025: CP 110

# Utilization of superhydrophilic metallosurfactant electrocatalyst for enhanced cathodic oxygen reduction reaction in MFC

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## Abstract

The microbial fuel cells (MFCs) have the ability to produce clean energy from waste, but the process needs to be more sustainable, cost effective, durable and scalable. A PdDDAB metallosurfactant based super-hydrophilic bilayered film was developed as ORR cathode catalyst for microbial fuel cell using one step hydrothermal approach. At 1.5mM concentration, catalyst shows the 400% increase in current density, thousandfold rise in exchange current density, 60 times reduced polarisation resistance and decreased tafel slope than bare CC. The PdDDAB-coated electrode exhibited a lowered onset potential and retained 90.8 % initial current density for 24 hours showing remarkable stability against ORR. The enhanced catalytic performance in ORR is due to formation of uniform bilayered lamellar membrane with super-hydrophilic behavior, arising from the synergistic effect of electrochemical properties of Pd and the surface characteristics of DDAB surfactant. The catalyst also demonstrated 150% higher current density (471.8 mA/m$^2$) in single-chamber MFCs with Pseudomonas Aeruginosa compared to bare CC electrodes (187.7 mA/m$^2$).

EIHE 2025: CP 111

# Enhanced Seawater Electrolysis for Hydrogen Production by Using a Nickel Ferrate/Nickel Oxide Catalyst Supported on Nitrogen-Doped Carbon

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## Abstract

Hydrogen production from the electrolysis of seawater is more attractive than that from pure water, especially in regions where freshwater resources are scarce. However, under such harsh conditions, higher requirements are put forward for the catalytic activity and adaptability of a catalytic electrode. Herein, we synthesize affordable and highly active nickel-iron oxide fused with nitrogen doped carbon by simple pyrolysis method for an alkaline seawater electrolysis. The N@C-$Ni_1$-$Fe_5$/NFexhibits η of 331 mV (85 mVdec$^{-1}$) for OER and 115 mV(73 mVdec$^{-1}$) for HER to achieve 10 mAcm$^{-2}$ (without iRcorrection). TOF of N@C-$Ni_1$-$Fe_5$/NF(OER: 0.0624 s$^{-1}$/$IrO_2$/NF- 0.0185 s$^{-1}$;HER: 0.0382 s$^{-1}$/Pt/NF- 0.0843 s$^{-1}$) was found to be higher than $IrO_2$and near to Pt, respectively. The N@C-$Ni_1$-$Fe_5$/NFdisplays durability of 50 h with potential loss of 3.2% (OER) and 3.0% (HER).Alkaline water electrolyser of N@C-$Ni_1$-$Fe_5$/NF//N@C-$Ni_1$-$Fe_5$/NFrequired only 1.66 V for effective water splitting and stable over 50 h with low potential loss of 3.5 %.In solar to hydrogen water splitting, the solar cell structure of N@C-$Ni_1$-$Fe_5$/NFrequires 1.65 V for non-stop evolution of $H_2$ and $O_2$, allowing low-cost, large-scale hydrogen generation.

**Keywords:**Seawater electrolysis, oxides, Solar-driven electrolyzer, OER, and HER

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EIHE 2025: CP 112

# Zinc Oxide based Electrochemical Sensor for simultaneous detection of Ferulic acid and Hydroquinone

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## Abstract

The current work reveals a new, simple, non-toxic, sensitive, and environmentally friendly electrochemical approach for the analysis of ferulic acid (FA) by fabricating aspargine (AG) on ZnO-Carbon nanotube composite sensor (ZnO-CNTCS) using cyclic voltammetry (CV). The sensitive and selective AG modified composite electrode (PAG/ZnO-CNTCS) displayed an effective electrochemical behaviour of FA. The characteristic of both unmodified and modified sensor was evaluated using electrochemical impedance study (EIS) and scanning electron microscopy (SEM). FA exhibited a good current response in phosphate buffer solution (PBS) of 3.5 pH. The concentration variation analysis of FA in the linear range of 5.0 μM – 10 μM showed limit of detection (LOD) of 0.82 μM and limit of quantification of (LOQ) of 2.73 μM. The anti-interference property was observed for PAG/ZnO-CNTCS in the presence of organic compounds and metal ions. The simultaneous detection of FA in the presence of hydroquinone (HQ) indicated the good selectivity of the developed sensor. The real sample analysis for the presence of FA showed fine recovery rate and hence the developed sensor can be applicable on the real sample.

**Keywords:** Metal oxide, Zinc oxide, Ferulic acid, Hydroquinone, Graphene.

EIHE 2025: CP 113

# Rhodium Substituted $La_{0.85}Sr_{0.15}CoO_3$ Perovskites: An Active Oxygen volution Electrocatalyst Based upon Ionic Rhodium

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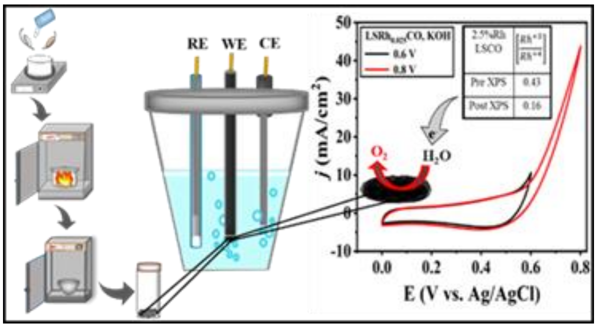
## Abstract:

On behalf of the energy crisis, catalysis frontiers have been focusing on developing high-efficient and low-cost oxygen evolution reaction (OER) catalysts in order to get better activity and stability for energy conversion and storage (ECS) devices. OER plays a vital role in ECS devices as it provides electrons for other half reactions in ECS devices. $La_{0.85}Sr_{0.15}CoO_3$ (LSCO)perovskite is the best choice for selecting a substitute (Rh, Pt, Ru, and Pd) noble metal to get the desired OER activity[1]. $La_{0.85}Sr_{0.15}Co_{1-y}M_yO_3$ (M = Rh, Pt, Ru, and Pd) perovskites were synthesized by the solution combustion method, and complete characterization was performed followed by electrocatalytic investigation for OER. In this work, owing to the best activity from Rh substituted LSCO for OER we have synthesized 1, 2.5, and 5% Rh substituted LSCO by the solution combustion method, followed by XRD, FE-SEM, elemental mapping, EDX, XRF, and XPS analysis. It's necessary to perform XPS studies for $LSRh_{0.025}CO$ of pre- and post OER by chronoamperometry after getting the best result from 2.5% Rh LSCO in both 0.5M KOH and buffer media. The electrochemical surface area of $LSRh_{0.025}CO$ is 2.2 times larger compared to LSCO. Normalizing the steady state current density with the ECSA, the $LSRh_{0.025}CO$ is still anticipated to be 2 times higher than the LSCO.



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EIHE 2025: CP 114

# Sustainable CO2 Management: Electrochemical Technologies for Converting Emissions into Renewable Chemicals and Fuels

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**Abstract:**

A practical option for closing the anthropogenic carbon cycle is the $CO_2$Electroreduction process, which transforms sporadic electricity from renewable energy sources like solar and winds into chemical energies in the form of life-saving fuels and feedstock. In this study, we aim to reduce the existing high amounts of $CO_2$ released from the industries to value-added products and reduce the $CO_2$ emission. Here, we propose to synthesize a novel class of catalysts based on the concept of Metal Support Interaction, where we will evaluate their effects individually and combined. AsCopperis the only metal that is capable of synthesizing hydrocarbons from $CO_2$Electroreduction, we will be dispersing Copper in the form of Cu nanoparticles on a metal oxide support, mainly transition metal oxides. The formaldehyde Reduction Method is used to prepare the supported catalyst. Characterization of the synthesized catalyst is done by X-ray Crystallography, TEM, XPS, FESEM & EDX analysis which gives new insights into the catalyst morphology and structural variations. The Electrochemical studies were performed on a potentiostat in two environments i.e., Nitrogen and Carbon -dioxide, which gives high current densities inthe latter environment. The faradaic Efficiency is calculated for both the Gaseous and Liquid products. The high current densities and high Faradaic Efficiency in the $CO_2$environment manifest that the synthesized catalyst is more active in the $CO_2$environment.

EIHE 2025: CP 115

# Engineering Scale Molten Salt, Electrorefining of Metallic Uranium

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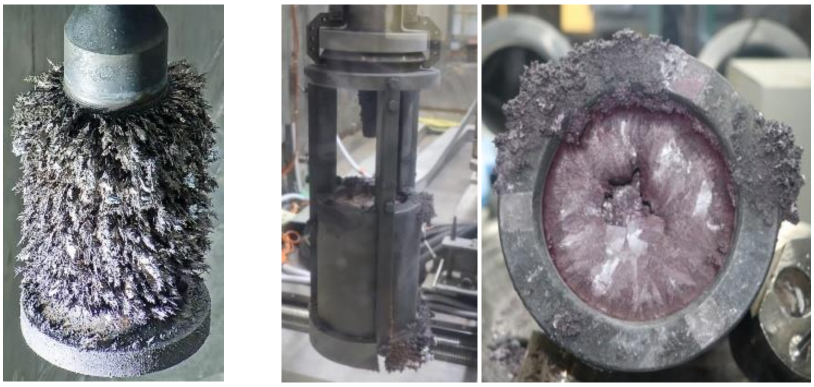
## Abstract:

Research and development activities in IGCAR both in laboratory and engineering scale is in progress for realization of pyrochemical reprocessing for metallic fuel in India [1]. Metal fuelled Fast Breeders Reactors (FBRs) in combination with pyrochemical reprocessing is one most suitable process in view of reducing the overall doubling time, exploring minor actinide recycling potential and minimizing nuclear waste generation volume. In this regard a PyroProcessing Research and Development Facility (PPRDF) was constructed with an objective to demonstrate high temperature Electrorefining and cathode deposit consolidation steps of Pyroprocess flowsheet on an engineering scale which is 10 kg natural metallic uranium /alloys per batch. As part of commissioning of the facility two Uranium electrorefining runs were carried out. In the first run, 10 kg of metallic uranium was loaded in anode basket and 4.5 kg Uranium was electrodeposited on solid cathode (Fig.1a). In the second run, 2 kg of Uranium was loaded into anode basket and 500g (approx) metallic Uranium electrodeposited into liquid cadmium cathode (Fig.1b). The details of the two Uranium electrorefining runs and the experience gained will be covered in the presentation.



(a)

(b)

**Fig.1: Uranium deposit on (a) Solid Cathode and (b) Liquid Cadmium Cathode**

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## EIHE 2025: CP 116

# Highly Sensitive Electrochemical Detection of Nitrite Using $MnCo_2O_4$ Spinel Nanorods

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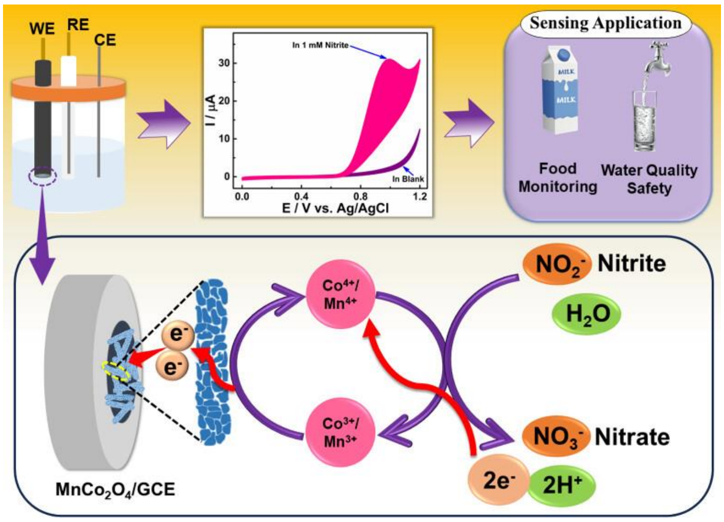
## Abstract

The design of nitrite sensors has attracted considerable research interest due to their extensive applications and the health risks linked to methemoglobinemia and carcinogenicity. This study explores the previously unexamined nitrite-sensing capabilities of $MnCo_2O_4$ (MCO) spinel, synthesized via an oxalate-assisted coprecipitation method. Structural and morphological analyses confirm the formation of uniform MCO nanorods with a high aspect ratio. The MCO-coated glassy carbon electrode (MCO/GCE) demonstrates remarkable electrocatalytic activity for nitrite oxidation, showing a detection range of 5 µM to 3 mM, an impressive detection limit of 0.95 µM, high sensitivity of 857 $\mu A\ mM^{-1}\ cm^{-2}$, and a rapid response time of 4 seconds. In MCO, mixed-valence states of $Co^{2+}/Co^{3+}$ enhance electrical conductivity, while the redox couples of Mn and Co boost electrocatalytic activity for nitrite oxidation. The MCO spinel facilitates efficient faradaic reactions, promoting nitrite oxidation, while the mesoporous structure of the nanorods supports rapid electrolyte and nitrite ion diffusion. Testing in real samples, including milk, lake, and tap water, highlights the electrode's potential for practical nitrite detection. $MnCo_2O_4$ spinel nanorods demonstrate significant promise in electrochemical nitrite sensing, paving the way for furtherexploration of transition-metal oxide-based mixed-spinels.



**Keywords**: spinel metal oxides; $MnCo_2O_4$ nanorods, nitrite sensing; electrochemical sensor; amperometry; high sensitivity

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# Boron doped MXene Nanocomposite based Bioelectronic System for Diagnosing Kidney Disease

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## Abstract:

In recent years, increase in the number of chronic kidney disease (CKD) cases has led to global health burden affecting majorly the under-developed and developing nations. A key biomarker for assessing the kidneys' normal functioning is creatinine, which is filtered out from the blood by the kidney. Thus, timely and specific detection of creatinine becomes necessary for diagnosis and subsequent treatment of CKD. Hence, in this study, we have tried to develop a field-deployable, software-integrated immunosensor for the detection of creatinine in serum sample. The immunosensor was developed by incorporating gold nanoparticles, boron doped MXene, polyaniline, and anti-creatinine antibody using an appropriate bioconjugation reaction. The developed sensor was able to detect creatinine in a linear dynamic range of 10 nM to 0.1 M with a limit of detection of 1.72 nM. The sensor was integrated with anindigenously developed software named ‘CretCheck’ which simplifies the process of data analysis. The software integrated personalized biosensing device was used to findthe creatinine concentrations directly from the obtained analytical signals.The developed immunosensor with the integrated software can also be implemented directly in primary health care facilities for creatinine detection in future.

EIHE 2025: CP 118

# Development of CTAB modified Bismuth nanoparticles decorated Carbon paste electrode for facile voltammetric determination of Caffeic acid in food samples

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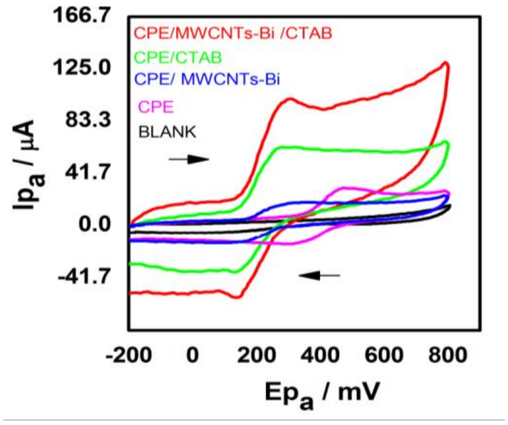
## Abstract:

An unceasing quest to fabricate environmentally friendly and uncomplicated sensor for the quantification of antioxidants is an ongoing process. Consumption of food rich in antioxidants can prevent or reduce instances of liver cirrhosis, colorectal cancer, type II diabetes, inflammation of cardiovascular muscles leading to death and various other such diseases to name a few. CA, a potent antioxidant, checks HIV reduplication and is an inhibitor of industrial corrosion. It is also noteworthy to mention that CA is one of the most investigated polyphenol compounds in its group. In the present work, Caffeic acid (CA) was successfully quantified using Bismuth decorated multi-walled carbon nanotubes drop cast with cetyltrimethylammonium bromide (CTAB). The sensor demonstrates synergistic catalytic properties on enhancing the surface area of the carbon paste electrode. The proposed modified sensor showed exceptional linearity over a range of $6.0 \times 10^{-8}$ to $5.0 \times 10^{-4}$ M, and a limit of detection of 0.157 nM, limit of quantification of 1.910 nM (S/N = 3) using the swift and sensitive DPV technique at physiological pH.The proposed sensor exhibited unique discerning abilities for CA amongst a host of common interferants including applications validated in complex media such as foodstuffs and biological samples without pre-treatments.



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EIHE 2025: CP 120

# MorphologyModulation of CuO Photocathodes Using a Porous Metal-Organic Framework for Enhanced Visible-Light-Driven Water Splitting

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## Abstract:

Designing metal oxide photocathodes with optimal photoelectrochemical (PEC) properties is essential for efficient water-splitting applications. Copper oxide, a well-established photocathode material, has demonstrated significant hydrogen generation potential through PEC water splitting. In this study, we present a comparative analysis of visible-light-responsive copper oxide photocathodes, synthesized through a sustainable approach using metal-organic frameworks (MOFs) as the primary precursor. For the first time, we achieved a rod-shaped CuO morphology by optimizing fabrication techniques, including chemical treatment, hydrothermal synthesis, and electrodeposition, to maximize PEC-driven hydrogen evolution. Departing from the traditional pyrolysis methods for metal oxide synthesis from MOFs, which are often inefficient, energy-intensive, and environmentally taxing—our streamlined approach offers a more sustainable alternative for copper oxide photoelectrode fabrication. Additionally, we carefully examine the enhanced capabilities of different CuO morphologies in PEC water splitting. To further improve charge separation and activity, we coupled CuO with a suitable n-type semiconductor, forming a novel Z-scheme p-n junction. This MOF-derived copper oxide configuration is specifically tailored for PEC water splitting, effectively enhancing both the photostability and efficiency of conventional copper oxide. Our findings highlight the critical role of these design improvements in facilitating efficient hydrogen production.

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**EIHE 2025: CP 121**

# Development of Copper Cobalt Oxide Decorated Nitrogen-doped Hollow Carbon Spheres as a Bifunctional Oxygen Electrocatalyst

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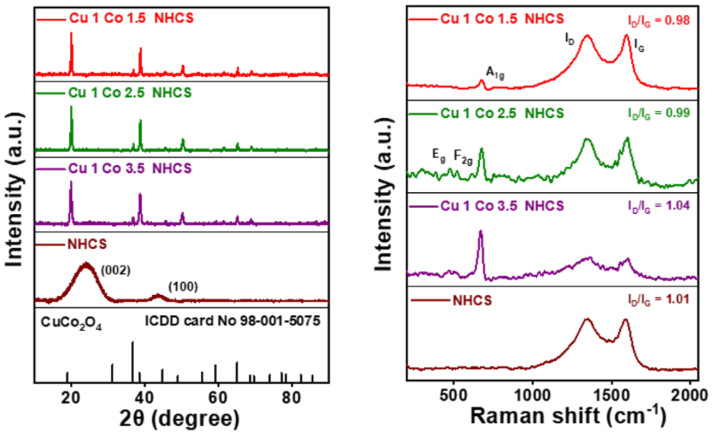
## Abstract:

The increasing demand for sustainable energy has led to renewed interest in zinc-air batteries (ZA). While ZA offers high energy density and performance, their practical application is limited by the sluggish kinetics of oxygen reduction and evolution reactions (ORR and OER) at the air cathode. Noble metal catalysts, such as Pt and $RuO_2/IrO_2$, are highly efficient but expensive and unstable. To address these limitations, researchers have explored cost-effective alternatives, including metal oxide-based catalysts like cobalt oxide spinel ($Co_3O_4$) and copper oxide (CuO). However, these materials suffer from limited active sites and low conductivity. Heteroatom-doped carbon materials offer high conductivity but lack the necessary active sites for OER. To overcome these challenges, a synergistic approach involving the integration of metal oxides and carbon materials has been pursued. This study presents a novel single-step method to synthesize cobalt-phase-enriched $CuCo_2O_4$ within nitrogen-doped hollow carbon spheres. This innovative approach leverages the combined advantages of both components, resulting in a highly efficient and durable bifunctional oxygen electrocatalyst. This development holds significant potential for advancing ZA technology and other sustainable energy storage solutions.



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EIHE 2025: CP 122

# Electrochemical aptasensor platform for chlorpyrifos pesticide detection in Solanumtuberosum (potato)

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## Abstract

A highly sensitive electrochemical aptasensor was assembled on a carbon Quantum dots embedded screen printed electrodes (CQDs/SPE) against chlorpyrifos (CPF) pesticide. Under optimal conditions, the aptasensor showed a wide linear sensing range from 0pM to 500 nM with a calculated limit of detection as low as 0.929pMand sensitivity of 16.23 µA $pM^{-1}$ $cm^{-2}$with good linearity of $R^2 = 0.966$ against CPF. The aptasensor showed excellent selectivity against few other pesticides. Further, the stability of the apta sensor electrode was evaluated and showed high stability over a period of five months. The ability of the developed aptasensor in real samples was evaluated by testing it on spiked potato (*Solanumtuberosum*) extract. Also, un-spiked potato extract was tested against CPF on the apta sensing platform and showed excellent linearity and sensitivity. Hence the developed aptasensor demonstrated reasonable recovery rates, which indicate that it can be best suitable in food and agriculturefields. Also, the results were compared with another aptasensor prepared on $AuCeO_2$-CH nanocomposite coated on ITO substrate platform and found the paper substrates performed superior as compared to the ITO coated glass substrates. This will be useful to construct an electrochemical device platform for CPF detection in future.

**Keywords**: - Screen-printed electrode, Aptasensor, chlorpyrifos, Electrochemical, Potato.

EIHE 2025: CP 123

# Boosting Activity of AgNi alloy by Coupling$CeO_2$ for Efficient Electrochemical Overall Water Splitting at High Current Densities.

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## Abstract:

Developing highly active nonprecious electrocatalysts with superior durabilityfor both the hydrogen evolution reaction (HER) and oxygen evolutionreaction (OER) is crucial toimprove the efficiency of overall water splittingbut remains challenging. In this study, a novel AgNi-$CeO_2$ hybrid is fabricated using a hydrothermal technique.The coupled $CeO_2$ into AgNi can favor dissociation of$H_2O$ and adsorption of hydrogen, reduce the energy barrier of intermediatereactions of OER, and improve the compositional stability, therebydramaticallyboosting the HER performance while simultaneously inducing enhancedOER activity. Additionally, the electrode with a conductive substrate enhances electron transfer between the substrate and catalyst, promotes timely bubble release from the electrode, and prevents catalyst detachment, ensuring high efficiency and stable operation. Consequently, the AgNi-$CeO_2$/NF electrode shows low overpotentials for HER andOER, respectively, as wellas remarkable durability in alkaline media. An alkaline electrolyzer using AgNi-$CeO_2$/NF as both cathode and anode requires an optimum cell voltage to generate 10 mA $cm^{-2}$, outperforming the conventional Pt/C||$RuO_2$electrolyzer (1.54 V@10 mA $cm^{-2}$).Notably, the electrolyzer exhibits remarkable long-term stability at high current density, indicating its potential for large-scale applications.

**EIHE 2025: CP 124**

# Dignity in Diabetes: Advancing Patient Care with Diaper-Integrated, Self-Powered Urinary Glucose Sensor

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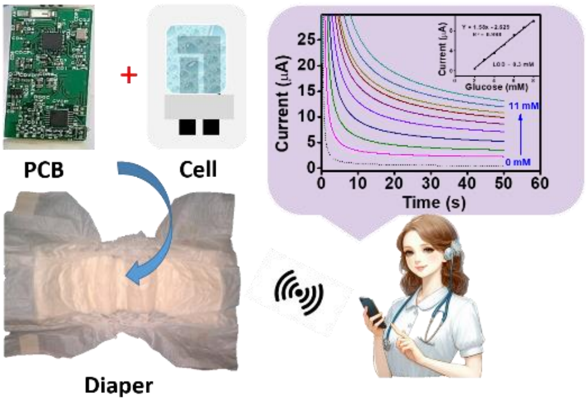
## Abstract:

Self-powered sensors are promising alternatives to traditional three-electrode electrochemical sensors, offering a simpler design that eliminates the need for external power sources and potentiostats. Here, we report on a novel screen-printed, self-powered glucose biosensing system that uses short-circuit current measurements for quantification. The bioanode and cathode consist of a 1,4-Naphthalquinone and glucose oxidase immobilized on a cobalt imidazole metal organic framework, and manganese oxide nanowires decorated reduced graphene oxide, respectively. We propose to integrate the self-powered sensor into a diaper substrate to monitor urinary glucose without exposing patients to humiliation during urine sampling. The sensor coated with agarose gel for urine sampling and mechanical protection is embedded in the adsorbent material of the diaper substrate and connected to a Bluetooth-enabled printed circuit board to take the current measurements. The sensor was found to detect glucose in artificial urine in the concentration range of 0 to 11 mM with a sensitivity of 1.44 µAmM-1 and a limit of detection of 0.3 mM. The sensor's validity was confirmed by correlating urinary and blood glucose measurements yielding a correlation coefficient of 0.994. This self-powered biosensing system integrated into a diaper shows significant potential as a simple, affordable, monitoring solution for real-time diabetes management.



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EIHE 2025: CP 126

# Study of Impact of Defects on Fuel Cell Performance during Automated Manufacture

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**Abstract:**

Mass production and complete automation of the fuel cell assembly line are essential for the commercialization of polymer electrolyte membrane fuel cells (PEMFC). The primary bottleneck to the complete automation of PEMFC is the surface defects that develop during catalyst-coated membrane (CCM) production. The most common defects that occur during CCM manufacture are vacancies, wrinkles, streaks and folds. Therefore, before assembling the stack, each cell needs to beexamined and any defectsor flawsmust be identified. Therefore, the analysis of defects and, eventually, the determination of rejection parameters are necessary for a fuel cell stack to operate steadily. In current study, different kinds of defects in CCM have been investigated along with their implications on fuel cell performance and, ultimately, the rejection parameter.

Electrochemical methods and polarization studies were used to map the effect of intentional defects on membrane electrode assembly (MEA). It was observed that a CCM with folds larger than 10% of the active surface under the fold has a major impact on the fuel cell's overall performance. In contrast, the behaviour of MEA with streaks caused a decrease in fuel cell power density when more than 25% of the area had streaks. In the case of MEAs with voids, it was observed that the voids completely inside and around the centre of the CCM caused a significant drop in fuel cellperformance than voids at the edges.

EIHE 2025: CP 127

# Dual active metal centre Torus shaped Mo-doped $Ni_2P$ for Enhanced Seawater Electrolysis

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## Abstract:

Considering the vast abundance of seawater on Earth, direct seawater electrolysis represents a promising and sustainable strategy for hydrogen fuel production.[1]However, developing highly efficient multifunctional catalysts for this promising technology remains a significant scientific challenge.[2]Herein, torus-shaped Mo-doped $Ni_2P$ nanorings are synthesized via a one-pot approach for application in seawater electrolysis. The Mo-doped $Ni_2P$ demonstrates exceptional bifunctional catalytic performance for the hydrogen evolution reaction (HER) and oxygen evolution reaction (OER) catalytic activity for seawater electrolysis in alkaline conditions. Significantly, Mo-doped $Ni_2P$ achieves a high current density of 1000 mA $cm^{-2}$ with overpotentials of 227 mV and 397 mV for the hydrogen evolution reaction (HER) in alkaline freshwater and alkaline seawater, respectively. Under industrial conditions (30 wt% KOH), it requires an overpotential of 378 mV to sustain the same current density. The $Mo_{0.1}Ni_{1.9}P$//$Mo_{0.1}Ni_{1.9}P$couple demonstrated outstanding seawater splitting capabilities when a cell voltage of 1.47 V was applied at 10 mA $cm^{-2}$ at 25 °C and showed stability of 60 h at high current density of 400 mA $cm^{-2}$. This study offers valuable insights into improving the activity of nickel-based phosphide catalysts and identifying their real active sites.

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EIHE 2025: CP 128

# Comparative Studies of Electrodes for Degradation of Nitro dye

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## Abstract

Nitro dye is a toxic and is also suspected to be a carcinogen[1]. The rate of reduction of Nitro dye concentration is faster in case of Functionalized Reduced Graphene Oxide (FRGO) modified GC over bare GC electrode. A cyclic voltammetry study reveals the superiority of electrodes for the degradation of Nitro group into amine group. In this study, electrochemical measurements of Nitro Dye were carried over the bare and modified glassy carbon electrode surface in aqueous solution. Cyclic voltammetry scans were recorded as displayed in Fig.1A. Over the bare GC electrode surface one clear electrochemical reduction peak at -0.38 V and a hump at -0.56 V for the reduction of it are observed. Similar experiments were carried out using the FRGO modified GC electrode and the results are shown in Fig.1B. Interestingly, three clear reduction peaks due to the reduction of it are observed at -0.13, -0.16 and -0.26 V. The peak currents were increased with increase in the scan rate of the measurements and the peak positions were shifted towards more negative potentials. The mechanism of the electrochemical reduction of it was reported previously[2] reduction of one nitro group to amine group requires the transfer of 6 electrons and six protons. It is important to have the catalyst to completely reduce the nitro group to generate amine group.

On bare GC electrode generation of one complete peak and a shallow reduction peak indicates that over GC electrode surface complete reduction of it is not possible. Over FRGO modified electrode the generation of the three reduction peaks indicates the catalytic activity of FRGO and its capability in complete reduction of nitro group in Nitro dye to amine group. When compared with bare GC electrode the FRGO modified GC produced significantly higher cathodic current, indicating superior catalytic activity of FRGO for the reduction. The reduction current is decreased steadily due to the decrease in Nitro dye concentration in the reaction solution. Initial sharp rise in the reduction current is due to the activation of the electrode and also removal of capacitive resistance. Present results thus indicate efficient reduction over FRGO modified GC substrate, which is capable for degradation through the reduction of nitro groups to amines and seems superior to GC.

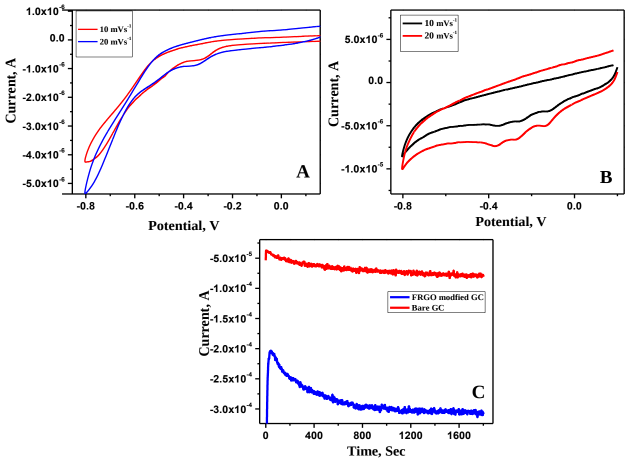

Fig. 1 (A) Cyclic voltammetry scans of 10 ppm Nitro Dye over bare glassy carbon electrode (B) FRGO modified glassy carbon electrode and (C) The decomposition process of Nitro dye over the modified and bare electrodes

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## EIHE 2025: CP 129

# Triggering the phase transition of $MoSe_2$ by introducing the $Cu^+$: Effective strategy to generate 1T@2H phase for enhanced hydrogen evolution reaction.

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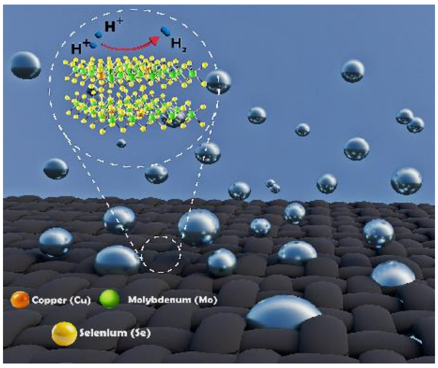
## Abstract:

The quest to find a precise catalyst with non-precious metals for hydrogen evolution process catalysts has garnered astounding attention, Currently, Platinum (Pt) and other platinoids are serve as a catalyst for Hydrogen evolution reaction (HER). However, their adoption is restricted by their elevated cost and scarcity prevent them from being used in widespread utilization. In this work, we effectively built a distinctive 1T/2H phase structure and simple direct growth method via hydrothermal technique to deposit pristine $MoSe_2$ & Cu-$MoSe_2$ on the carbon fibre surface of carbon cloth to directly employed as electrodes without the need for binders for the HER, the as-prepared pristine $MoSe_2$@CC & 3%,5%-Cu-$MoSe_2$@CC sample are analysed by XRD,FESEM,EDS and XPS this meticulously developed architecture is based on carbon fibre substrate possesses to remarkable HER activity with a low onset potential of −113 mV *vs.* RHE (reversible hydrogen electrode), with a Tafel slope of 89 mV per decade with excellent long-cycle stability of 80hrs. In addition, density functional theory (DFT) studies predict that the introduction of $Cu^+$ ions into the $MoSe_2$ monolayer can make the interfacial semiconducting $MoSe_2$ transform into metallic $MoSe_2$. The transformation is beneficial to speeding up charge transfer between the interfaces, promoting H atom adsorption and desorption kinetics, and therefore accelerate the sluggish HER kinetics of 2H-$MoSe_2$ by enhancing the catalyticperformance. In short, the present findings provide both practical and theoretical research avenues, as well as new opportunities for developing of advanced functional catalysts using phase engineering for sustainable energy conversion applications.



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**EIHE 2025: CP 130**

# Metallic 1T – $MoS_2$ decorated N, S dual doped mesoporous hollow carbon spheres for efficient electrochemical hydrogen evolution reaction

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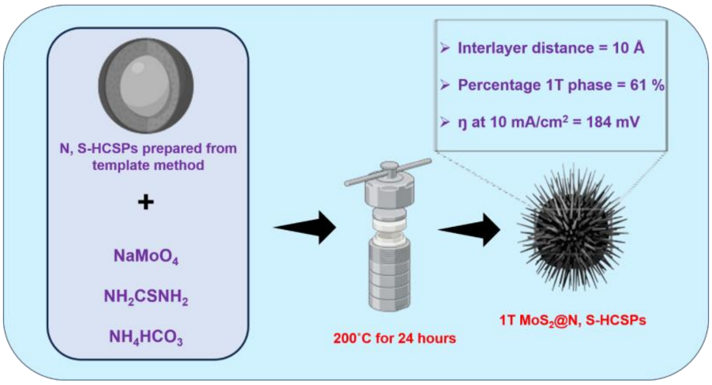
## Abstract

Molybdenum disulfide ($MoS_2$) a transition metal dichalcogenide utilized for many reactions such as hydro desulfurization. It has been considered a potent substitute for benchmark Pt catalyst for electrochemical hydrogen evolution reactions owing to its unambiguous near-zero $\Delta G$ value. However, its semiconducting nature, limited active site, and stability factor inhibit mass transfer and limit its commercialization. On account of this, we developed the $NH_4^+$ ion intercalated metallic 1T phase of $MoS_2$ grown over template-driven N, S, dual-doped hollow carbon sphere as a support. In virtue of the phase conversion and dual doping of carbon support, the remarkable HER performance of 184 mV to reach 10 mA $cm^{-2}$ in an acidic medium has been achieved with a low Tafel slope of 74 mV $dec^{-1}$and compared with its 2H counterpart and N-doped variant of carbon. The introduction of secondary heteroatom for elevated conductivity, optimum loading of $MoS_2$ over the carbon support, and intercalant required for the successful phase conversion with enhanced activity are the key explorations of this study. These findings demonstrate that the fine-tuning of $MoS_2$ electrocatalysts has been a nominal strategy in scaling it up for future sustainable green hydrogen generation.



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EIHE 2025: CP 131

# Impedance Studies for Evaporation of Nitric Acid by Ohmic Heating

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## Abstract:

In Purex process, Nitric acid, TBP and dodecane are the main fluids used. These fluids are separated after the desired processes. A ton of spent fuel is processed in 10 Te of acid solution. Removal of water and nitric acid is carried out in engineered evaporators. Objective of evaporation for reprocessing is to store and recycle. In waste management, various concentrations of acid streams, dilutions are handled in thermo siphon evaporators which are made of SS 304L. Mechanical construction in SS304L and its quality assurance are difficult issues wrt longevity due to corrosion.

Hence conductivity studies of nitric acid solutions during evaporation were carried by impedance measurement. Impedance of nitric acid (1 to 10 M) at variable frequencies at room temperature and boiling temperatures was measured. For these experiments conductivity was measured using pre calibrated electrodes (Standard potassium chloride). The laboratory results would be useful to decide the optimum frequency ranges, electrode design and power supply range for engineering plant scale setups.

It is found that the concentration of HNO3 solution from 1 M to 10 M can undergo ohmic heating without any appreciable electrode corrosion or gas evolution due to electro chemical reactions at electrodes at 10 kHz frequency.

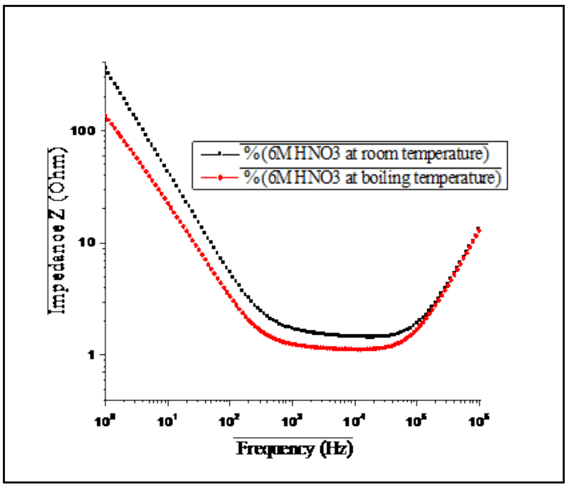

Figure: Representative plot of 6M $HNO_3$ showing impedance in frequency range

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EIHE 2025: CP 132

# High-Efficiency Photocatalytic Hydrogen Evolution with Pd Single Atom-Functionalized $CuCo_2S_4$ Nanosheets

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## Abstract:

Photocatalytic hydrogen evolution represents a key solution for sustainable and clean hydrogen production, addressing critical energy and environmental challenges. This study presents a simple, eco-friendly hydrothermal method for synthesizing atomically dispersed palladium (Pd) catalysts on $CuCo_2S_4$ nanosheets. The resulting Pd-$CuCo_2S_4$ (PCCS) catalysts demonstrate outstanding photocatalytic performance due to their ideal band structure, high charge carrier mobility, and abundant active sites. The Pd-$CuCo_2S_4$ catalysts achieve a hydrogen evolution rate of 39.5 mmol $g^{-1}$ $h^{-1}$approximately 3.6 times higher than that of pure $CuCo_2S_4$ under visible light. Additionally, they exhibit a remarkable apparent quantum efficiency and retain stable photocatalytic activity for up to 18 hours of continuous visible light irradiation. These results underscore the effectiveness of Pd single atom catalysts in significantly enhancing photocatalytic hydrogen production.

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**EIHE 2025: CP 133**

# $Ni_xCo_yO_4$ nanostructures as electrocatalysts for urea oxidation reaction

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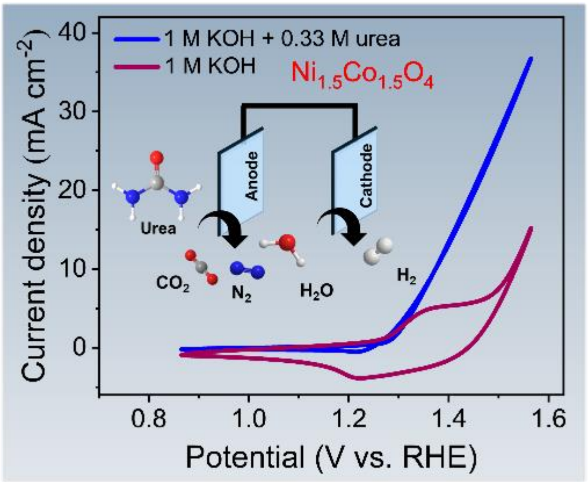
## Abstract:

The urea oxidation reaction (UOR) has attracted considerable interest in recent years as a potential sustainable clean energy technology [1]. Urea-containing wastewater has significant risks to both the environment and human health. Urea is naturally converted to ammonia, which is further oxidized to nitrates, nitrites and nitric acid. These substances accumulate in the water bodies and pose a potential threat to human health and aquatic life [2]. Numerous studies are focused on advancing the UOR as an effective method for wastewater treatment and energy conversion. The available urea-rich wastewater has also been identified as a good source of $H_2$ production, offering a sustainable energy solution [3]. Moreover, the standard redox potential for urea electrolysis is 0.37 V (vs. RHE), which is significantly lower than that of conventional water electrolysis (1.23 V vs. RHE) which is 70% less than that required for water electrolysis [4].We have synthesized$Ni_xCo_yO_4$($NiCo_2O_4$,$Ni_{1.5}Co_{1.5}O_4$and $Ni_2Co_1O_4$)materialsusing hydrothermal methods and identified their precise composition and active sites for UOR.The$Ni_{1.5}Co_{1.5}O_4$ shows much higher catalytic activity, lower overpotential, and better stabilityperformance towards UORcompared to other composition.



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EIHE 2025: CP 134

# Impedance modeling of full SOC cell of tubular configuration

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## Abstract:

Thermal behaviour of Solid Oxide Cell (SOEC) is typically analysed using electrochemical impedance spectroscopy (EIS) modeling of symmetrical cells, within limited temperature ranges[1]. There has been limited focus on impedance modeling of full SOC cell over a wide temperature range, outlining quality of fit. A tubular Solid oxide cell with YSZ electrolyte, Ni-YSZ cathode and LSM anode is fabricated having 200 mA/cm$^2$current density at 820 °Cin electrolysis mode [2]. The impedance is modeled using CNLS fitting of experimental EIS data at OCP, across a temperature range from 200°C to 820°C.Impedance arcs are resolved and this correlation is supported by the equivalent capacitance obtained from the capacitanceof associated constant phase elements (CPE). The transition in cell response with temperature is correlated with changes in the equivalent circuit, and the cell behavior is further analyzed by comparison of the resolved impedance components.The modelled impedances fit experimental data with a maximum error of 2% in most cases, and all fits are within a 5% error margin.

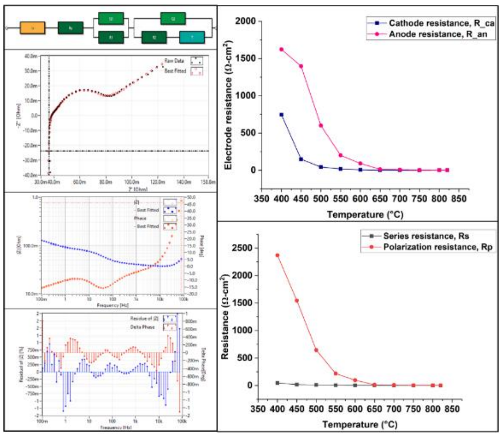

Fig. 1 a) Impedance fitting at 820 °C in 7% steam, b) resolved bulk vs grain boundary resistance with temperature c) resolved series resistance vs polarization resistance with temperature

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EIHE 2025: CP 135

# Ru Prussian blue analogue-derived Ru nanoparticles composited with a trace amount of Pt as an efficaciouselectrocatalystfor hydrogen evolution reaction

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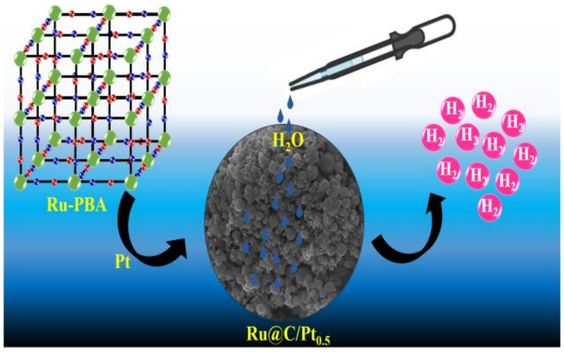
## Abstract:

In this work, we have designed a straightforward and highly reproducible synthetic methodology to prepare Ru$^0$-Pt$^0$composite. We report a significant improvement in the electrocatalytic performance upon composition of Ru with only a very trace amount of Pt. In particular, Ru nanoparticles were derived from the Ru-Prussian blue analogue (Ru PBA) and composited with (0.1, 0.5, and 1 mmol) metallic platinum following an optimized chemical reduction method. Interestingly, the composite with 0.5 mmol of Pt ($Ru@C/Pt_{0.5}$) requires low overpotentials of 32 and 140 mV to achieve current densities of 10 and 100 mA/cm$^2$ respectively.Furthermore, the $Ru@C/Pt_{0.5}$ exhibits a smaller Tafel slope (26 mV/dec), robust durability with 50 hours of long-term stability and a higher turnover frequency (TOF: 5.6 $s^{-1}$@$\eta_{10mA/cm^2}$) than the commercial Pt/C (TOF: 4.1 $s^{-1}$@$\eta_{10mA/cm^2}$). It appears that restricting the use of Pt to trace amounts is a necessary condition for the observed catalytic efficiency, as the catalytic efficiency decreases with increasing island size due to stronger binding of atomic hydrogen on peripheral Pt atoms and stabilization of adsorbed atomic hydrogen caused by softening of phonon modes with increasing island size. This study opens up a novel avenue towards the exploration of highly efficient electrocatalyst for hydrogen evolution reaction.



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**EIHE 2025: CP 136**

# Vanadium-doped cobalt selenide: an efficient bifunctional electrocatalyst for overall water-splitting

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*[b] Centre for Interdisciplinary Sciences (CIS), NISER, Khurda, Odisha, India, 752050*

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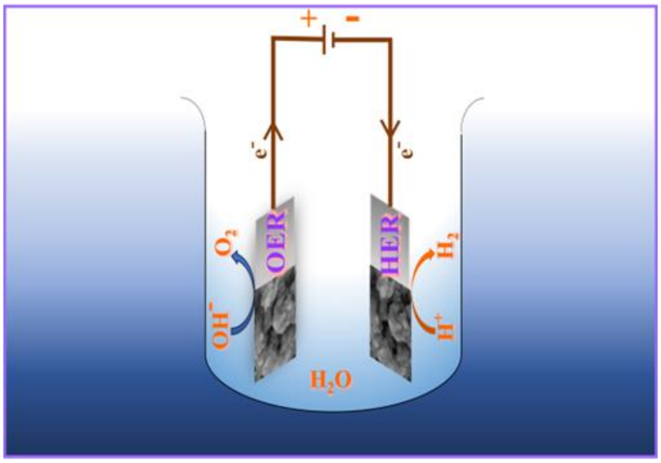
## Abstract:

To obtain catalysts with remarkable activity for the overall water splitting, rational design and synthesis of doped catalysts with rich active sites are paramount. Herein, we report a series of vanadium-doped cobalt selenides (V@$CoSe_2$-1, V@$CoSe_2$-2, V@$CoSe_2$-3) by varying the composition of Co and V. Among the synthesized materials, V@$CoSe_2$-1 has exhibited excellent performance towards the Oxygen Evolution Reaction (OER). V@$CoSe_2$-1 facilitates the sluggish kinetics of the OER mechanism and leads to a low overpotential value of 315 mV at the current density of 10 mA/cm$^2$ and has a lower Tafel slope of 63 mV/dec. The efficiency of the electrocatalyst can be attributed to the V doping, which led to an enhancement in the number of electroactive sites for the process of OER. The electrocatalyst shows 16hour stability at 10 mA/cm$^2$ current density, enhancing its practical durability as an effective catalyst for anodic OER in the water electrolysis process. Furthermore, V@$CoSe_2$-1 shows a good hydrogen evolution reaction (HER) activity in an alkaline medium showing an overpotential value of 270 mV at 10 mA/cm$^2$ current density, Tafel slope of 124 mV/dec, and a good stability of 20 hours in the harsh environment. V@$CoSe_2$-1 is thus employed as a bifunctional electrocatalyst for alkaline water splitting, requiring a cell voltage of 1.96 V and demonstrating exceptional stability over 24hours.



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EIHE 2025: CP 137

# Exploring superior electrocatalytic activity of Co-excess Ni-Co oxide spinel nanowires towards Oxygen Reduction Reaction

*Debarati Das[1,2], Manodip Pal[3], Mridusmita Sarma[4], Yashwant Kharwar[3], Srinivasu Kancharlapalli[5], Arnab Dutta[3] and Kathi Sudarshan[1,2,*]*
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## Abstract:

Defect engineered transition metal oxides with tailored morphology are being extensively explored as a cheaper alternative of noble metal based catalysts towards Oxygen Reduction Reaction (ORR).[1] In this context, one-dimensional mesoporous Ni-Co oxide spinel (NCO) nanowires with varied Co to Ni ratio are synthesized and extensive structural and morphological characterisation was performed using various experimental techniques. Positron Annihilation Spectroscopic studies identified the presence of Co-ion vacancies in Co-deficient nanowires, as well as oxygen vacancies in both Co-rich and Co-lean nanowires. The Co-excess NCO catalysts demonstrated exceptional electrocatalytic activity toward ORR, with an extremely low Tafel slope around 50 mV/decade and half-wave potential around 0.87 V vs RHE, comparable to those of benchmark noble metal-based catalysts.[2] Periodic DFT calculations highlighted the critical role of Co ions on the surface of the catalyst surface in achieving such superior activity. Co-excess NCO catalyst with least peroxide formation (as determined from RRDE experiment, Fig.1) is deployed in a real-life alkaline Anion Exchange Membrane Fuel Cell operating at room temperature. This study demonstrates the practical applications of judiciously designed NCO catalysts as promising alternatives to noble metal-based catalysts in advanced energy applications.

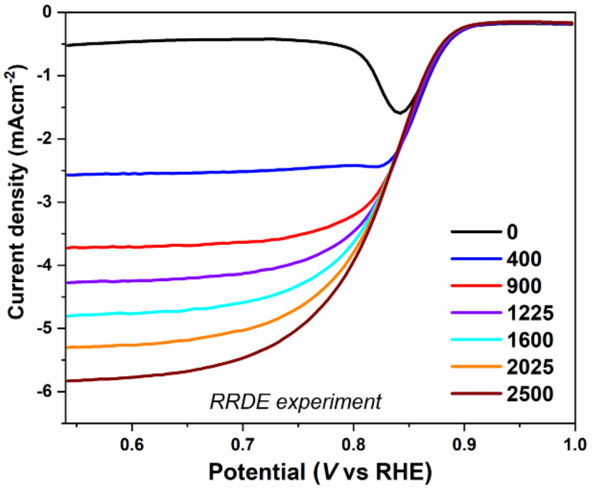

Fig.1: LSV plots of best performing NCO catalyst under different rpm in 1M KOH.

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EIHE 2025: CP 138

# Simulation Driven Electrical Parameters for Lithium and Sodium ion Batteries

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## Abstract

This paper presents a comparative analysis of Lithium Nickel Manganese Cobalt Oxide (NMC), Lithium Iron Phosphate (LFP), and Sodium-ion batteries using the simplified equivalent circuit approach. Key electrical parameters, including open circuit voltage (OCV), internal resistance, and transient response, are evaluated under various operational conditions, incorporating the effects of temperature, using 1RC and 2RC models. The analysis explores differences in energy density, power performance, and thermal stability across these chemistries, linking them to practical applications. Additionally, the paper examines the origins and effects of hysteresis on electrochemical behaviours such as voltage polarization and charge-discharge efficiency, employing charge-discharge cycling tests. The effects of hysteresis based on various temperature values and operating conditions, for each cell chemistry have been studied in this paper. The same electrical parameters will be derived from the above tests performed (HPPC and Low C-rate). The findings, as presented in the paper, provide valuable guidance in determining the suitability of these cell chemistries for various applications. This includes insights into balancing trade-offs in energy, power, thermal performance, and lifecycle considerations, which are critical for applications ranging from electric vehicles to stationary energy storage systems.

***Keywords:*** Sodium-ion, Equivalent Circuit Modeling, Lithium-ion, Resistance, Thermal Stability, Hysteresis

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EIHE 2025: CP 139

# Synthesis of Ni-$Co_3O_4$ supported on orange peel derived activated carbon as electrocatalysts for oxygen evolution reaction (OER)in alkaline medium

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## Abstract:

Transition metal spinels such as $Co_3O_4$with mixed valence cationshas attracted much attention towards oxygen evolution reaction. Incorporation of carbon material with $Co_3O_4$ is an important strategy to enhance their electrocatalytic activity. Herein, Orange peel is utilised as a precursor for the synthesis of activated carbon (OPAC). Asimple hydrothermal method is employed to fabricate Ni-$Co_3O_4$/OPAC hybrid. $Co_3O_4$ and $Co_3O_4$/OPAC were also synthesized to compare the activities. The Ni-$Co_3O_4$/OPAC showed remarkable activity towards oxygen evolution reaction. The lower over potential of 360mV and Tafel slope of 55.47 mV/dec indicate a higher electrochemical performance of the synthesized catalyst. As the orange peel is a cheap and readily available material, the synthesis of Ni-$Co_3O_4$/OPAC could serve as a potential candidate for electrochemical water spitting reaction. This work can provide significant advancement in the development of electro catalyst material for energy conversion and storage technologies and metal air batteries.

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2. Ashalatha Vazhayil, LinshaVazhayal, Jasmine Thomas, Shyamli Ashok C, Nygil Thomas,Applied Surface Science Advances 6 (2021) 100184 (journal)

**EIHE 2025: CP 140**

# Advanced NaF Layer Deposition for Stabilizing Lithium Metal anodes

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## Abstract:

The highly reactive nature of lithium metal anodes with liquid electrolytes causes the formation of an unstable solid electrolyte interphase (SEI) film. This instability can lead to dendritic formation resulting in extremely poor cycling stability and substantially low Coulombic efficiency (CE). It is known that interfacial engineering to create a robust passivation layer on the metal anode can improve cycling stability and CE by delaying electrolyte degradation and preferential growth. Along the same line, we propose a NaF coating on the Li anode as a protective layer that mitigates dendrite growth and electrolyte decomposition, challenges often faced by uncoated Li metal anodes. This unique setup gives excellent rate capabilities, achieving stable performance across a range of charge/discharge rates. Additionally, the NaF-coated Li anode significantly enhances cycling stability for up to 500 cycles at the current density 1 $mAcm^{-2}$ and areal capacity 0.5 $mAhcm^{-2}$. The improved performance is attributed to the formation of stable solid electrolyte interphase (SEI) facilitated by the NaF layer, promoting uniform lithium deposition. Therefore, this simple and low-cost method may benefit the future applications of the next generation Li metal batteries.

**EIHE 2025: CP 141**

# Metal Films from Single Source and their Application in Nanoporous Filtration Synthesis and Electro adhesion

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## Abstract:

An electrolessmetal deposition approach from single source of metal ions has been developed, that works with synthetic and natural substrates. Using this approach, we anchored $Pd^{2+}$ ions on a polycarbonate membrane; reduced it with $NaBH_4$ to get Pd nanoparticles which subsequently reduced Pd ions to form palladium films. The removal of facial metal film resulted in Pd microtubes embedded membrane that serve as efficient microscopic reactors, significantly enhancing catalytic activity. On filtering*p*-Nitrophenol and $NaBH_4$ solution through the microtubes (Fig.1a.),100% conversion of *p*-Nitrophenol to *p*-Aminophenol can be accomplished in under five minutes (Fig.1b.). This method eliminates the need for traditional Ag seeding. Additionally, metal-coated substrates demonstrate unique electroadhesion properties (Fig.1c.).Thin nickel coated stainless steel mesh facilitate the electrodeposition of poly(3,4-ethylenedioxythiophene) (PEDOT), which adheres gel-like substances at a low voltage of 1.5 V. This innovation extends to energy storage systems, where PEDOT-coated nickel substrates are used to fabricate supercapacitors.

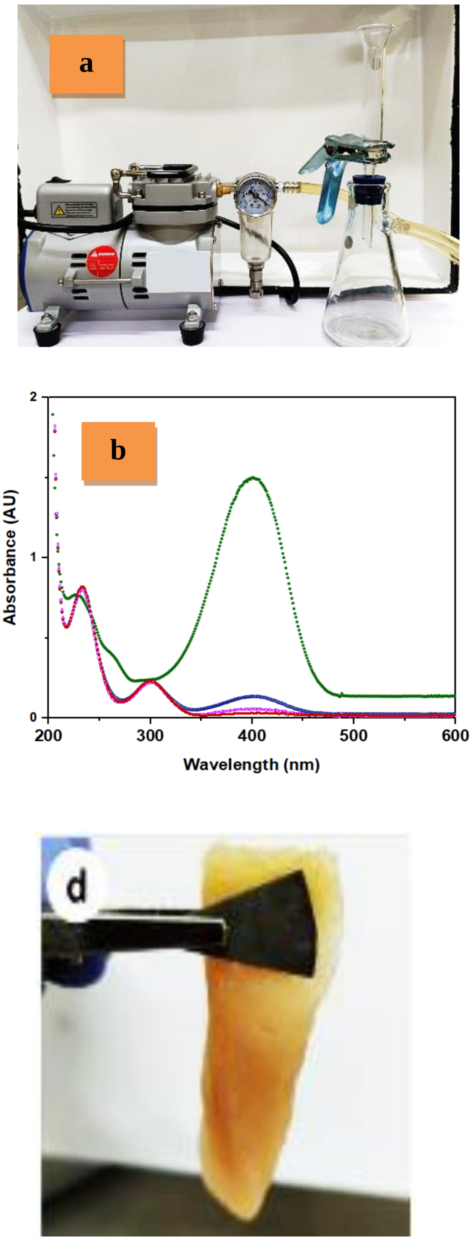

**Fig.1.** Photograph of Filtration Setup (a), UV-Vis Spectra of nanoporous filtration synthesis (b) and Electroadhesion of chicken on Pd@PBI membrane.

EIHE 2025: CP 142

# Facile Synthesis of $LaBO_3$ (B = Cr, Mn, Fe and Co) Perovskite Nanocrystallites for Supercapacitor Application

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## Abstract:

Recently, Perovskite oxides have attracted significant popularity as favourable electrode materials for supercapacitors. In this study, $LaBO_3$ (B =Cr, Mn,Feand Co) perovskite nanocrystallites were synthesised by facile and ultrafast solution combustion method. The structural and morphological aspects were investigated by X-ray diffraction (XRD), Fourier transform infrared spectroscopy (FTIR), Field emission scanning electron microscopy (FE-SEM), and the electrochemical performance has been assessed by cyclic voltammetry (CV), galvanostatic charge-discharge (GCD) measurements and electrochemical impedance spectroscopy (EIS). The as-prepared$LaCrO_3$, $LaMnO_3$, $LaFeO_3$ and $LaCoO_3$electrodes demonstrated specific capacitance of225.1, 373.8, 159.6 and 454.7 F $g^{-1}$ at a current density of 0.5 A $g^{-1}$ respectively. Among them, $LaCoO_3$ showed superior specific capacitance over others along with good rate capability and cycling stability indicating that $LaCoO_3$ can be used as a promising electrode material for supercapacitors.

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EIHE 2025: CP 143

# Tellurium/CNT composite with modified separator as cathode material for Lithium-Tellurium battery

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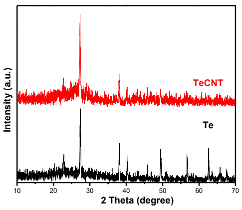
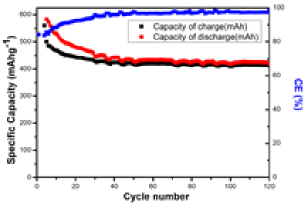
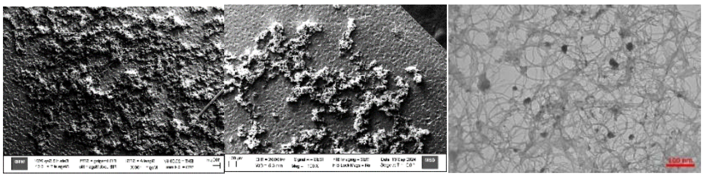
## Abstract:

Due to limited energy density of commercial LIBs, there is a need for next generation battery with higher energy density. One of the available alternatives is lithium-tellurium (Li-Te) batteries. Te has a high electrical conductivity and volumetric capacity. Tellurium was prepared by molecular precursor method and then its composite with CNT was made. Separator was modified to arrest the dissolution of tellurium. Half-cell was prepared by mixing active material with conductive carbon and PVDF in the ratio 7:2:1 for 30 min in mortar and pestle. Li-Te battery showed a significant improvement in capacity of Te on modification of separator.

The synthesised material was characterised by XRD, TG and SEM/EDX. There was a steady capacity decline of Te electrode caused by the dissolution of bulky Te and the loss of active materials in long cycles. The modified electrode showed a capacity of ~420 mAhg$^{-1}$at 100mAg$^{-1}$ for more than 200 cycles. Rate capability, high current rate measurements and impedance spectroscopy were also carried out.The addition of CNT and separator modification enhanced the conductivity and prevents the tellurium dissolution resulting in better electrochemical performance of composite with modified separator compared to either individual constituent.







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**EIHE 2025: CP 144**

# Carbonate Free Sulfone-Based High-Voltage Electrolyte for Li-ion Batteries

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## Abstract:

Lithium-ion batteries (LIBs) are critical for applications ranging from consumer electronics to electric vehicles, driving the need for innovations in cathode materials and electrolytes to achieve higher energy densities and enhanced safety. High nickel-containing layered Li-transition metal oxide cathodes, such as $LiNi_{(1-x-y)}Mn_xCo_yO_2$(Li-NMC), offer high specific capacity, positioning them as leading candidates for next-generation LIBs [1]. However, their operation at elevated voltages (>4.2 V vs. $Li/Li^+$) is hampered by the instability of conventional carbonate-based liquid electrolytes, which results in detrimental side reactions and safety concerns [2].This study introduces a novel sulfone-based electrolyte designed to address these challenges. The sulfonyl group enhances oxidative stability, dielectric permittivity, and reduces flammability, making it ideal for high-voltage applications. Electrochemical testing of Li-NMC811 cathodes in Li half-cells demonstrated that the sulfone-based electrolyte effectively maintains stability, mitigates adverse reactions, and supports efficient electrochemical cycling at high cut-off potentials and even at high temperature of 45 °C.This progress is crucial for unlocking the full capabilities of high nickel-containing ‘layered’ Li-transition metal oxide cathodes, enabling increased cell voltages while maintaining safety and electrochemical efficiency. This research contributes to the ongoing efforts in developing sustainable and high-performance energy storage solutions, essential for the continued growth of electric mobility and renewable energy integration.

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EIHE 2025: CP 145

# Investigating the Role of Pre-sodiation Strategy on the Surface Chemistry and Cyclic Stability ofSnBi-based anodes for Na-ion Batteries

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## Abstract

Pre-sodiation technique counters Na-loss, increases initial capacity, and extends long-term cycling stability ofNa-ion cells. In this work, the direct pre-sodiation of $Sn_{70}Bi_{30}$-based electrode (prepared via simple ball-milling of Sn and Bi, sans any carbon) facilitates the formation of a robust polymer-based solid electrolyte interface (SEI), complemented by an optimally engineered NaF-inorganic layer, which is tailored by systematic variations in time and pressure conditions.The anode, pre-sodiated under the optimized condition of 3 min at 100g pressure exhibits a notably enhanced Na-storage capacity of ~647 mAh $g^{-1}$ at a current density equivalent to0.2C, surpassing the capacity (~536mAh $g^{-1}$) of the pristine (*i.e.*, non-pre-sodiated) counterpart [as reported earlier by us in *ACS Appl. Mater. Interfaces* 15[31] (2023) 37504–37516]. The formation of sodiated phases, including $Na_{15}Sn_4$, $NaSn_2$, and $Na_3Bi$, in conjunction with metallic Na, also significantly enhances kinetics, yieldsimprovedcycling stability, with ~80% capacity retention even after 300 cycles. Thus,our findings showcase a promising approach towards engineering robust SEI layers on Sn-based anodes and enhancing electrochemical performances, paving the way for high-energy-density SIBs.

**Keywords:** Pre-sodiation; Sn-based anode; solid electrolyte interface; electrochemical behaviour/performance; Na-ion battery

# Electrodeposited bimetallic Copper based alloys as electrocatalysts for $CO_2$ Reduction

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## Abstract

Development of novel electro-catalytic materials based on copper metal is an economically viable and easy to scale up, due to the exceptional characteristic of copper to reduce the overpotentials. Combining Copper (active element) with other electrocatalytic metals can bring synergy in $CO_2$ conversion by improving selectivity and mitigating competitive hydrogen evolution reaction (HER).In this work, electrodeposition of bimetallic alloy (Cu-Bi[1]& Cu-Sn[2,3]) was performed on pre-treated carbon paper and evaluated for their electrochemical $CO_2$ conversion efficiency. Variation in morphologies and surface adhesion of the synthesized catalytic materials was obtained by varying the deposition parameters like current density, bath composition and duration of plating time. The electrodes were characterized using advanced analytical techniques like XRD, XPS and FESEM. Polarization studies like CV and CA have been performed. The performance evaluation of the electrodes where studied using three electrode system and the reaction was monitored for various products like methanol and formic acid by using NMR technique.

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EIHE 2025: CP 147

# Electrochemical Investigation of Doped Binary Metal Oxide/PANI Nano composite for Supercapacitor Application

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## Abstract:

The article outlines a study focusing on a binary composite, novel metal oxide/PANI nano composite synthesized using a simple oxidative polymerization method aimed at energy storage application. Characterization techniques such as FTIR, XRD, XPS, FE–SEM, and TEM confirmed the successful formation of the nano composite. Electrochemical assessments including Cyclic Voltammetry (CV), Galvanostatic Charge–Discharge (GCD), and Electrochemical Impedance Spectroscopy (EIS) demonstrated specific capacitances 903.10 $Fg^{-1}$ on Nickel foam (NF) at 1 $Ag^{-1}$ current density. Further, the asymmetric hybrid supercapacitor (ASHC) device displayed a specific capacitance value of 209.66 $Fg^{-1}$ at the current density of 1 $Ag^{-1}$ with remarkable energy density 94.35 Wh/kg at an amicable power density of 900.00 W/kg respectively with 89% retention and 94% coulombic efficiency upto 5000 cycles. As a result, the novel nano composite exhibits promising characteristics as an efficient electrode material in energy storage applications.

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2. V.Pandey, S. Verma, B. Verma, Chem. Phys. Lett. 802 (2022), 139780.

# Co-Ni Encapsulated Carbon Nanospheres: Boosting Solar-Driven Oxygen Evolution for Sustainable Energy

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**Abstract:**

This research explores the use of glucose-derived carbon, doped with cobalt and nickelas electrocatalysts for the oxygen evolution reaction (OER) in water splitting for green hydrogen production. The carbon was synthesized through an environmentally friendly hydrothermal method and doped with Co and Ni using a solvothermal technique. The Co-Ni-doped carbon catalysts exhibited exceptional OER performance, with a low overpotential of 280 mV and high current densities, outperforming traditional catalysts such as $IrO_2$ (370 mV). With impressive catalytic activity (1.55 V) and stability (100 hours), these catalysts present a cost-effective, sustainable approach for large-scale hydrogen production, contributing to renewable energy efforts.

EIHE 2025: CP 149

# Electrocatalytic application of Cauliflower Shaped CuO-ZnO-rGO Nano composite for Ethanol Oxidation

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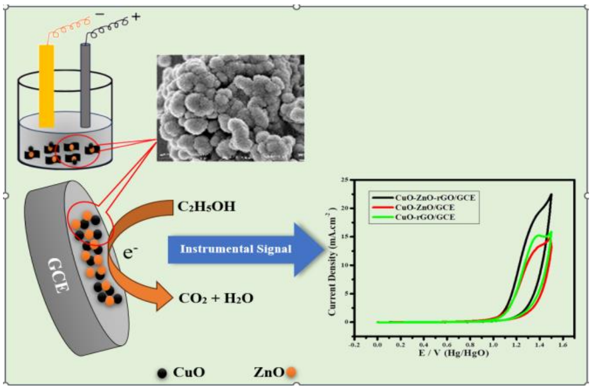
## Abstract:

In the present research work a highly active electrocatalyst for ethanol oxidation that consists of a nano composite of CuO, ZnO, and reduced graphene oxide (rGO). This nanocomposite was synthesized using a simple electrochemical etching method and has been characterized using a variety of physical methods including XRD, FE-SEM, HR-TEM, and XPS. Moreover, electrochemical impedance spectroscopy (EIS) and cyclic voltammetry (CV) was used to evaluate the performance of the electrocatalyst for ethanol oxidation in alkaline medium. The CuO-ZnO-rGO catalyst exhibits potential catalytic activity with a high current density of 19.11 mA cm$^{-2}$ and good long-term stability towards ethanol oxidation. These results are attributed to the large electrochemically active surface area of the catalyst, synergism between the three components of the nanocomposite, and uniform dispersion of CuO and ZnO on the graphene support.



*Scheme: Synthesis of CuO-ZnO-rGO nano composite and its application for ethanol electrooxidation*

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**EIHE 2025: CP 150**

# Electrodeposited Layered Double Hydroxides: Catalysts for Hydrogen and Oxygen Evolution Reactions

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[2]*Electro Organic and Materials Electrochemistry Division, CSIR-CECRI, Karaikudi-630003, Tamil Nadu, India*
[3]*Academic of Scientific and Industrial Research (AcSIR), Ghaziabad -201002*

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## Abstract

This investigation examines the electrocatalytic performance for both the oxygen evolution reaction (OER) and the hydrogen evolution reaction (HER) by synthesizing NiCo LDH using the electrodeposition method on nickel foam.NiCo LDH electrodeposition is studied in relation to the deposited material's structure, morphology, stability, and activity, all of which in turn affects the material's electrochemical performance. The crystalline structure of the electrode material is confirmed by XRD for both graphite sheet and Ni foam substrates, exhibiting the characteristic properties of LDH material. The existence of distinctive vibrational modes of NiCo LDH is further confirmed by Raman and IR spectroscopy, while X-ray photoelectron spectroscopy (XPS) is used to examine elemental composition and oxidation states followed by morphological studies like FE-SEM and HR-TEM. Electrochemical measurements, including cyclic voltammetry (CV), linear sweep voltammetry (LSV),chronoamperometry (CA), and electrochemical impedance spectroscopy (EIS) has been carried out to compare the efficiency in HER and OER reactions of NiCo LDH which are electrodeposited nickel foam. Further, durability and electrochemical performance indicates, LDH electrodeposited has highcatalytic activity for both HER and OER. Effective catalytic activity is promoted by high conductivity and vast surface area, which improve electron transport and expand the number of accessible active sites. Hence, this work advances renewable energy technology by focusing on the significant electrodeposited NiCo LDH showing efficient electrocatalytic performance.

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EIHE 2025: CP 151

# Carbon NanoTube-Incorporated Nafion Composite Membranesfor Polymer Electrolyte Membrane Electrolyzers

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## Abstract

The production of green hydrogen through water electrolysis is a promising solution for sustainable energy storage and conversion applications. The membrane-based water electrolysis using proton exchange membranes (PEMs) plays an important role in generating hydrogen & oxygen with a high purity of 99.99% with less energy consumption and effectively separates hydrogen from other gases. However, Nafion is generally used in low-temperature applications ranging from 60-80°C. If the temperature surpasses this range the membrane may undergo deformation and reduced conductivity. However, incorporating carbon nanotubes (CNTs) has been shown to enhance water retention, mechanical properties, and proton conductivity at elevated temperatures for the generation of green hydrogen. The incorporated composition of CNTs was 1%, 3% and 5% by weight. The CNT/Nafion composite membranes were tested and compared with 5wt% recast pristine Nafion membrane regarding water uptake, swelling, tensile strength, protonic conductivity and ion exchange capacity. The results indicated improved proton conductivity & water retention in the doped membranes than the pristine. Although achieving homogeneity was difficult and not uniform,the studies conducted on the 1x1 membrane showed better results. These findings make the membranes cost-effective and highly efficient for the production of green hydrogen and offer promising advancement in membrane-based water electrolysis.

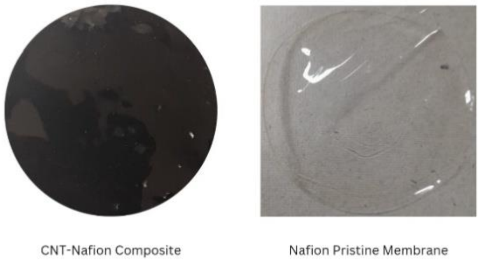
CNT-Nafion Composite
Nafion Pristine Membrane

**Figure 1-** Nafion and CNT-Nafion Membrane in their hydrated form

**Keywords:**
Nafion, Carbon Nanotubes, Composite Membranes, Proton Exchange Membranes, Water Electrolysis, Polymer Electrolyte Membrane Electrolysers

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# Development of alternate hydrocarbon ion-exchange membranes for water electrolysers

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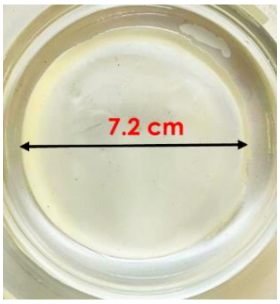
## Abstract

Ion-exchange membranes are widely employed in industrial electrochemical processes including membrane electrolysis, diffusion dialysis, electro-deionization, and electrodialysis[1]. The pressing demand for clean and green fuel, finds their use in unique applications ofwater electrolysis. Membrane based water electrolysis produces high-purity hydrogen that can also be produced at high pressures. Water electrolysers employ solid polymer ion-exchange exchange membranes which can be either cation exchange membranes (CEM) or anion exchange membranes (AEM). CEM mainly contains negatively charged fixed groups with exchangeable $H^+$ions, whereas AEM contains positively charged fixed groups with exchangeable $OH^-$ions. The chemical, thermal and mechanical properties along withthe ionic conductivity are crucialfactors that decide the performance of the membranes in electrolyzers. The optimization of these, along with chemical stability towards degradation, is a critical challenge in developing efficient and durable ion exchange membranes[2]. The present work focuses on the development ofaromatic hydrocarbon-based cation exchange membranes with high ionic conductivity and stability. Thework reports systematic approach of synthesis of the proton-exchange polymer, such as poly(styrene)-co-poly(styrene sulfonate) with varying monomer ratios, theircharacterisation, membrane fabrication, physico-chemical characteristics evaluation, and ultimately the application of the developed membranes in water electrolysers.



Photographic image of the developed proton exchange membrane

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# Synthesis of $Co_3O_4$-CuO Supported AgNPs Nanocomposite as a Potential Electrode Material for Supercapacitor Application

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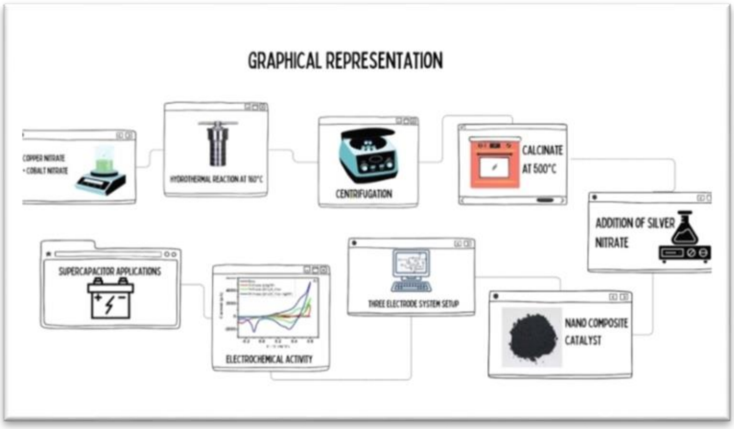
## Abstract

A simple greener approach was developed for the synthesis of highly conducting Ag@$Co_3O_4$/CuO nanocomposite material based on the hydrothermal method. The AgNPs were deposited using Cu plate. Herein, Cu plate was used as a reducing agent for the reduction of AgNPs due to its lower positive reduction potentil (+ 0.37 V) than that of Ag metal (+0.80 V) without using any toxic reducing or stabilizing agent. The synthesized Ag@$Co_3O_4$/CuO nanocomposite was characterized by different analytical techniques The electrochemical performance of the composite material for supercapacitor application was studied by using cyclic voltammetry (CV), galvanostatic charge–discharge (GCD), and electrochemical impedance spectroscopy (EIS). The results demonstrated that the Ag@$Co_3O_4$/CuO composite material exhibited a high capacitance value of 585F/g at 1 A/g and excellent charging and discharging capacity. Furthermore, the complex material showed good stability and 100% retention of capacitance over 3000 cycles. The overall performance of the catalyst attributed to the high conductivity of Ag ions, synergistic effect with support material an large EASA offered by the catalyst. Hence, the synthesized material proved the feasibility for its supercapacitor application.



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# Corrosion inhibition of magnesium alloy AZ31 B by lithium salts in NaCl solution

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## Abstract

The corrosion inhibition effect of lithium carbonate ($Li_2CO_3$) and lithium oxalate ($Li_2C_2O_4$) for Mg AZ31 B alloy was investigated. Electrochemical techniques, including linear polarization resistance (LPR), potentiodynamic polarization (PDP) and electrochemical impedance spectroscopy (EIS) along with characterization techniques such as scanning electron microscope (SEM) and X-ray photoelectron spectroscopy (XPS)were used to evaluate the inhibition efficiency of the lithium salts and the surface morphology and chemical composition of the inhibited Mg AZ31 B surface. The mechanism of lithium ion's role is determined by comparison of equimolar concentration of sodium salts (sodium carbonate and sodium oxalate) with lithium salts. A concentration of 50 mM $Li_2CO_3$ provides the optimal inhibition effect with an inhibition efficiency of 96 % while $Li_2C_2O_4$ exhibits inferior performance. SEM and XPS analysis confirm a protective magnesium carbonate ($MgCO_3$) is formed on the $Li_2CO_3$-inhibited Mg AZ31 B. In contrast, in a $Li_2C_2O_4$ solution, sodium carbonate ($Na_2CO_3$) is formed on the surface rather than $MgCO_3$. Time-dependent corrosion studies further verify that the inhibition effect of $Li_2CO_3$ remains effective for 48 hours, whereas $Li_2C_2O_4$ becomes ineffective after 12 hours.

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# Investigating Potential of Polyoxometalates as Redox Mediators for Water-Splitting Using HER-Peak Current

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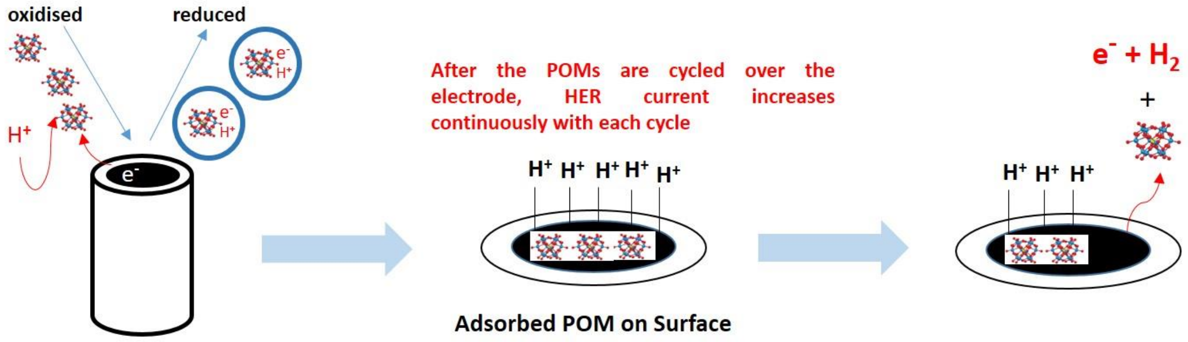
## Abstract

A unique property of polyoxometalates (POMs) is the proton-coupled electron-transfer (PCET) due to which they can store $H^+$ ions during their reduction. $H^+$ ions get released as $H_2$ gas upon reoxidation of POM in the presence of electrocatalysts. This property of POMs helps in decoupling $H_2$ and $O_2$ to avoid the formation of reactive oxygen species which can corrode membranes in the electrolyzers. Instead of water, a POM solution is used at the cathode chamber in the electrolyzer. The reduced POM formed at the cathode during $O_2$ production at the anode is further reoxidised to release $H_2$ in a controlled manner without any additional energy input. Tungstosilicic Acid and other Phosphorus-based POMs were tested for quantitative analysis of hydrogen production in the presence of precious metal catalysts (Pt or Pt/C).

The present study investigates PCET in POMs through anew method by adsorbing POM overa bare-glassy carbon disc electrode to evaluate its HER peak current.Three POMs ($Li_6[P_2W_{18}O_{62}]$), $H_3[PW_{12}O_{40}]$, and $H_4[SiW_{12}O_{40}]$) are analysed to investigate the impact of HER peak current on electrolyte pH, sensitivity towards terminal potentials, and reaction kinetics.These analyses can help in determining the necessary parameters for POM reduction in the water-splitting step and enhancing the hydrogen storage in POM.



**Schematic.** Schematic of the step-wise process of hydrogen storage and release in POM by virtue of adsorption on the carbon surface

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# Electrooxidation of Ammonia and Hydrazine on Polycrystalline Platinum

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## Abstract

Electrooxidation of ammonia ($NH_3$) and hydrazine($N_2H_4$) are investigated on Pt-black catalyst in 0.1 M KOH electrolyte on a rotating disc electrode (RDE) in the potential window of 0.05 – 0.9 V (vs. RHE). The effect of concentration, bulk-pH, and upper-potential limit is investigated. The onset of hydrazine oxidation reaction (HzOR) depicts a negative shift of ~400 mV as compared to that ofammonia oxidation reaction (AOR) [1]. Ammonia electrooxidationon Pt results in the formation of NxHy and possibly N adsorbed intermediates. The adsorbed N species strongly bindon the active sites of Pt, subsequently deactivating the catalyst [2,3].HzOR study is relevant since $N_2H_4$ is a plausible intermediate of AOR [4].With increasing concentration and bulk pH, a rise in the anodic peak currents for both AOR and HzOR is observed. Continuous potential cycling with varying upper-potential limits enables a clear distinction of several redox features.Such analysis is imperative to understand the AOR and HzORkinetics as $NH_3$ and $N_2H_4$ are prospective hydrogen carriers.

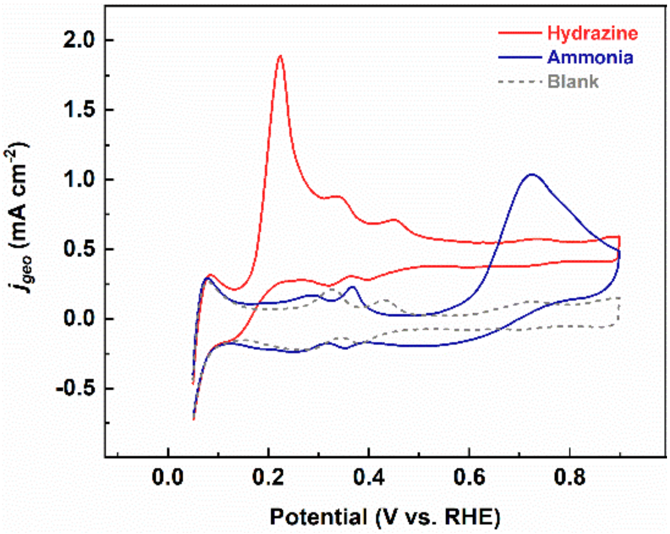

**Figure** Cyclic voltammograms of Pt-black in 0.1 M KOH in the presence of 1 mM $NH_3$and $N_2H_4$ at a scan rate of 20 mV s$^{-1}$

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# Investigation of HER/HOR based on Tafel and Eyring analyses on platinum in acidic medium

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## Abstract

The rate ofhydrogen evolution reaction (HER) and hydrogen oxidation reaction (HOR) are examined on platinum (Pt) electrode in acidic medium. The mechanism of these reactions is analysed based onthe Tafel and Eyring analyses. The Tafel plots (log $|i_k|$ $vs.\eta$) reveal two distinct slopes for HER inlow current density (LCD) and high current density (HCD) regions, whereas, for HOR,Tafel slop isobservedonly in the LCD regiondue to its fast kinetics [1]. The same numberof slopesare observed in plotsof $\Delta H^{\#}$andlog$(A_f)vs.\eta$ within the same potential range. The charge-transfer coefficient ($\alpha$) is estimated from the Tafel slop and $\Delta H^{\#}$andlog$(A_f)vs.\eta$plots [2, 3].In the LCD region, $\alpha$>1 is observed for both the HER and HOR, indicatingan one-electron transfer preceding the rate-determining step (rds). Consequently, the Heyrovsky and Volmer steps are the rds for HER, and HOR, respectively. However, for HER, $\alpha$ <1 in the HCD suggests a shift in the rds to the Volmer step. This study demonstrates the use of $\alpha$ inidentifying the rdsin multi-electron transfer reactions and provides mechanistic insights into the electrochemical behaviour of the reactions. These findings advance the understanding of reaction mechanisms in hydrogen electrocatalysis.

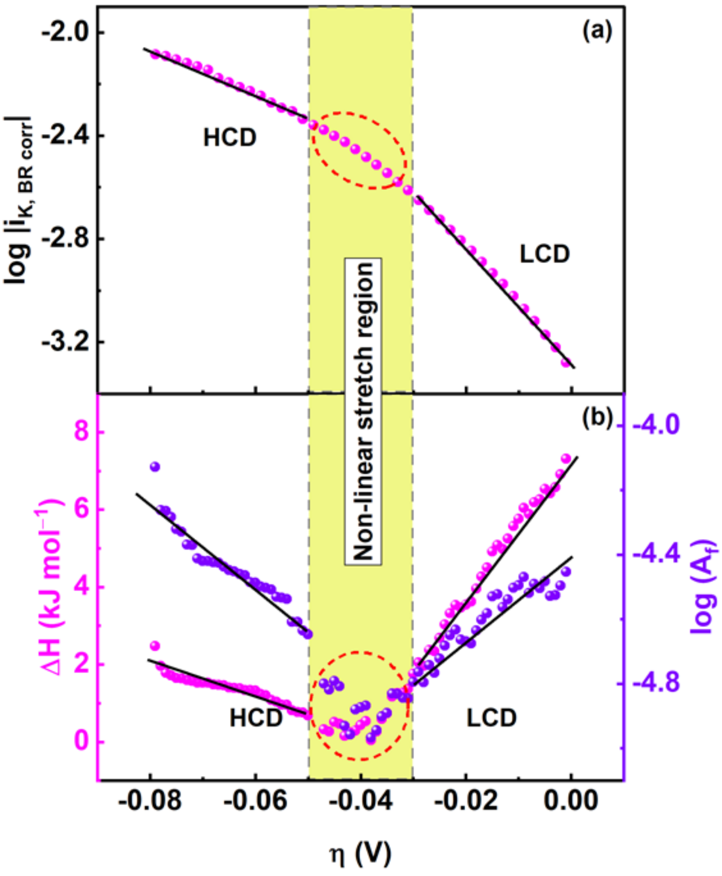

**Figure** (a) Tafel Plot and (b) $\Delta H^{\#}$ and log$(A_f)vs.\eta$ plots for HER

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# Comparison of hydrogen oxidation and evolution reactions on Pt and Ni electrodes

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## Abstract

The kinetics of hydrogen oxidation reaction (HOR) and hydrogen evolution reaction (HER) are investigated on platinum (Pt) and nickel (Ni) electrodes in alkaline medium [1-3]. The composition of the electrolyte and the pH significantly influence the electrocatalytic performance [4,5]. The impact of spectator species on the reaction kinetics is analyzed. For Pt, the continuous adsorption of oxide species ($O_xH_y$) leads to active site blockage, as evidenced by an increase in activation enthalpy ($\Delta H^{\#}$) with overpotential ($\eta$) and a reduction in the Pt-$H_{upd}$area with electrochemical cycling [3,5].In contrast, partially oxide-covered Ni exhibits enhanced HOR/HER kinetics as compared to metallic Ni.Furthermore, the catalytic activity on Ni is higher in 0.1 M KOH than that in 1 M KOH, suggesting that high concentrations of cations in the double-layer region inhibit the reaction by blocking active sites. A comparative analysis of HOR/HER on Pt and Ni reveals thatanion adsorption inhibits these reactions on Pt.Whereas, cation interactions are responsible for inhibition on Ni.This inhibitory effect is corroborated by the observed negative reaction order with respect to cation concentration.

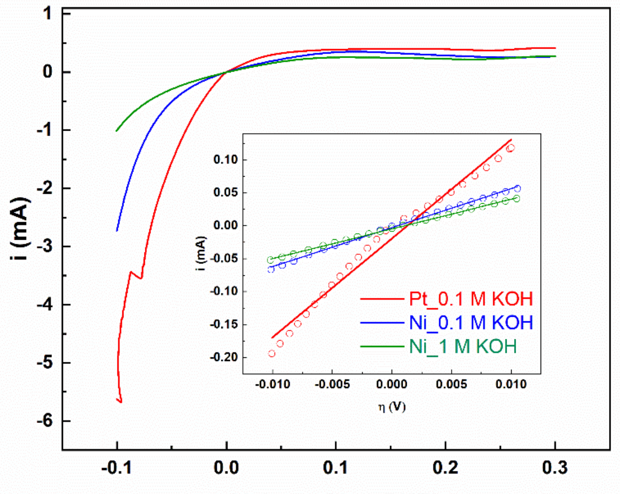

**Figure** HOR/HER polarization curves in alkaline media on Pt and Ni; inset shows the micropolarization region

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# Electrochemical Investigation of Polyoxometalates for Redox Flow Battery Applications

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## Abstract

Redox flow batteries (RFBs) are electrochemical energy storage systems that can store excess energy and deliver when the demand is high. Among RFBs, Vanadium RFBs are well-established because of their long cycle life and scalability. However, VRFBs are limited by the low energy density, crossover, and sluggish redox kinetics [1, 2]. The synthesis and electrochemical characterization of a keggin-typepolyoxometalate (POM) cluster, $H_6ZnW_{12}O_{40}$, for its potential application in RFBs is investigated. Cyclic voltammogram of $ZnW_{12}$reveals two distinct redox reactions, each facilitating two-electron transfers. Electrochemical impedance spectroscopy is used to determine the heterogeneous rate constants ($k^0$)of these redox reactions,and it is found to be of the order of $10^{-3}$ cm $s^{-1}$[3]. The rate of $ZnW_{12}$ is ~1000 times faster than that of vanadium-based redox systems (~$10^{-6}$ cm $s^{-1}$). Additionally, Randles-Sevcik analysis is used to estimate the diffusion coefficient of $ZnW_{12}$, yielding a value of $2.67\times10^{-6}$ $cm^2$ $s^{-1}$[3-6].These results highlight $ZnW_{12}$ as a promising candidate for significantly enhancing the performance of RFBs due to its fast electron transfer kinetics and redox properties.

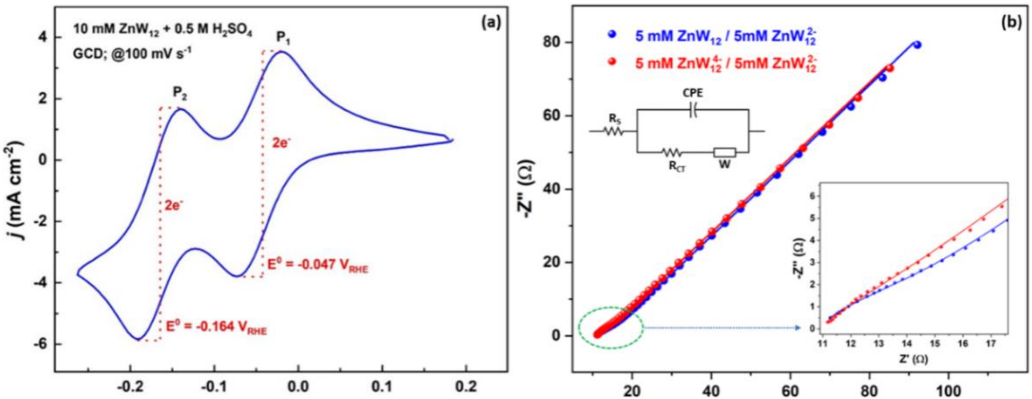

**Figure** (a) Cyclic voltammogram of 10 mM $ZnW_{12}$ in 0.5 M $H_2SO_4$ at a scan rate of 100 mV $s^{-1}$ on glassy carbon disk (b) EI spectra of 5 mM $ZnW_{12}$/5 mM $ZnW_{12}^{2-}$ (Blue) and 5 mM $ZnW_{12}^{4-}$/5 mM $ZnW_{12}^{2-}$ (Red) in 0.5 M $H_2SO_4$ in the frequency range of 10 kHz to 50 mHz. The inset provides a magnified view of the high-frequency region.

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# Redox speciation of Neptunium in Maline media

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## Abstract

Deep eutectic solvents (DESs) are a fascinating class of novel solvents that have gained popularity in the electrowinning process for metal recovery in the twenty-first century [1–3]. These solvents are used as the most environmentally friendly and promising substitutes for ionic liquids and traditional organic solvents, and they have resolved the problems associated with traditional recovery procedures. For use as solvents in metal recovery processes, DESs offer a number of advantageous characteristics, including low volatility, a broad range of liquids, low melting points, low/non-flammability, and large electrochemical window. In the present study, the Maline DES (Choline Chloride and Malonic acid) was synthesized and it was used to dissolve neptunium oxide. Cyclic voltammetry was used to probe the redox speciation of dissolved Np species in Maline media using three type of working electrodes namely, GC, Pt and Au [Fig. 1a]. Interestingly, variation in redox pattern and diffusion coefficient ($D^0$) was obtained at these electrodes. At Pt and Au electrodes, the single reduction step was found associated with the Np(VI)-Np(V) conversion while the two reduction peaks corresponding to the Np(VI)-Np(V) and Np(V) to Np(IV) was observed at GC. The CV plots were also recorded with varying scan rates [Fig. 1b] which was used to evaluate the D0, and rate constant (k0) values at above working electrodes. It was found that $D^0$ ($5.1\times10^{-7}$ cm$^2$/sec) and $k^0$($2.4\times10^{-4}$ cm/sec) of Np(VI)/Np(V) couple is higher at Pt electrode compared to others. Using theses redox parameters, the electrodeposition of Np from Maline media was performed. The present study has potential application in reprocessing of spent nuclear fuel and associated waste management.

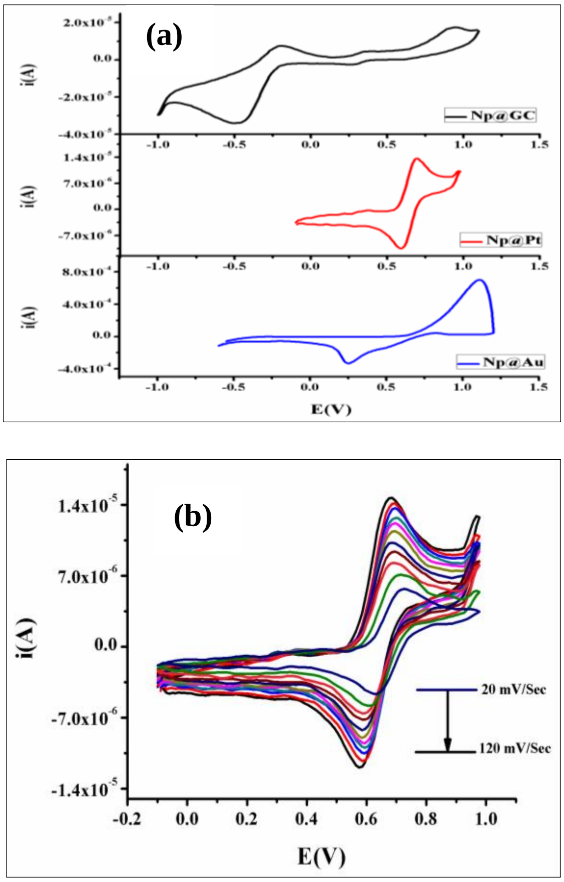

**Figure 1.** Cyclic voltammetry plots of dissolved Np-oxide in (a) at various working electrodes (b) CV with varying scan rates.

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# Effect of in-situ treated carbon electrode on the performance stability of vanadium redox flow battery (VRFB)

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## Abstract

In this study, in-situ treated carbon felt ($CF_{in\text{-}situ}$)electrode is used to improve the performance stability of the vanadium redox flow battery (VRFB) by charge-discharge cycling. It is observed that the accessible capacity of the system with $CF_{in\text{-}situ}$increases consistentlywith the cycling as compared to that with the heat-treated and pristine electrodes [1, 2]. As thecharge-discharge cycling progresses, utilisation of the electrolyte increases and the sameis confirmed fromthe increasein capacityof the system. This treatment leads to decrease in activation potential losses. Cyclic voltammetry (CV) and electrochemical impedance spectroscopy (EIS) are conducted to study the individual electrode characteristics. From the CV studies, it is observed that the improvement of the system can be attributed to the increase in active area of the electrodes asevident from the increase in peak current.In the literature, the activity of the system is limited by the negative electrode [3]; however, in this study, improvementis observed in both the electrode performances,which is crucial in performance stability of the VRFB [2]. To support the analysis, the decrease in charge-transferresistance is observed for$CF_{in\text{-}situ}$as compared to that of the heat-treated and pristine electrodes as estimated from the EIS measurements [4].

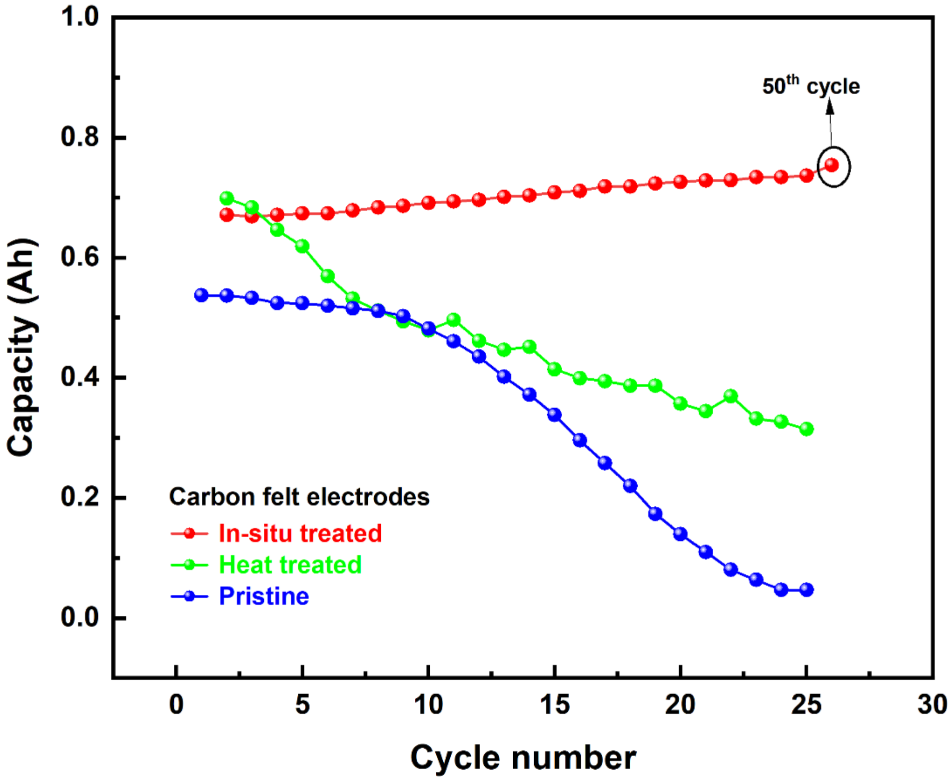

**Figure** Comparison of capacity for three carbon felt electrodes in 1.8 M V + 3 M $H_2SO_4$ with 60 $mAcm^{-2}$ applied current density at 60 mL $min^{-1}$ flow rate on 25 $cm^2$ area electrode.

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# Electrochemical analysis of carmoisine by using poly (Glycine) modified carbon paste electrode.

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## Abstract

This study introduces a highly sensitive and selective method for detecting carmoisine (CMS) using a glycine modified carbon paste electrode (GNMCPE).The GNMCPE exhibit an optimal oxidation peak at 0.537 V, generating a current response of 17.33µA in a 0.2 M phosphate buffered saline (PBS) solution at pH 6.5. The electrode's performance was characterized through cyclic voltammetry (CV), differential pulse voltammetry (DPV), scanning electron microscopy (SEM), and electrochemical impedance spectroscopy (EIS). The results showed that the GNMCPE produced a significantly higher current compared to the bare electrode. Several factors, such as pH, active surface area, concentration variation, and the number of protons and electrons involved in the oxidation process, were analyzed using this electrode. In DPV method, the GNMCPE exhibited a limit of detection (LOD) of 0.16µM and a limit of quantification (LOQ) of 0.79µM, while in CV, the LOD and LOQ were 0.23µM and 0.79µM, respectively. The modified electrode shows excellent sensitivity for detecting carmoisine even in the presence of interfering compound like indigo carmine (IC), methyl red (MR), and methyl orange (MO).Additionally, the glycine modified carbon paste electrode's stability, reproducibility, and repeatability were rigorously evaluated. This method was successfully applied to detect carmoisine in real world sample, including soft drinks and tap water.

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# Study on the Effects of Bubble Diameter and Reaction Rate Kinetics in an Mg-$CO_2$Electrochemical System

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## Abstract

Since the Industrial Revolution, rising atmospheric $CO_2$ levels have caused environmental issues like sea-level rise, flooding, droughts, and global warming [1]. Recent advancements in electrochemical $CO_2$conversion presents a promising solution for reducing $CO_2$ emissions while enabling sustainable production of hydrogen and value-added fuels.The $CO_2$gas dissolves in water, forming $HCO_3^-$, $H^+$, and $CO_3^{2-}$ ions, which lowers the electrolyte pH. On this concept, an Mg-$CO_2$ electrochemical cell is developed using a metal Mg as the anode, 1 M KOH + 1 M KCl electrolyte, and a Pt/C coated cathode to convert $CO_2$into hydrogen, $Mg(HCO_3)_2$, and electricity [2]. A mathematical model is developed by using dilute solution theory to explain species transport, the Euler-Euler (EE) multiphase approach for the conversion of gaseous $CO_2$ to aqueous $CO_2$, and the porous electrode theory for the electrochemical conversion of $H_2$ within porous media, and validated with the experimental data from Kim et al. [2]. The results show that the bubble diameter significantly influences the gas-liquid interfacial area, impacting the efficiency of mass transfer in the Mg-$CO_2$ system. Changes in the chemical reaction rate constant further affect the reaction kinetics, playing a critical role in system performance. A detailed analysis of these parameters is performedto improve the $CO_2$conversion efficiency of the Mg-$CO_2$ system.

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# Comparative analysis of various polyoxometalates through electrochemical investigation

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## Abstract

Polyoxometalates (POMs) exhibit multi-electron transfer redox reactions leading to high energy density, which makes them promising electrolytes for their use in batteries and supercapacitors [1]. In this study,synthesisand electrochemical characterization of Tungstocobaltate Acid ($[CoW_{12}O_{40}]^{6-}$) is reportedand compared with the Tungstosilicic Acid ($[SiW_{12}O_{40}]^{4-}$), Tungstophosphoric Acid ($[PW_{12}O_{40}]^{3-}$) [2]. Cyclic voltammogram (CV) of $CoW_{12}$ reveals that it undergoes two redox reactions, each with two electron-transfer as compared to one electron-transfer in $SiW_{12}$ and $PW_{12}$ in the comparable potential range [3].Equimolar solutions for the two processes are prepared through bulk electrolysis for further electrochemical analysis, and the presence of species under equimolar conditions is confirmed by theopen circuit potential (OCP) of the solutions.Electrochemical impedance spectroscopy (EIS) and Tafel analysis are used to estimate heterogenous rate constants ($k^o$) for all the three POMs.The results reveal that the second redox reaction is more facile compared to the first, and the rate constants of $SiW_{12}$ and $CoW_{12}$ are comparable, despite transferring twice the number of electrons.This study aims to understand the reaction kinetics of Keggin-type POMs, emphasizing their potential for energy storage applications and provides foundation for future research in this field.

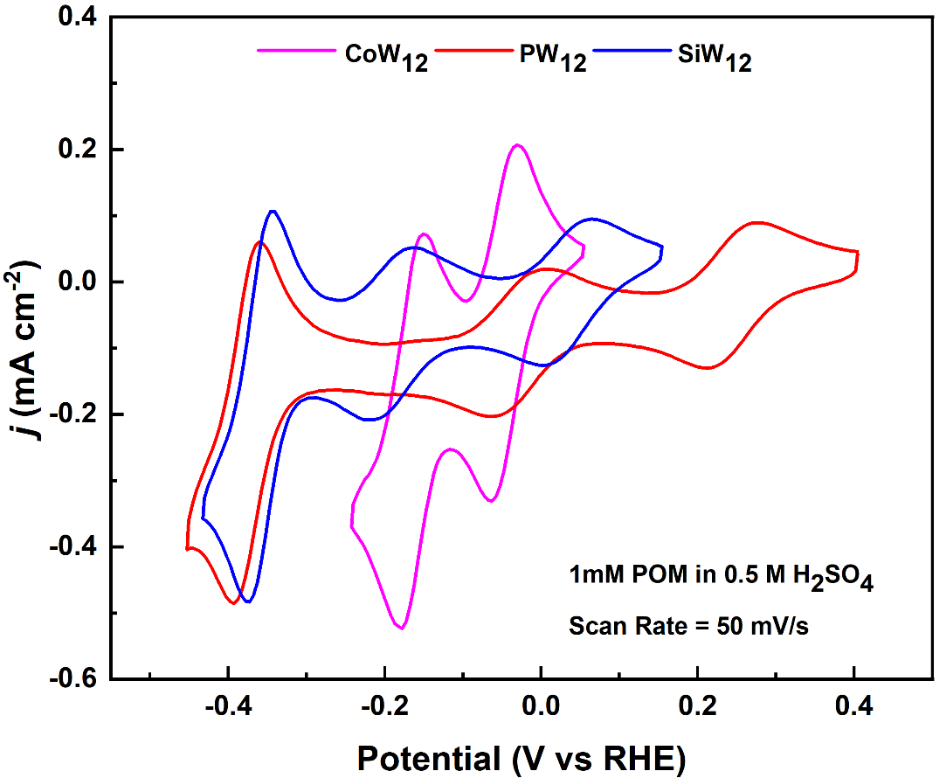

**Figure.** Voltammograms of Keggin-type POMs ($CoW_{12}$, $PW_{12}$, and $SiW_{12}$)

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# Suppression of Dendritic Growth in Hybrid Redox Flow Batteries

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## Abstract

Hybrid redox flow batteries, including zinc-bromine, zinc-cerium, soluble lead, and all-copper systems, undergo metal deposition and dissolution processes during their charge-discharge cycles. In zinc-based systems, non-uniform deposition accompanied by side reactions, such as hydrogen evolution, result in the formation of mossy or dendritic structures [1,2].The progressive growth of dendrites over multiple charge-discharge cycles is an inevitable phenomenon in most of the redox flow batteries. Starting with an initial performance loss, dendritic growth can lead to short-circuit failure. Therefore,addressing dendritic growth is crucial to optimize the performance and longevity of these batteries [3]. This work is concerned with studying the influence of electrolyte composition, electrode morphology, and operational parameters on dendritic growth during electrodeposition of zinc, lead, and copper. The results show that the formation of dendrites is dependent on the reduction potential of the metal ions, with zinc exhibiting the most pronounced dendritic growth as a result of its high reduction potential. Various suppression strategies are examined, including the use of additives, surface coatings, and advanced electrode materials. Electrochemical techniques like cyclic voltammetry, chronoamperometry, and impedance spectroscopy are used to analyze the efficacy of these strategies.Understanding dendritic growth mechanismsoffers valuable insights into the improvement ofthe battery performance, longevity, and safety.

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# Development of MOF-Derived $CeO_2$/MWCNT Nanocomposites for Enhanced Hydrogen Evolution Reaction

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## Abstract

The advancement of sustainable hydrogen production requires the creation of efficient and economically viable electrocatalysts for the hydrogen evolution reaction (HER). The present investigation showcases, the development of a metal-organic framework (MOF) derived ceria ($CeO_2$) that are modified using multi-walled carbon nanotubes (MWCNTs) for evaluation of HER performance. The $CeO_2$ is synthesized by calcination of MOF while a sonochemical approach is followed to create its composites with MWCNT.[1] Ceria derived from MOF provide homogeneous porosity, enhanced surface area, and tuneable morphology. Incorporating MWCNT into $CeO_2$ further improves its performance for HER by serving better conductive support, boosting structural stability, and better charge transfer.[2] Thus, the synergetic interactions of MWCNT and $CeO_2$ result in enhanced catalytic activity, greater electrical conductivity, and long-term durability in challenging electrochemical environments.

Structural and morphological characterization is carried out using different techniques like XRD, FTIR, RAMAN, XPS, SEM, and HR-TEM which confirms the uniform distribution of $CeO_2$ on the MWCNT framework. Additionally, electrochemical testing is carried out which reveals excellent performance of nanocomposite towards HER, by providing less overpotential, smaller Tafel slope, enhanced electrochemical active surface area (ESCA), and long-term durability. These results underscore the potential of MOF-derived $CeO_2$/MWCNT nanocomposites as effective and durable electrocatalysts for sustainable hydrogen production.

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# Synthesis of Cobalt Manganese Layer Double Hydroxide (Co-Mn-LDH) In Nitrate Form for Hybrid Supercapacitor Application

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## Abstract

Cobalt-manganese-layer double hydroxide (Co-Mn-LDH) in nitrate form is synthesized by conventional co-precipitation method and its consecutive exfoliation is achieved using vigorous shaking in formamide.[1,2] Its monolayer exfoliation is confirmed by the LASER Tyndall effect. The obtained samples are characterized for structural and surface charge study by powder X-ray diffraction (XRD) and Zeta potential, respectively. Structural study of Co-Mn-LDH revealed the layered arrangement of Co-Mn-$(OH)_2$ nanosheets stacked together with nitrate as an interlayer anion. The exfoliated Co-Mn-LDH nanosheets demonstrate the Zeta potential of +36.65 mV, indicating the positively charged state of exfoliated Co-Mn-LDH nanosheets.In addition, Co-Mn-LDH will be studied with different characterization techniques for morphological, chemical bonding, and surface area analysis like FE-SEM, FT-IR,and BET, etc., and used as positive electrode material in the hybrid supercapacitor application.

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# Synthesis and Structural Characterizations of Layered Sodium Manganate forSupercapacitor Application

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## Abstract

Transition metal oxides (TMOs) are gaining significant attention in energy storage and conversion applications due to their environmental friendliness, structural diversity, large surface area, and high theoretical capacitance. Noble TMOs like $RuO_2$ and $IrO_2$ exhibit excellent performance but are expensive and less sustainable. In contrast, base TMOs such as $MnO_2$, NiO, and $V_2O_5$ are cost-effective, eco-friendly, and demonstrate remarkable capacitive properties, making them a key focus of recent research. Among these, manganese oxides ($MnO_2$) are particularly promising due to their non-noble composition, wide operating potential (~1 V), admirable capacitive performance, and environmental benignity.In this study, a novel composite, **$Na_{0.5}Fe_{0.5}Mn_{0.5}O_2$**, was synthesized by heterogenizing$MnO_2$ with $Fe_2O_3$ and $Na_2CO_3$. The phase-pure formation of $Na_{0.5}Fe_{0.5}Mn_{0.5}O_2$ was confirmed by **X-ray Diffraction (XRD)**. Further characterization using **TEM**, **SEM**, **BET**, and**EDAX** revealed its structural, morphological, and elemental features. Electrochemical performance assessed through **Cyclic Voltammetry (CV)**, **Galvanostatic Charge-Discharge (GCD)**, and**Electrochemical Impedance Spectroscopy (EIS)** demonstrated its high capacitance, and efficient charge transport, making it a viable alternative to any other transition metal oxide composite for energy storage applications. This eco-friendly and cost-effective material holds promise for scalable supercapacitor technologies.

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# Palladium nanoparticle supported nickel-cobalt layered double hydroxideon glassy carbon electrode for enhanced electro oxidation ethanol oxidation

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## Abstract

We reported a facile electrochemical strategy for the synthesis of highly dispersed Pd nanoparticles coated on a nickel-cobalt layered double hydroxide (Ni Co-LDH) nanocomposite material via electrochemical deposition method and hydrothermal method on glassy carbon electrode (GCE) without any external agent. The modified electrode named Pd/Ni-Co LDH/ GCE composite was characterized by various characterization techniques such as XRD, FE-SEM, HR-TEM, and XPS etc. The application of the composed material was investigated for the electro-oxidation of Ethanol in alkaline medium by using cyclic voltammetry technique, electron impedance spectroscopy and chronoamperometry showing potential electrocatalytic activity with a high current density of 11.60 mAcm$^{-2}$ as well as better anti-poisoning ability with stability towards ethanol oxidation than commercial Pd/C. The enhancement due to uniform dispersion of ultrafine Pd NPs, the synergistic effect and stable support of Ni-Co LDH with increased specific surface area and location sites for supporting Pd NPs for accelerating the ethanoloxidation reaction (EOR).

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# Enhancing Electrochemical Performance through MOFs sensitized $MoS_2$/rGO Nanocomposites-based Electrodes for Supercapacitors

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## Abstract

The present investigation includes the designing of $MoS_2$ nanosheets-based electrodes for supercapacitor studies since $MoS_2$ nanosheets have garnered significant attentiondue to their exceptional properties, including high electrical conductivity, substantial theoretical specific capacity, and remarkable electrochemical activity. Followed by the synthesis via slightly modified hydrothermal method[1],$MoS_2$ nanosheets were utilized by electrode fabrication. In addition, to further augment the capacitive performance,rGO was integrated with the $MoS_2$nanosheets. Herein, the nanocomposite ($MoS_2$/rGO) was thoroughly characterized to investigate the associated structural, morphological, and electrochemical properties. Due to this incorporation of rGO, the electrochemical performance observed to be enhanced. Not only upto this said binary nanocomposites but also for ternary nanocomposites, the results were described. In this concern, a chemical method was employed to fabricate MOFs-sensitized $MoS_2$/rGO nanocomposites-based electrode. As a result, the saidelectrode demonstrated a high specific capacitance of 1400F/g at a scan rate of 5 mV/s, coupled with exceptional long-term cycling stability. In conclusion, the integration of $MoS_2$ NSs with rGO and MOFs resulted in a highly efficient electrode for supercapacitorstudy, which underscores its potential for practical implementation in advanced energy storage devices[2].

**Keywords:**$MoS_2$,MOFs, Nanostructures, Supercapacitor

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# Activated Carbon from Lignocellulosic Biomass for Supercapacitor Electrode

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## Abstract

Lignocellulosic biomass is plant-based materials which mainly contain lignin, cellulose and hemicellulose. These plant-based materials have potential to produce activated carbon due its natural interconnected pore network. The conversion of lignocellulosic biomass feedstock into porous carbon material for supercapacitor has increases [1]. Here, lignin and glucose has used as feedstock for production of activated carbon that used as electrode material for supercapacitor. The carbonizing temperature and chemical treatment method determine the attributed properties of activated carbons in terms of surface area and pore size distribution that required for the fabrication of electrode material of supercapacitor. The structure composition of biomass component effects the morphology and capacitive performance of activated carbon electrode[2]. Characterization techniques such as X-ray diffraction, Raman spectroscopy, fourier-transfer infrared spectroscopy, $N_2$ physisorption, and field emission scanning and transmission electron microscopy were performed to assess the physicochemical properties of the carbon material. The electrochemical characterization of activated carbon was conducted in aqueous electrolyte using technique such as cyclic voltammetry, galvanostatic charge-discharge test and electrochemical impedance spectroscopy. This study has shown that lignocellulosic derived activated carbon has a significant potential to be utilized as an electrode material for electrochemical energy storage system.

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# Synthesis of Schiff bases of 4-methoxybenzyl amine and hydrazide derivatives and their application in corrosion inhibition of mild steel in 1.0 M $H_2SO_4$

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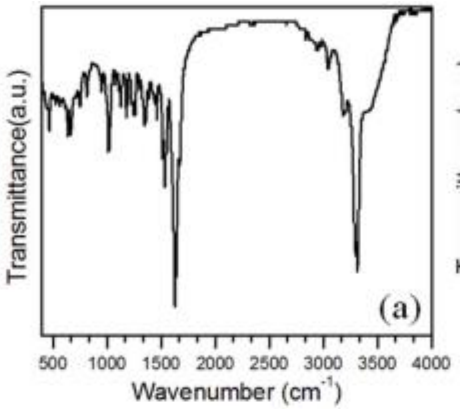
## Abstract

In this work, Schiff bases of 4-methoxybenzyl amine and hydrazide derivatives containing succinic (BMSHE), oxalyl (BMOHE), and phenylaceto (BMPHE) have been synthesized and applied for corrosion inhibition of mild steel (MS) in 1.0M $H_2SO_4$.The synthesized compounds are characterized by Fourier-transform infrared (FTIR) and $H^1$ nuclear magnetic resonance (NMR) spectroscopy. The FTIR and H1 NMR results have confirmed their formation through the presence of functional groups and hydrogen associated with them. Corrosion mitigation examination is done by polarization measurements (PM), electrochemical impedance spectroscopy (EIS), scanning electron microscopy (SEM) equipped with energy dispersive X-rays (EDX), and atomic force microscopy (AFM). All inhibitors demonstrated notable efficacy in preventing MS in $H_2SO_4$ BMSHE-88%, BMOHE-84%, and BMPHE-72%). As per corrosion potentials, BMOHE and BMPHE have been found to be mixed types of inhibitors, and BMSHE is noticed as a cathodic inhibitor. The SEM results demonstrated how these hydrazide derivatives prevented corrosion by covering the MS surface. The EDX analysis of the surfaces has revealed that the inhibited MS contains lower amounts of O and Cl, which indicate that the inhibitors prevent MS in $H_2SO_4$. AFM analysis shows that the surfaces of MS in the presence of the inhibitors are damaged less than in their absence, which reveals the same facts as told above. The inhibition of MS by BMSHE, BMOHE, and BMPHE is also explained with a reason after analyzing the results.



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# Metal Oxide embedded Carboxy-functionalized Boron Nitride supported on Graphene oxide for sensing application

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## Abstract

The $ZrO_2$-embedded carboxy-functionalized h-BN composite, combined with graphene oxide (GO), resulted in the novel BN-COOH@$ZrO_2$/GO composite. Structural analysis using IR, Raman, P-XRD, and XPS confirmed its successful synthesis, while SEM and TEM revealed the morphology and distribution of components.TGA shows enhanced thermal stability compared to GO. Electrical conductivity analysis demonstrated significant improvement upon GO integration. The BN-COOH@$ZrO_2$/GO-based electrochemical sensor exhibited excellent electrocatalytic performance for diclofenac sodium (DS) detection, achieving a low detection limit (LOD = 0.0146 μM) and high sensitivity (0.2464 $\mu A\ \mu M^{-1}\ cm^{-2}$). The sensor showed remarkable selectivity, reproducibility, and stability, effectively detecting DS in real samples with recovery rates of 97.69% to 107.21%. This composite demonstrates significant potential for DS detection via cyclic voltammetry, combining enhanced thermal stability and electrical conductivity.

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# Water splitting $H_2$ generation using PdO-$TiO_2$ electrocatalyst deposited by Langmuir-Blodgett technique

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## Abstract

Hydrogen fuel, produced through electrochemical splitting of water, is a promising clean energy solution, but the use of expensive catalysts like platinum and ruthenium raises sustainability concerns. Metal oxides offer a cost-effective alternative with good catalytic performance and stability. This study investigates the enhancement of metal oxide catalysts by doping with noble metals to improve hydrogen production efficiency. $TiO_2$/PdO (100:1 ratio) was deposited on a FTO substrate using the Langmuir-Blodgett method, where approximately 120 monolayers were deposited. The film was then heated at 500°C for 5 hours before electrical characterization. Linear Sweep Voltammetry (LSV) was performed in 1 M KOH electrolyte with a three-electrode setup, using an Ag/AgCl reference electrode and a platinum counter electrode. The initial overpotential was 0.370 V, which increased to 0.4–0.5 V (fig.1) after stabilization over multiple cycles, whereas the overpotential of commercial $TiO_2$ is 0.92 V. This suggest that thin films of metal oxides dopedwith noble metals enhances their catalytic activity, offering a promising strategy for improving hydrogen production efficiency.

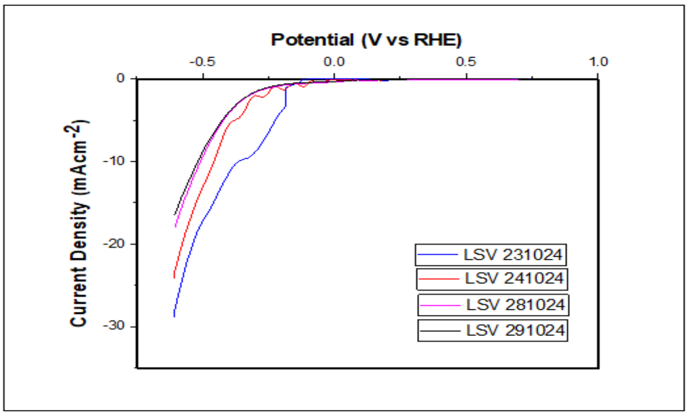

**Figure 1. LSV curve at scan rate of 5 mVs-1 of same TiO2-PdO sample**

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# Electrochemical determination of antibiotic using Sr@Se flower like structure on phosphorus doped g-$C_3N_4$ composite

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## Abstract

In this work, we designed a specific sensor for chloramphenicol (CAP) using a strontium selenium nanoflower decorated on phosphorus-doped graphitic carbon nitride (Sr@Se/PGCN) nanocomposite. The Sr@Se/PGCN nanocomposite was characterized using various spectrophotometric techniques. Its electrochemical properties were evaluated through Electrochemical Impedance Spectroscopy (EIS), Cyclic Voltammetry (CV), and Differential Pulse Voltammetry (DPV).(Sr@Se/PGCN) shows a LOD of 2.7nM with a linear range of 5-450µM. Additionally developed CAP showshigh sensitivity, good stability, outstanding reproducibility, and excellent recovery when tested with real food samples.

**Key words:** Strontium@Selenium, Antibiotic, Cyclic voltammetry, graphitic carbon nitride.

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# Enhancing Photovoltaic Efficiency and Stability of $TiO_2$/ZnO Nanocomposites with Metal-Free Dye and Polymer Gel Electrolyte: A Time Series Analysis Approach

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## Abstract

As part of the rapidly advancing field of energy technologies, solar energy-driven studies using nanomaterials have gained significant attention. In this context, designing dye-sensitized solar cells (DSSCs) with nanostructured titania ($TiO_2$) and its composites is a key focus in material selection. This study investigates the synthesis and photovoltaic performance of $TiO_2$ nanoparticles (NPs) and their composites with ZnO nanorods (NRs), synthesized via a one-step ex-situ approach. The devices were evaluated using a metal-free SK3 dye (D–π–A carbazole) and a $Co^{2+}/Co^{3+}$-based polymer gel electrolyte. Structural properties were analyzed using Rietveld refinement, alongside other physicochemical characteristics. Notably, the $TiO_2$/ZnO nanocomposite (TZ-3 NCs) with 30 wt.% ZnO NRs in the photoanode demonstrated a significant improvement in solar energy conversion efficiency (η) of 4.3%, which is 1.8 times higher than the $TiO_2$/SK3 NCs-based photoanode (2.38%). This enhancement is attributed to reduced charge transfer resistance, improved donor density, and increased surface area, facilitating efficient charge transport. Additionally, the study explored the stability of the TZ-3/SK3 NCs-based photoanode using time series analysis, a statistical tool that contributed to understanding its long-term performance.

**Keywords**: $TiO_2$ NPs, $TiO_2$/ZnO NCs, dye-sensitized solar cells, metal-free dye, polymer gel electrolyte, time series analysis

**EIHE 2025: CP 177**

# Electrode Fabrication for Enhancing Activity and Selectivity using β-$MnO_2$ and $RuO_2$ for Seawater Electrolysis

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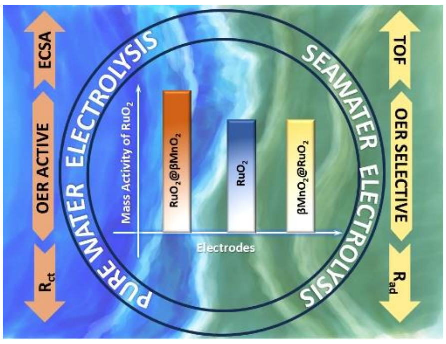
## Abstract

Efforts are being made to improve the efficiency of purified water and seawater electrolysis for sustainable hydrogen production[1]. Various approaches explored include the design of efficient anode material, the engineering of electrolytes, and the application of a diffusion protective layer over the catalyst to safeguard it from corrosive reactions[2].This study investigates an alternative vertical within this field through straightforward electrode fabrication. This vertical focuses on engineering electrode fabrication to improve the efficacy of anode catalysts through meticulous material selection[3]. We have developed a cost-effective method for electrode fabrication using β-$MnO_2$, which directly establishes a Schottky junction and heterostructure interface. This method converts commercially available $RuO_2$, known for its lower activity, stability, and high selectivity for chlorine oxidative reactions, into a highly active, stable, and OER-selective $RuO_2$ in alkaline medium and surrogate seawater. Thorough electrochemical studies, including LSV and EIS analysis, demonstrate that this engineering significantly enhances the effective electrochemical surface area, accelerates kinetics, and improves conversion per unit site. These changes profoundly influence the charge transfer mechanism and optimize the adsorption of OER intermediates, leading to a substantial increase in mass activity.The selectivity of the OER was enhanced due to the Lewis acid effects of β-$MnO_2$. This electrode fabrication technique, with further enhancements, has the potential to progress to the device level for sustainable hydrogen generation through seawater electrolysis.



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EIHE 2025: CP 178

# Synthesis and application of $SrCuO_2$ an effective catalyst: A facile synthesis of Dihydropyridine

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## Abstract

Heterogeneous catalysts have emerged as powerful tools in synthetic organic chemistry due to their wide range of applications such as reusability, stability and ability to operate under mild conditions. This research focuses onsynthesis of Dihydropyridine (DHP's) using a heterogenous catalyst $SrCuO_2$ nanoparticle. These $SrCuO_2$ nanoparticles were successfully synthesised employing a co-precipitation method and validated through characterization techniques such as SEM, EDX and XRDwhich confirmed their rhombic micro-seed morphology, elemental composition, and crystalline structure. The$SrCuO_2$ nanoparticle was employed in a Hantzsch multicomponent reaction as a catalyst,a cost-effective and environmentally friendly method for synthesizing DHPs, which yielded high efficiency and the structure was confirmed through HR-MS, FT-IR, and $^1$H-NMR spectroscopic techniques. Studies such asrecyclability demonstrated the catalyst's robustness and reusability over multiple cycles without significant loss of efficiency. This environmentally friendly and efficient approachillustrates the significance of heterogeneous catalysis in green chemistry and its potential to revolutionize the production of bioactive compounds, also itsignifies the potential of $SrCuO_2$ nanoparticles in industrial-scale organic synthesis, which can be further analysed for their future importance.

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EIHE 2025: CP 179

# Voltammetric Analysis of Sunset Yellow FCF Using Poly (L – Glutamic Acid) Modified Carbon Nanotube Paste Electrode

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## Abstract

In this study, a novel electrochemical sensor was developed for the simultaneous detection of Sunset Yellow (SSY) and Indigo Carmine (IC), two widely used synthetic food dyes, using a carbon nanotube paste electrode modified with electrochemically polymerized L-Glutamic acid (P(L-GLA)/MOCNTE). The modification significantly amplified the redox signal for SSY, enabling enhanced detection sensitivity, with a current reading of 8.46 µA in 0.2 M phosphate buffer solution (PBS) at pH 7.0. Various characterization techniques were used to assess the properties of the modified electrode, including scanning electron microscopy (SEM), electrochemical impedance spectroscopy (EIS), cyclic voltammetry (CV), differential pulse voltammetry (DPV), and linear stripping voltammetry (LSV). Scan rate experiments indicated that the process was governed by absorption. Additionally, parameters such as pH and concentration were optimized to enhance the performance of the sensor. The modified electrode exhibited superior electrochemical characteristics, with a limit of detection (LOD) of $0.5\times10^{-6}$ M and a limit of quantification (LOQ) of $1.6\times10^{-6}$ M, showing strong resistance to interference from metals and organic compounds. The sensor also demonstrated excellent reproducibility, repeatability, and stability. The proposed sensor was successfully applied to the detection of SSY in orange juice, yielding reliable and consistent results.

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**EIHE 2025: CP 180**

# Electrochemical analysis of microbial catalase for monitoring of sodium azide

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## Abstract

Sodium azide is a rapidly acting potentially deadly chemical that exists as an odorless white solid and it is used in automobile airbags, chemical preservative in hospitals and laboratories and in agriculture (farming) for pest control. Sodium azide prevents the cells of the body from using oxygen and is more harmful to the heart and the brain than the other organs. It has to be stated that although azide is a rapidly acting, potentially deadly chemical, so detection is azide is required. Catalase is an essential enzyme found in many organisms, playing a crucial role in protecting cells from oxidative stress. Its primary function is to break down hydrogen peroxide ($H_2O_2$), a reactive oxygen species (ROS) that, if left unchecked, can cause significant cellular damage. Sodium azide is inhibiting the catalase enzyme and reducing its activity. In our laboratory, previously *the Kat B* gene coding catalase enzyme was cloned and expressed in *E. coli BL21*, and its microbial enzyme activity was observed by electrochemical analysis when $H_2O_2$ was used as substrate on screen printed carbon electrode (SPCE). For this, we have optimized the pH of buffer (6.0 to 8.0) and observed the best results of redox behavior with pH 7.0. From these experiments, we determined that a 0.1 mM concentration of hydrogen peroxide (1.025 V) assay range (0.01–1 mM) was optimal for further experiments. The voltammograms showed a clear redox current peak at peak potential 1.025V, and current was reduced and shifted to 0.795V when sodium azide was added with this. Further, this microbial catalase will be used as a biocomponent and integrated on SPCE and will be used for application in electrochemical biosensors for the detection of sodium azide.

**EIHE 2025: CP 181**

# Electrochemical analysis of crude extract of mushroom for laccase assay and its application in DTC pesticide biosensor

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## Abstract

Although pesticides are beneficial from a crop production point of view, extensive use of them possesses serious consequences because of their biomagnification and persistent nature. Dithiocarbamates (DTC) group pesticides are organosulfur amides mainly used in agriculture as non-systemic fungicides in a number of crops. These pesticides have been reported to be a threat to the overall ecosystem, causing serious health hazards for living beings, soil contamination, and bioaccumulation. Henceforth, their detection and monitoring are essential. However, the detection of DTCs is very little explored in the biosensory field compared to other classes of pesticides. Given their metal-chelating properties, DTCs can inhibit metalloenzymes, including laccase, a multicopper oxidase widely distributed in fungi, bacteria, and plants, essential in biological processes, including lignin degradation and pigment biosynthesis. By chelating the copper ions, DTCs are proposed to alter the geometric and electronic environment of the active site of laccase, affecting the enzyme’s ability to interact with its substrates and reducing its overall catalytic efficiency.

In our studies, initially *in-silico* analysis, docking, was performed to understand the inhibitory mechanism of ziram, a DTC group pesticide, by interacting with pdb of laccase enzyme, and their binding energy was observed. Later on, an experimental study of the colorimetric assay of laccase enzyme was optimized. A protocol was optimized (buffer concentration and its pH) for preparing crude extract of mushroom (*Agaricusbisporus*) and observed its laccase enzyme activity at 340 nM absorbance in the presence of substrate ABTS (0.1 mM). Further electrochemical analysis of mushroom extract by cyclic voltammetry technique was carried out between + 1 and -1 V, and a change in peak current (13.4 µA) at peak potential 0.869 V was observed. Further inhibition study of laccase by ziram pesticide was carried out for biosensor application.

EIHE 2025: CP 182

# Laser-irradiated B-doped Graphene showing enhanced capacitance in Fluorine-free water-in-bisalt electrolyte

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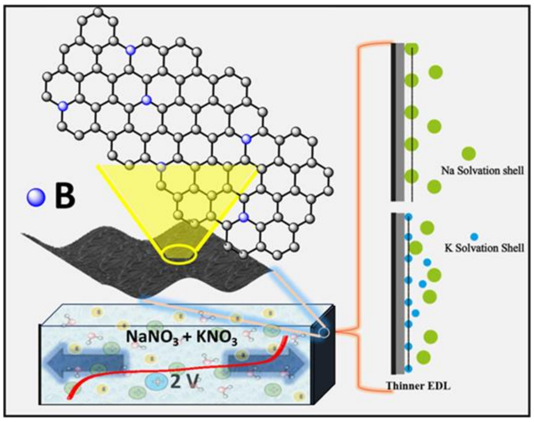
## Abstract

The development of aqueous supercapacitors has rapidly advanced with the integration of carbon-based nanomaterials, driven by their cost-effective synthesis, environmental compatibility, and safety. Recent innovations in electrolyte chemistry, including water-in-salt (WIS) and water-in-bisalt (WIBS) electrolytes, have expanded the electrochemical stability window (ESW) beyond the 1.23 V limitation of conventional aqueous electrolytes. This study explores the synergy between laser-irradiated (LI) boron-doped graphene (BG) electrodes and a WIBS electrolyte (12 m NaNO3 + 0.1 m KNO3). The WIBS environment fosters a thinner electric double layer (EDL), enhancing capacitance while maintaining a wide ESW of 2 V. The system demonstrates a specific capacitance of 102.45 mF $cm^{-2}$ at a current density of 0.2 mA $cm^{-2}$. Notably, the symmetric full-cell supercapacitor exhibits exceptional cycling stability, with nearly 100% Coulombic efficiency over 8000 cycles, ~90% capacitance retention up to 6000 cycles, and ~79% retention after 8000 cycles. The B-doped electrode achieves a remarkable energy density of 56.916 mWh $cm^{-2}$ and a power density of 6 kW $cm^{-2}$. These findings highlight the promise of LI-BG electrodes combined with WIBS electrolytes to significantly enhance energy density and cycling performance in aqueous supercapacitor systems, paving the way for advanced energy storage solutions.



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## EIHE 2025: CP 183

# Cucurbit[7]uril functionalized bimetallic nanoparticles for electrocatalytic hydrogen generation

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**Abstract**

Hydrogen is regarded as a potential fuel for green and sustainable energy applications[1,2]. Electrocatalytic hydrogen evolution reaction (HER) is one of the promising methods to generate green hydrogen. However, the sluggish kinetics of the reaction leads to the requirement of an efficient electrocatalyst. In general, platinum group metals are used as the electrocatalysis of HER. However, the cost and scarcity of these metals are major drawback for large scale hydrogen production. In this work, CoNinanoalloys were synthesized and functionalized by cucurbit[7]uril (CB7). The electrocatalytic hydrogen evolution reaction (HER) was evaluated in aqueous medium at pH 5.8. The overpotential at -10 mA/cm$^2$ current density reduced by about 74 mV due to incorporation of CB7 in nanoalloys. The Tafel slope analysis suggested “Volmer- Heyrovsky” mechanistic pathway for all nanoparticles. The electrochemically active surface area was also found to be 39 µF cm$^{-2}$ and 365 µF cm$^{−2}$for (CoNi) and (CoNi)(CB7) nanocomposites respectively. The long term stability also improved in presence of CB7 and the composition showed stability upto 8 hours.

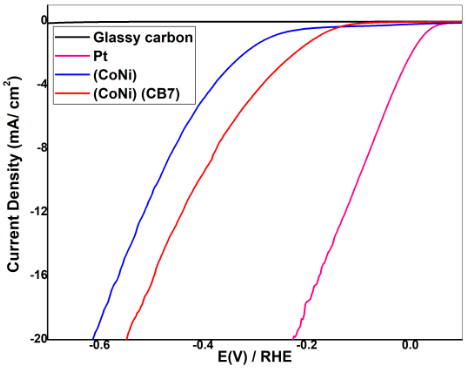

**Figure 1:** Linear sweep voltammogram of different catalysts at sweep rate 5 mV/s.

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EIHE 2025: CP 184

# Electrochemical Synthesis of Helicenes and their Dimers

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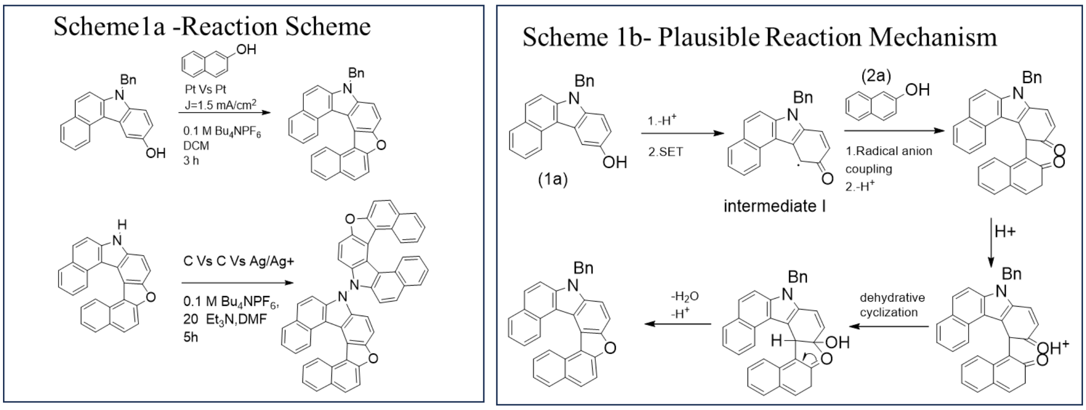
## Abstract

Electrochemical syntheses have advantages of carrying out reactions under mild conditions. Herein we report the sequential synthesis of helicene molecules and their dimers via electrochemical oxidative hetero-coupling (Scheme 1a). The plausible reaction mechanism for the electrochemical sequential coupling is the anodic oxidation of 3-hydroxybenzocarbazole(1a) to form an electrophilic radical species of hydroxybenzocarbazole followed by single electron transfer (SET) to generate the electrophilic radical species I of the same molecule at the anode. This intermediateI undergoes radical-anion coupling with the more nucleophilic 2-hydroxy naphthol(2a). Further anodic oxidations can afford intermediate that can either tautomerize to generate diol or readily undergoes dehydrative cyclization to afford the C-shaped helicene molecule(Scheme 1b). The synthesized molecule was characterized by $^1$H NMR and Mass Spectrometry. Further the N-N coupling of helicene molecule was also carried out using the electrochemical synthesis method.The substrate scope of using benzothiophene and thiol to synthesise helicene molecule were used to study the role of specific precursor in the product formation. This molecule will be used as anode material in Li-ion batteries to study the role of short π core helicene in Li-ion storage.


Scheme1a -Reaction Scheme

Scheme 1b- Plausible Reaction Mechanism

**Scheme 1**: Steps involved in the synthesis of helicenes (a) and the plausible mechanism (b)

EIHE 2025: CP 185

# Optimized Mn-Doped V2O5: A Promising Material for Dual-Functionality in Energy Storage and Photocatalysis

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## Abstract

The 21st century faces pressing challenges, particularly in the development of advanced energy storage solutions to support sustainable energy systems and reduce environmental impacts[2]. Efficient energy storage is essential for stabilizing renewable energy sources, minimizing energy wastage, and addressing the global energy demand. Simultaneously, freshwater scarcity remains a critical issue, exacerbated by industrial pollutants like synthetic dyes, with over 700,000 tons produced annually and more than 15% polluting water bodies[1].Vanadium pentoxide ($V_2O_5$) is a promising material due to its low cost, narrow bandgap (~2.3 eV), stability, and multiple oxidation states, making it suitable for photocatalysis and energy storage[3]. However, its narrow bandgap leads to rapid recombination of photogenerated electrons and holes, limiting photocatalytic and cyclic stability. Enhancing carrier separation, photocatalytic efficiency, and cyclic stability are critical challenges[4].Various strategies, including metallic/non-metallic ion doping, semiconductor recombination, and noble metal deposition, have been explored to improve $V_2O_5$ performance[5]. In this study, pure and Mn 4%-doped $V_2O_5$ were synthesized via a solid-state reaction method and characterized using XRD, SEM, TEM, and EDS. The photocatalytic efficiency of Mn-doped $V_2O_5$ was evaluated against methylene blue dye under solar irradiation. Additionally, its electrochemical performance as a cathode material for Li-ion batteries was tested using a three-electrode system with $LiPF_6$ as the electrolyte. Mn doping significantly enhanced both photocatalytic and electrochemical performance.

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EIHE 2025: CP 186

# Electrochemical sensing of Uranium using a multi-functional carboxylate ligand modified Glassy carbon electrode

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## Abstract

The electrochemical sensing of uranium ions, particularly U(IV) and U(VI), is of significant interest due to their environmental toxicity and potential health risks. A carboxylate based multifunctional chelator (Lcarboxy) [**Fig. 1(a)**] was synthesized and characterized by $^{1}$H and$^{13}$C NMR and IR. This study investigate the potential applications of the above multiofunctional ligand as an electrochemical sensor for the selective and sensitive detection of uranium in its two oxidation states viz., U(IV) and U(VI) ions. Because of its high density, this highly functionlized chelator was used as a ligand to preconcentrate the uranium at the electrode surface using the ligand modified glassy carbon electrode (GC). The electrochemical response evaluated through techniques such as cyclic voltammetry (CV) and differential pulse voltammetry (DPV) [**Fig. 1(b)**]. The interaction between the Lcarboxy and the uranium ions induces significant changes in the redox behavior, allowing for the discrimination between U(IV)and U(VI) based on distinct electrochemical signatures. The detection limits for U(VI) and U(IV) were found to be $10^{-11}$ M and $10^{-9}$ M, respectively [**Fig. 1(c)**]. The diffusion coefficient ($D_0$) of U(VI) and U(IV) at Lcarboxy/GC electrode were determined to be in the range of $10^{-5}$ cm$^{2}$/sec. The sensor exhibits excellent sensitivity, with low detection limits for both U(IV) and U(VI), and shows high selectivity against common interfering ions. The proposed Lcarboxy/GC modified eletrodeelectrochemical sensor offers a promising tool for the real-time monitoring of uranium contamination in ground water by providing an efficient and cost-effective method for environmental monitoring.

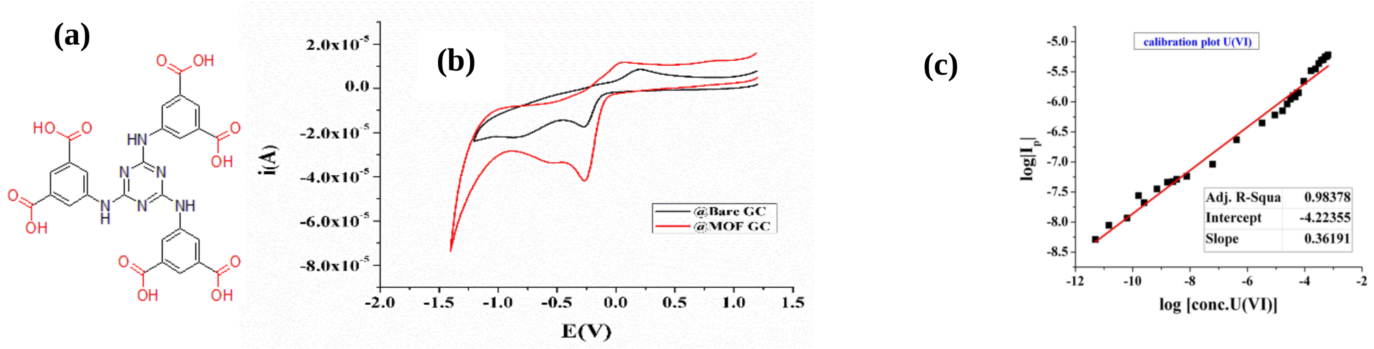

Figure1. (a)Ligand structure (b)Cyclic voltammetry plots U(VI) at bare GC and modified GC of U(VI) [$10^{-4}$ M] in 0.1 M $NaClO_4$ at pH 3 (c) Calibration plot of U(VI)

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EIHE 2025: CP 187

# Effect of nitric acid concentration on corrosion behaviourofTi-Al-Zr alloy and Zircaloy-4 in comparison to 304L SS

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## Abstract

Austenitic stainless-steel(SS) type 304L is commonly used as the structural material for nitric acid service in nuclear reprocessing plants [1]. However, some of the critical equipment like thermosyphon evaporatorundergo frequent failures due to transpassive dissolution of SS in aggressive nitric acid solution [2-4]. Ti and Zr based alloys are being considered as alternate materials for these kind of applications [5]. In the present study, the corrosion behaviour of Ti-Al-Zr alloy and zircaloy-4was evaluated in nitric acid and compared with 304L SS. The corrosion rates (CR) of the materials were estimated after 120h exposure in various nitric acid concentrations (1M, 4M, 10M, 14.5M and 15.8M). The CR of 304L SS increased with increase in $HNO_3$concentration.Ti-Al-Zr alloy showed the highestCR in mid concentration (10M) of nitric acid. Zircaloy-4 exhibited very low CR in all the solutions. The exposed surfaces were examined using a scanning electron microscope to understand the mode of corrosion attack. The exposed surface of the specimens was subjected to electrochemical impedance spectroscopy in borate buffer solution. The impedance values were measured at 3162.3 Hz and 1000 Hz at applied potentials ranging from-0.5V to 2V.The defect density of the surface filmswascalculated from the slope of the Mott-Schottky plots.

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EIHE 2025: CP 188

# Pore Size Regulated Vertically Aligned CoFe-LDH on Carbon Support for Oxygen Evolution Reaction

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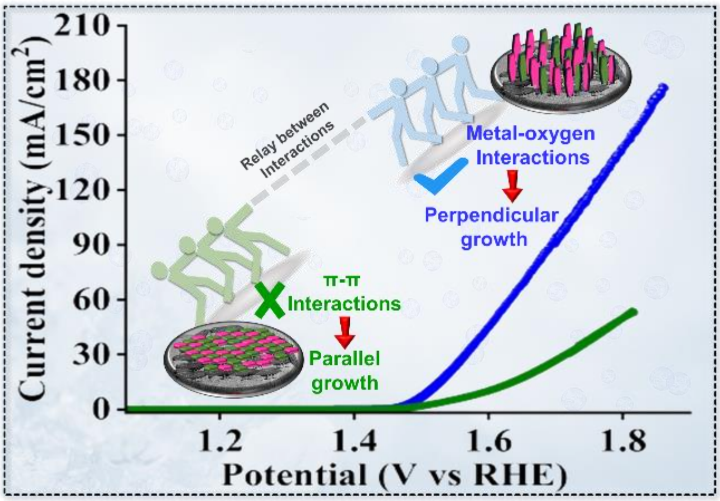
## Abstract

Porous carbon-supported CoFe-LDH catalysts were synthesized and employed as superior oxygen evolution reaction catalysts in an alkaline environment. High-resolution transmission electron microscopy pictures and $N_2$-sorption experiments indicated the vertical growth of LDH on carbon support and the narrow mesoporous characteristics of the materials,[1-2] respectively. We proposed that the surface oxygen functional groups of carbon materials served as nucleation sites for the crystal formation of the LDH on the carbon support through short-range electrostatic interactions, resulting in the vertical growth of LDH with a narrow mesoporous structure. Among the synthesized materials, CoFe-LDH/MMC exhibited an exceptional mass activity of 559.2 A $g^{-1}$, a turn-over frequency of 4.22 $s^{-1}$, and a substantial roughness factor of 269. This remarkable reactivity is ascribed to: (a) the vertically aligned narrow mesoporous structure of the material, which enhances electrolyte accessibility and consequently improves catalytic active sites, (b) the material's high electrical conductivity, and (c) the augmented electron contribution to the 3d orbital of cobalt from carbon, which weakens the Co-oxygen bond and further promotes O–O bond formation and $O_2$ desorption during water oxidation.[3]



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EIHE 2025: CP 189

# Investigating proton conduction through functionalized graphene

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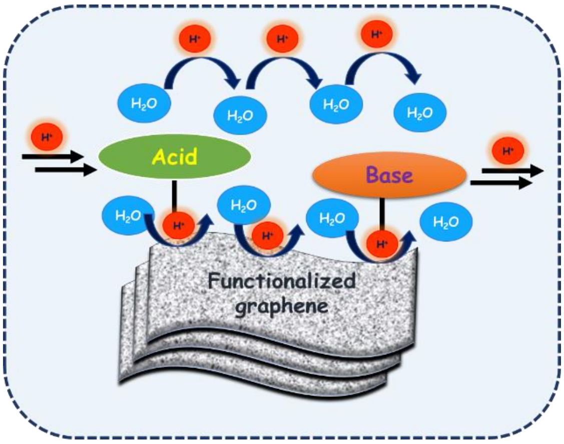
## Abstract

The efficient utilization of energy resources is currently a subject of widespread concern.With rising populations and industrialization, conventional energy sources are diminishing at rapid pace. In order to generate clean and efficient power, proton-exchange membrane fuel cells (PEMFCs) are considered to be a potential candidate for the present scenario.[1]In PEMFC one of the most critical parameters is capability of proton transport through the membrane across a broad spectrum of operating temperatures with minimal activation energy.[2]Additionally, proton migration primarily depends on various proton carriers that function as proton donors or acceptors facilitating proton hopping. In such cases, acid base synergism plays a crucial role promoting protonation and deprotonation which results in accelerated low-energy-barrier.[3] Furthermore, carbon-based precursors, including graphite oxide (GO) and reduced graphene (RG), are economically viable and exhibit architectural diversity making them suitable for superior proton conductivity.[3,4]

In order to understand the effect of acidic and basic functionalities in graphene, we synthesize functionalized graphene which exhibit improved proton conduction at both low humidity and varying temperatures. This work will be helpful toward further development of proton conduction graphene-based materials.



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**EIHE 2025: CP 190**

# Unlocking Superior Lithium-Sulfur Battery Performance through Polysulfide Chemisorption on Pyridinic Nitrogen Sites in Conjugated Small Molecules

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## Abstract

Lithium-sulfur (Li-S) batteries are promising energy storage devices but suffer from several challenges, including the dissolution of lithium polysulfides (LiPSs) in the ether-based DOL-DME electrolyte, leading to the "shuttle effect" that results in rapid capacity fading. Additionally, the mismatch in energy levels between the sulfur species and the host material results in poor electrocatalysis. To address these issues, a small molecule, 3,6-di(pyridine-4-yl)-2,5-dihydropyrrolo[3,4-c]pyrrole-1,4-dione, was designed and synthesized. This molecule features carbonyl oxygen atoms, pyridinicnitrogens, and lactam nitrogens, providing multiple binding sites for LiPSs. Density Functional Theory (DFT) studies confirmed that the pyridinicnitrogens enhance the electronegativity of carbonyl oxygens, significantly improving the binding strength with LiPSs. The strong interaction between the host and LiPSs suppresses dissolution of later. Furthermore, the reduced molecule's energy levels are commensurate with those of LiPSs, facilitating efficient charge transfer and electrocatalysis. As a result, Li-S batteries using this material exhibited a high specific capacity of 980 mA h/g at 0.5 C and stable performance over 300 cycles. In contrast, a control molecule with phenyl groups instead of pyridine showed weaker LiPSs binding and poorer battery performance, highlighting the importance of the pyridinic nitrogen functionality in enhancing battery efficiency and stability.

**EIHE 2025: CP 191**

# Electrocatalytic heterogeneous $N_2$ oxidation

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## Abstract

The Ostwald process produces $HNO_3$ for commercial use through catalytic oxidation of $NH_3$.Due to energy intensive nature, these activities play a major role in greenhouse gas emissions and global energy consumption. In response to the urgent requirements of the global energy and environmental sectors, there is a critical need to develop novel, highly efficient and environmentally sustainable methods. Herein we show that cobalt based material[1] for $N_2$ oxidation at 2.0V with an yield rate of 941 $mmol.h^{-1}.g_{cat}^{-1}$ with corresponding faradaic efficiency(FE) of 60%.

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EIHE 2025: CP 192

# Directing Group Strategy for the Isolation of Organoselenium(VI) Benzoselenonates: Metal-Free Catalysts for Hydrogen Evolution Reaction

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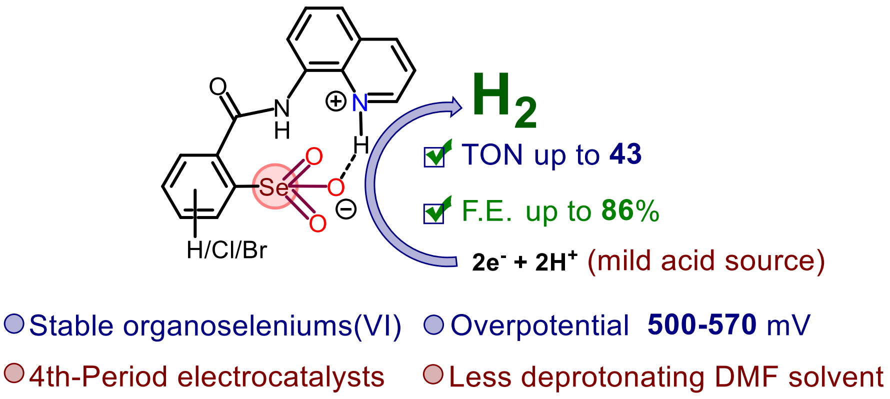
## Abstract

Currently, the very high demand for energy and the recent abrupt climate change enforce society to utilize a renewable and environment-friendly fuel $H_2$ gas. Recently, the demand for $H_2$ gas production has been immense as it could serve as an alternative, carbon-free green fuel (95 metric tons in 2022).[1] $H_2$ production is an intriguing approach to converting electrical energy to chemical energy ($H_2$). In this regard, scientists have developed a detailed mechanistic understanding to develop efficient electrocatalysts to produce hydrogen gas by reducing protons. However, non-innocent ligands or organic molecules have recently gained attention for hydrogen evolution reactions. These molecules could form a hydride intermediate (hydride with main group elements: N, P, S) and unlock the new catalytic possibilities by avoiding the M-H bond formation to follow the ligand-centered HER.[2] Very recently, we explored ligand-centered HER by metal-free hexavalent organoselenium Se(VI) electrocatalysts for hydrogen evolution reaction.[3] The unique ability of selenium to act as an electron reservoir and adjust its coordination site during the catalytic reaction could play a crucial role in the catalytic reaction.



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EIHE 2025: CP 193

# Secondary Phosphine Sulfide stabilized Gold Nanoparticlesfor Hydrogen Evolution Reaction

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## Abstract

Phosphorus has rich capability of forming organosulphurderivatives. Among these, phosphine sulphides have diverse applications in synthetic, pharmaceutical, and medicinal chemistry.[1]Over time, complexes of these ligandswere found to be excellent catalysts for a wide variety of organic transformations but their use as a hydrogen production is newer.[1,2]This investigation is directed towards the introduction of new family of ligand secondary phosphine sulphide (SPS)to synthesiseAu-SPS nanoparticle(6.2 ± 1 nm) and theirelucidation as cathode electrocatalyst for hydrogen evolution reactions.The Au-SPS nanostructures were characterised using high resolution transmission electron microscopy (HR-TEM), X-ray diffraction, FTIR analysis, Brunauer-Emmett-Teller (BET) surface area measurements, electron dispersive analysis, and X-ray photoelectron spectroscopy. The electrocatalytic performance was evaluated using cyclic voltammetry (CV), linear sweep voltammetry (LSV), electrochemical impedance spectroscopy (EIS), and Tafel polarization measurements. The results demonstrate an onset potential of 329 mV versus RHE, reached at a current density of 10 mA/cm². Additionally, the Tafel slope was measured at 131 mV/dec, with an exchange current density of 10 mA/cm², remarkable stability (over 500 cycles) and a low charge transfer resistance 11.29 Ω. This catalyst notably reduces cell costs and streamlines the preparation process in comparison to existing high-efficiency platinum and other noble metal-free cathode electrocatalysts.

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EIHE 2025: CP 194

# Preparation and performance of a $WO_3$/CTAB modified carbon sensor for enhanced electrochemical detection of mefenamic acid

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## Abstract

This study explores the electrochemical behavior of the anti-inflammatory drug mefenamic acid (MFA) using a tungsten trioxide ($WO_3$) nanostructure-modified carbon paste electrode (CPE). The investigation is conducted in the presence of the cationic surfactant Cetyltrimethylammonium bromide (CTAB) in a 0.2 M phosphate buffer solution (PB). Significant improvements in the oxidation peak current of MFA were observed at the $WO_3$/CTAB/CPE. The $WO_3$/CTAB/CPE applied potential effectively oxidized MFA, leading to considerably higher oxidation currents than the bare CPE. To evaluate the crystallinity, morphology, and structural properties of the synthesized $WO_3$, techniques such as scanning electron microscopy (SEM), transmission electron microscopy (TEM), X-ray diffraction (XRD), and X-ray photoelectron spectroscopy (XPS) were employed. Additionally, we studied electrokinetic parameters, including the effects of temperature, heterogeneous rate constant, scan rate, accumulation time, activation energy, pH, thermodynamic parameters, and the number of protons and electrons involved in MFA electro-oxidation. The $WO_3$/CTAB/CPE exhibited outstanding physiological properties, including simplicity of fabrication, enhanced surface area, stability, and reproducibility. This proposed technique reliably detects MFA in pharmaceutical and biological samples, achieving excellent recovery rates.

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EIHE 2025: CP 195

# Conductivity detection of NOx- species post chromatographic separation in plasma activated water

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## Abstract

Plasma activation processes for nitrogen fixation are gaining importance over the commercial Haber-Bosch process owing to the advantages such as mild operational conditions, low energy consumption, higher efficiency, minimal environmental impact etc [1,2]. Recently, thermal plasmabased compact portable catalytic system for fast synthesis of nitrate and nitrite from atmospheric air and water was developed at BARC [3,4].A systematic study of quantification of nitrate and nitrite ions in the plasma activated water under varying synthetic conditions was performed at ACD, BARC. The separation of $NO_2^-$ and $NO_3^-$ ions in the samples was carried out using ion chromatography followed by the detection of analytes in the suppressed conductivity mode using Metrohm-940 Professional IC Variosystem, Herisau, Switzerland. The identification and quantification of $NO_2^-$ and $NO_3^-$ ions in the sample solutions was performed by comparison of the retention time and peak area with those of the respective standards.The stability of the analytes in the water samples (plasma activated for 1, 5, 10 and 20 mins) have been investigated upto~1000 h. Time dependent concentration pattern for both the analytes after plasma treatment have been observed. The analysis played a major role in development of sustainable applications of nitrogen fixation via plasma treatment.

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EIHE 2025: CP 196

# Electrodeposited $Ni_3P$ as OER electrocatalyst

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## Abstract:

Hydrogen generation through water splitting currently used expensive platinum for hydrogen production while corrosive nature of oxygen evolution reaction warrants the use of rare earth elements like iridium and ruthenium, which does enhance the rate of reaction but in turn are very costly. Study using hydroxides of D block elements, for oxygen evolution reaction, has shown promising results,specially that of nickel. Hydroxide catalyst, if not prepared properly may fall out, to their low adhesion to the surface of the substrate, thus reducing the activity with time. In view of the above problems,non-noble metal catalyst nickel phosphide can be used as oxygen evolution catalyst and provides good erosion resistance after sintering.

An effort was made to synthesize crystalline $Ni_3P$ by first pulse electrodeposition followed by heating for crystallization. Activity experiments of the above catalyst shows a Tafel slope of 45.3mV/dec.

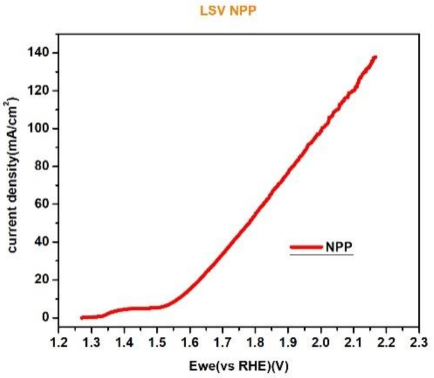

**Fig.1 LSV $Ni_3P$**

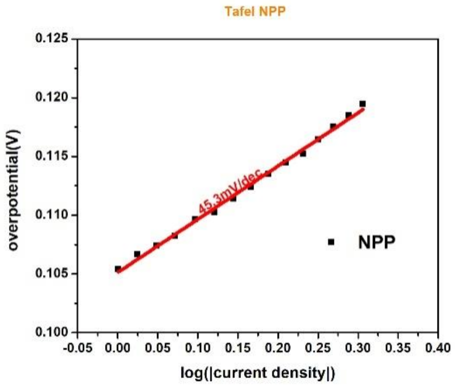

**Fig.2 Tafel $Ni_3P$**

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EIHE 2025: CP 197

# Enhanced dopamine sensing with MnO2-anchored Agnanoparticles decorated reduced graphene oxide nanoparticles

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## Abstract

We designed $MnO_2$ nanocomposites for detection of dopamine by Electrochemical sensing method. Dopamine (DA) present in the central nervous system, ventral and many other parts of our body mainly functions as the neurotransmitter.Bare $MnO_2$ and silver decorated carbon nanostructure functionalised nanocomposites are prepared by hydrothermal method.The incorporation of Ag with rGO NSs has led to dramatically heightened electrical as well as catalytic properties for Ag/rGO and further to MnO2 NSs by providing a conductive support with excellent electrical conductivity, which can improve its electrochemical performance.A sensitive Electrode for efficient sensing of dopamine is prepared by drop-casting synthesized material on glassy carbon electrode. The Electrochemical sensing performance was studied with the help of cyclicvoltammetry and differential pulse voltammetry studies. Parameters like pH of electrolyte, concentration, scan rate, and amount of material was optimised.As prepared samples were characterized by using sophisticated analytical tools to interpret the associated physico-chemical properties. Thereafter, regarding to electrochemical study, initially the samples were deposited on GCE, which were tested through different electrochemical techniques for obtaining LOD, limit of quantification (LOQ), and linear range. Notably, for ternary $MnO_2$/rGO/Ag NCs (with 10 weight % of rGO/Ag) exhibited the better electrochemical performance with adequate stability.

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EIHE 2025: CP 198

# Study of Air/Water stability of Bi-phase Sodium Titanate-based Anode and theirElectrochemical Performance for Na-ion Battery

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## Abstract

Aqueousprocessed electrodes are known to be environment friendly, cost-effective andfree of N-methyl pyrrolidone (NMP) which is hazardous in nature, providing an ease in handling and storage for electrode fabrication. The present work focuses onthe study of structural stability of $Na_2Ti_3O_7$, $Na_2Ti_6O_{13}$and“Bi-phase NTO” (having ~72 wt%$Na_2Ti_3O_7$ + ~28 wt%$Na_2Ti_6O_{13}$) upon being exposed to air and water; revealing an excellent stability of both $Na_2Ti_6O_{13}$ and ‘Bi-phase NTO, indicatingthe feasibility of ‘aqueous processed’ electrode (unlike for $Na_2Ti_3O_7$).In addition, the plausibility of ‘aqueous processing’ of electrodes paves way for the usage of binders other than polyvinylidene fluoride (PVDF), which may render the electrode more stable in terms of integrity and electrochemical behaviour.[1,2] Furthermore, different pre-sodiationstrategywere employed to improve the initial coulombic efficiency of Bi-phase NTOto compensate for the irreversible Na-loss that takes place during the first discharge/charge cycle due to SEI formation and other side reactions.

**Keywords:**Air/Water stability; Biphase sodium titanate; Binder; Pre-sodiation, Initial coulombic efficiency, Na-ion battery

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**EIHE 2025: CP 199**

# Pt aerogel as a catalyst for $SO_2$Electrooxidation for HyScycle

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## Abstract

The hybrid-sulfur (Hy-S) thermochemical cycle is a promising method for futuristic large-scale hydrogen generation by nuclear or solar thermal energy utilization. The electrochemical oxidation of $SO_2$ in this cycle proceeds with slow kinetics and so there is a requirement of an electrocatalyst. The ideal catalyst for aqueous $SO_2$ electrocatalytic oxidation in the anode should have an active metal component which can accelerate the $SO_2$ oxidation and also stable i.e. its dissolution or any oxidation on the electrode surface should be avoided.In this study, we report novel support carbon aerogel as platinum support for $SO_2$ electrooxidation application. Carbon aerogel (CA) was prepared by sol gel polymerization of resorcinol (R) with fur furaldehyde (F) in isopropyl alcohol (IPA) with hydrochloric acid (HCl) as catalyst (C). Impregnation of platinum on carbon aerogel was done using microwave assisted polyol processThe powder XRD pattern of the sample reveals that there are prominent peaks due to the presence of Pt. The FTIR and Raman spectra throw some light on the bonding and the D and G-bands of the support and their modifications on Pt loadings. The cyclic voltammetry (CV) patterns of the the sample in $Na_2SO_3$ media indicates that the sample shows reasonable activity for aqueous $SO_2$ electrooxidation with the electrooxidation peak appearing at 0.7 V vs RHE. The CV plots at different scan rates for the sample are also analysed which shows that the current density increases with increasing scan rates and further the peak current density for $SO_2$ electrooxidation varied linearly with the scan rate.

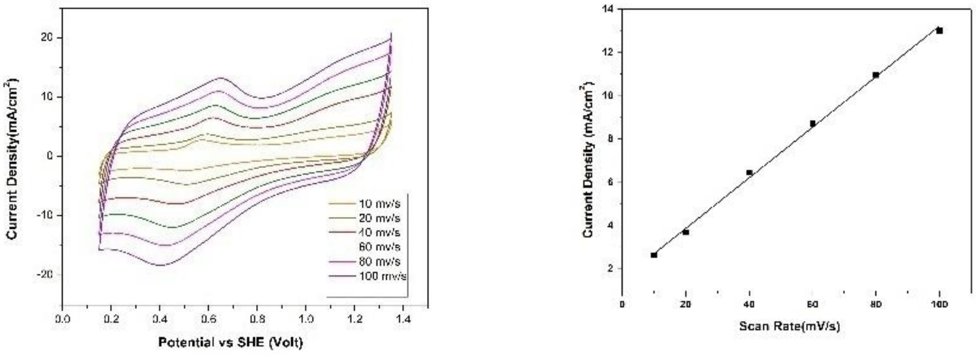

Fig: 1a) CV in different scan rate Fig :1b) Peak current density vs scan rate plot of the catalyst in 0.1 M $Na_2SO_3$ medium

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EIHE 2025: CP 200

# High-Selectivity Electrochemical Sensor for Picric Acid Using $MoS_2$-Decorated MWCNTs

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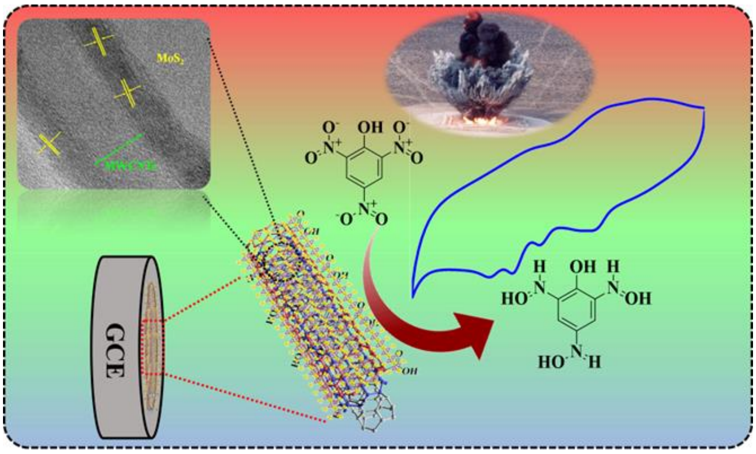
## Abstract

Nitrophenols are compounds with significant industrial applications but pose severe environmental hazards. In this study, we synthesized a molybdenum sulfide-based dichalcogenide supported on multiwalled carbon nanotubes ($MoS_2$@MWCNTs) via a straightforward wet chemical method for the electrochemical detection of picric acid (PA). The successful decoration of $MoS_2$ onto MWCNTs was verified through various characterization techniques. FE-SEM revealed $MoS_2$ layers grown on MWCNTs with an average size of ~80 nm. EDX confirmed the uniform distribution of elements in the nanocomposite. HR-TEM showed an increase in the average diameter of MWCNTs from 30 nm to 70 nm after $MoS_2$ decoration.FTIR spectroscopy identified characteristic Mo–S stretching at 605 $cm^{-1}$, along with hydroxyl, carbonyl, C–C, and C–O stretching vibrations. Raman spectroscopy, in addition to the D and G bands, exhibited prominent $E^2{}_g$ and $A_{1g}$ modes characteristic of $MoS_2$, confirming the presence of molybdenum and sulfur. XRD analysis indicated a hexagonal crystal structure (P63/mmc space group), while XPS revealed characteristic peaks for $Mo^{3+}$ 3d3/2 and 3d5/2 at 231.2 eV and 233.2 eV, respectively. Peaks at 162.7 eV, 165 eV, 169 eV, and 170 eV corresponded to sulfur in the 2S3/2 and 2S5/2 states.Electrochemical performance, assessed through CV, demonstrated the electrocatalyst's high selectivity, excellent anti-interference properties, a low limit of detection (LoD) of 0.5 μM, and a wide linear detection range. The low charge transfer resistance (Rct) and high-rate constant ($k^0$) confirmed the superior electrochemical behavior of $MoS_2$@MWCNTs for PA detection.



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EIHE 2025: CP 201

# Electrochemical Performance of Multi-Nano ferrites for Energy Storage Applications

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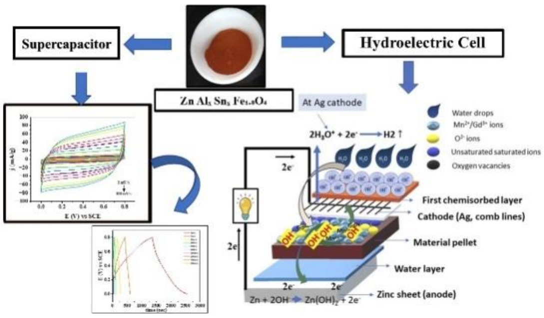
## Abstract

Nanocrystalline ferrites have garnered significant attention due to their exceptional electrochemical properties, making them suitable for energy storage applications. In this study, nano ferrites with the compositions $ZnAl_xSn_xFe_{1.8}O_4$, $CoAl_xSn_xFe_{1.8}O_4$, and$Co_xZn_xAl_xSn_xFe_{1.8}O_4$ were synthesized via the sol-gel auto-combustion method. The synthesized materials were annealed at 800°C and characterized using XRD, FTIR, and XPS to confirm their crystalline structure, phase purity, and surface composition.

The electrochemical properties of the prepared nano ferrites were evaluated through Cyclic Voltammetry (CV),Galvanostatic Charge-Discharge (GCD), and Electrochemical Impedance Spectroscopy (EIS).The results indicate excellent stability, high capacitance retention, and good charge-discharge efficiency of the synthesized ferrites. Among the compositions studied, $Co_xZn_xAl_xSn_xFe_{1.8}O_4$exhibited superior electrochemical performance, attributed to its enhanced electrical conductivity and optimized crystal structure. The specific capacitance values and impedance characteristics highlight the potential of these materials for use in supercapacitors and hydroelectric cells.

This work not only demonstrates the versatility of spinel ferrites in electrochemical energy storage but also emphasizes their suitability for industrial and environmental applications. The study paves the way for further research on multi-metallic ferrite systems to improve energy storage efficiency and sustainability.



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EIHE 2025: CP 202

# Chemical and Electrochemical strategies for advancing Potassium-rich Iron FluorophosphatePolyanionic Cathode: Enhancing the Stability of $Fe^{2+}/Fe^{3+}$ Redox Reactions

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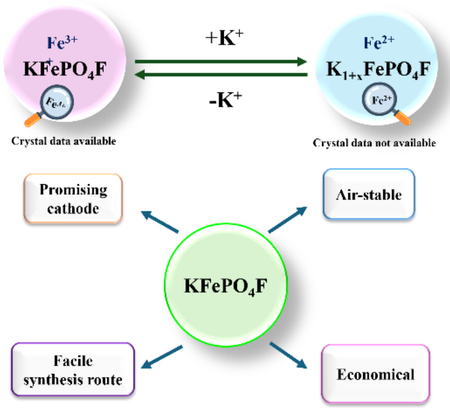
## Abstract

Potassium-ion (K-ion) battery chemistry is gaining attention as a sustainable alternative to Li-ion and Na-ion systems, with the use of graphitic carbon as an anode material being a significant advantage over Na-ion batteries. A key challenge for the commercialization of K-ion batteries is the development of a cost-effective, high-capacity, and stable cathode material. This study presents the synthesis, air-stability, and electrochemical performance of a novel polyanionic cathode-active material for K-ion batteries. The material, synthesized via a facile low-temperature method, demonstrates an initial reversible discharge capacity of ~102 mAh $g^{-1}$ at a current density of C/15 in potassium half-cells and 70 mAh $g^{-1}$ in full cells. Additionally, it exhibits good structural and electrochemical stability over extended charge/discharge cycles. To further enhance performance, a Pre-potassiation technique was incorporated and optimized, significantly improving the electrochemical properties of the electrode. These findings mark a promising step towards the commercial viability of K-ion batteries for energy storage applications.



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## EIHE 2025: CP 203

# Biosensor for prostate cancer biomarker using bio-functionalized nanoparticles as detection probe

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## Abstract:

Electrodeposited polyaniline (PANI) based sensing platform and bio-functionalized luminescent nanoparticles (L NPs) based detection probe was used for the sandwich electrochemical detection of prostate cancer biomarker, prostate specific antigen (PSA). In this biosensor, the signal amplification was imparted by L NPs which can accommodate large amount of HRP-conjugated antibody on its surface by EDC/NHS coupling chemistry. PANI based sensing matrix entrapped a large amount of capture antibody via glutaraldehyde coupling due to its amine-rich nature, whereas detection probe enhanced the electrochemical signal during its binding with PSA [1, 2]. Differential pulse voltammetry was employed to study electrochemical response signal during the binding of detection probe with PSA. Biosensor exhibited excellent sensitivity and wide linear range from 0.1–50 ng/ml. Sensor displayed good reproducibility with excellent selectivity for PSA. Furthermore, the proposed biosensor was validated by investigating PSA concentration in human serum sample where the result was found to be comparable with that obtained by conventional immunoassay. Hence, the amplification strategies adopted herein has potential for clinical screening of cancer biomarkers in point-of-care diagnostics.

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**EIHE 2025: CP 205**

# Engineered Garnet Frameworks: Intrinsic High Entropy And High Li-Ion Conductivity

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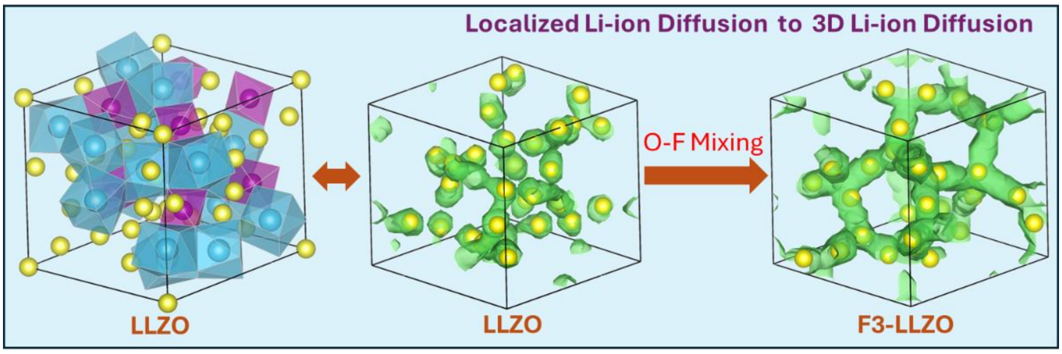
## Abstract:

Solid-state electrolyte (SSEs) are innovative materials for next-generation lithium-ion batteries due to their superior safety, wide electrochemical stability window, and potential for high energy density. LLZO garnets offer excellent chemical stability, moderate lithium conductivity, and high mechanical strength, making them promising for advanced battery applications.[1,2]However, challenges such as electrode-garnet interface issues and slower Li-ion conductivity compared to liquid electrolytes persist. The relationship between Li-vacanciesand ionic conductivity in Garnets is complex, and excessive Li-vacancy concentrationcan lead to (electro) chemical instability. By exploring cation and anion chemistry,including high-entropy (HE) mixedcation compositions, this work demonstrates thatgarnet frameworks can be engineered to enhance Li-conductivity while increasing ductility and minimizing instability. Overall, these results show that garnets possess aninherently high-entropy nature and are not constrained by compositional limits, whiletuning both cation and anion chemistry offer a pathway to achieving high lithiumconductivity. Notably, anion mixing with oxygen-fluorine mixtures in anion chemistrysignificantly boost Li-ion transport while maintaining low Li-vacancy concentrations.In addition, optimum F content ($Li_{6.25}La_3Zr_2O_{11.25}F_{0.75}$) leads to higher ductility and improved interfacial compatibility.



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EIHE 2025: CP 206

# Strengthening Magnesium-Ion Batteries with StructurallyRigid Black Phosphorus for Superior Anodic Performance

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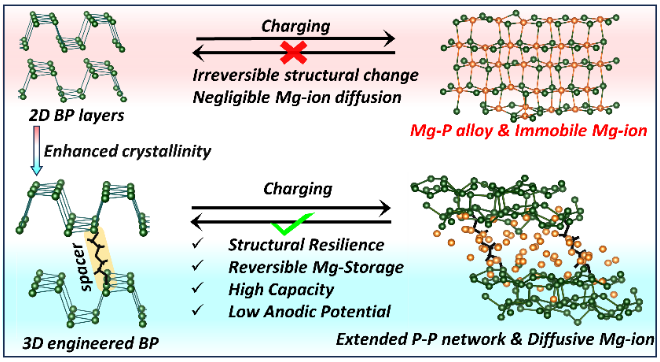
## Abstract:

Lithium-ion batteries (LIBs) have revolutionized energy storage in electric vehicles and portable electronics due to their lightweight design, and well-established manufacturing processes. However, as the demand for higher energy storage in transportation grows, LIBs are approaching their theoretical energy density limits, posing challenges for future applications. This has prompted researchers to explore alternative battery technologies with higher capacities to meet the increasing energy demands of electric vehicles. Multivalent ion batteries offer a promising alternative, utilizing higher-valency ions and providing several additional advantages. Magnesium ion batteries (MIBs) represent a major step forward in post-lithium technology, offering two-electron redox properties and abundant magnesium resources. Despite that, the development of MIBs is hampered by the strong polarizing effect of bivalent $Mg^{2+}$ ions, and sluggish insertion/extraction kinetics. Black phosphorus (BP) anode has similar intercalation chemistry to graphite, despite its Mg-P bond synergy, suffers from irreversible structural changes, and poor cycling stability at higher states of charge (SOC)[1] led to the disruption of P-P bonds within layers, as verified by both theoretical and experimental studies[1,2]. In this poster, I will present a design strategy focusing on intercalation chemistry to balance localized bonding and non-covalent interaction within the polarizable electronic cloud. Our recent work introduced engineered BP composites, reducing through-space interlayer interactions by enhancing localized bonding within BP frameworks. Structural reinforcement ensures Mg phase segregation into distinct layers, even at high SOC, hindering Mg-P alloy formation and promoting rapid electron and ion transfer kinetics. Our understanding of stability and $Mg^{2+}$ diffusion relied on first-principles electronic structure calculations and molecular dynamics simulations. These composites provide insights into tailored intercalation anodes for multivalent cations, offering the potential for advanced energy storage systems.



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**EIHE 2025: CP 207**

# Electrochemical and Spectrochemical investigation of Peptide molecule with Bioanalyte interaction over Gold NanoParticle (AuNPs) Modified Electrode

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## Abstract

The present work is focused on the designing of modified electrode for the electrochemical investigation of A9-PEPTIDE. However, the peptide does not produce any electrochemical response over bare electrode surface, in view of this the glassy carbon electrode has been modified with gold nano particles (AuNPs). The peptide molecules are responded well over the AuNPs modified electrode, their electrochemical and spectrochemical behaviour has been probed using various techniques such as differential voltammetry, electrochemical impedance spectroscopy and UV-Visible spectroscopy. In addition to the electrochemical investigations, the interaction of the peptide with dsDNA and HSA (Bioanalyte) has been investigated using electrochemical techniques and supported by FTIR, SEM and AFM measurements. To explore the A9 peptide's behavior under physiological pH (7), two sets of electrochemical experiments were performed in the presence of varying concentrations of HSA and dsDNA. Figure 1A shows that increasing the HSA concentration (10–60 µL) resulted in a marked rise in peak current, suggesting strong peptide-HSA interactions. Similarly, Figure 1B reveals a progressive current increase demonstrates that the addition of dsDNA (10–60 µL) led to a corresponding rise in peak current, reflecting peptide-DNA binding activity. Control studies using Au modified electrodes and peptide-only conditions (PEP-pH 7) confirmed that the A9 peptide is directly responsible for these biomolecular interactions. The applicability of the proposed method has been analysed by detection of electrochemical signal of bioanalyte (dsDNA and HSA) in synthetic sample.

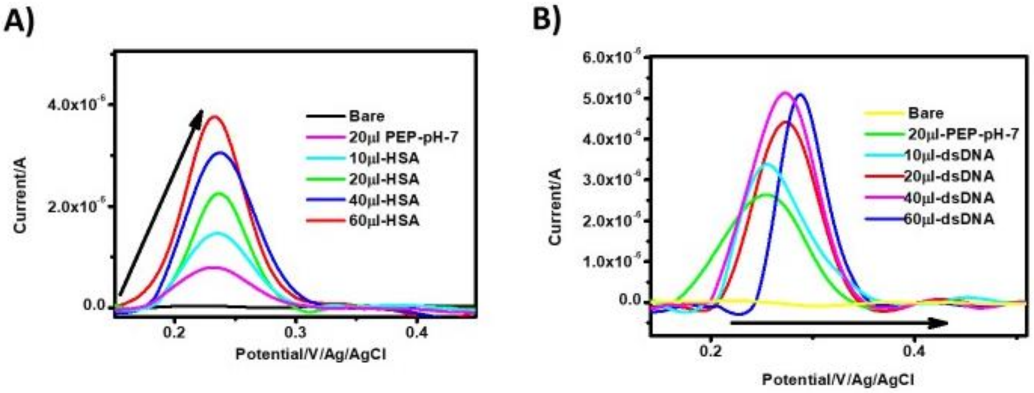

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Figure 1: A) DPV plot of A9 peptide in presence of variable concentration of HSA at pH7 and B) DPV plot of A9 peptide in presence of variable concentration of dsDNA atpH7.

EIHE 2025: CP 208

# Probing Biochemical Interactions of dsDNA on Iron Oxide Nanoparticles Modified Surfaceby electrochemical method

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## Abstract

The $Fe_3O_4$ nanoparticles(IONPs) with narrow size distribution were successfully prepared through chemical precipitation method. The synthesized materials were characterized using UV-vis spectroscopy, FT-IR, and XRD. The redox lability of these magnetic nanoparticles has several important biochemical applications. The iron oxide nanoparticles have been used for electrode fabrication to investigate the electrochemical signals to probe the interaction of these magnetic nanoparticles with dsDNA. In presence of UV light these IONPs produces DPV signals owing to their interactions with dsDNA which can provide some insight for fundamental understanding about the interaction mechanism between IONPs and dsDNA. The SEM images of the IONPs is shown in Fig.1A, indicating the spherical nature of the IONPs. The differential pulse voltammetry (DPV) signals of the control and the UV treated dsDNA samples over the IONPs modified electrode are shown in Fig.1B. The generated DPV response indicates that the IONP modifications of the glassy carbon electrode is able to probe the electrochemical response of the nucleotides released from the dsDNA strands due to the treatment of UV-Vis light perturbations.

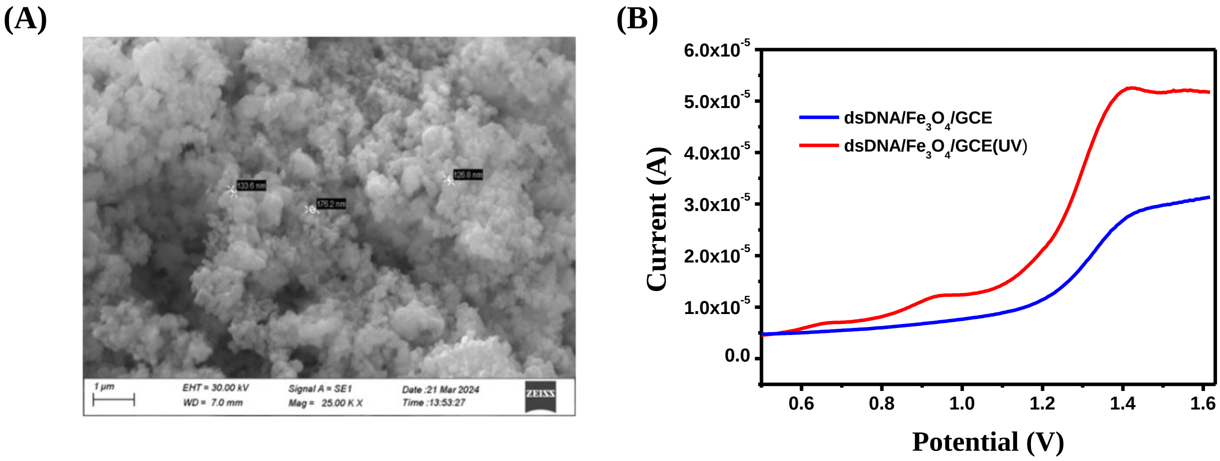

Fig.1 (A) SEM images of the as synthesized ironoxidenanoparticles, (B) the DPV responses of dsDNA drop casted over IONPs modified GCE in presence and absence of UV irradiation

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**EIHE 2025: CP 209**

# Hydrothermally Synthesized NiS/ZIF 67 Composite as a High Performance Anode Material for Lithium-Ion Batteries

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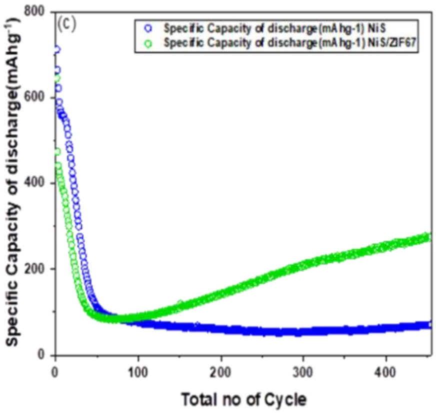
## Abstract:

Graphite is known as the conventional anode for Lithium-ion battery, but it has a low theoretical capacity of 372 mA hg$^{-1}$, moderate rate capability, and a large volume change during the cycling process. [1] Metal sulfides promise to be good anode materials because of their high theoretical capacities, simpler preparation methods, and low cost. Nickel sulfide is a conversion-type metal sulfide providing high theoretical capacity of 591 mA h g$^{-1}$. However, like most metal sulfides, NiS also suffers from low conductivity and structural deformation due to volume expansion during the cycling processes which is the prime cause behind the rapid capacity fading in the charge-discharge cycles. [2] ZIF-67 is a Co-based MOF consisting of Co$^{2+}$ forming the framework bridged by methyl imidazole entities. [3] In this report, we have attempted to improve the electrochemical performance of NiS as a lithium-ion battery anode by synthesizing a composite NiS/ZIF-67. The NiS/ZIF 67 composite showed a much better cycle performance with a specific capacity of 258 mA h g$^{-1}$ as compared to that of pristine NiSwhich delivered only 70 mA hg$^{-1}$ after 450 cycles at a current rate of 100 mA h g$^{-1}$.



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EIHE 2025: CP 210

# One-Step Approach using Spray-Pyrolyzed Cobalt Doped ZnO Photoanodes with Engineered Bandgaps for Enhanced Photoelectrochemical Water Splitting

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## Abstract:

Photoelectrochemical (PEC) water splitting emerges as a transformative and eco-friendly solution for hydrogen production, enabling a zero-carbon future [1]. Among the materials studied, zinc oxide (ZnO) stands out due to its earth abundance, cost-effectiveness, and chemical stability. However, its wide bandgap and limited visible light absorption restrict its photochemical activity. In this study, we address these limitations by introducing a gradient dopant concentration in ZnO films, forming a distributed $n^+$–n homojunction.

ZnO thin films are generated using low-cost, one-step spray-deposited, cobalt-doped ZnO (Co-ZnO) photoanodes, achieving incident photon-to-current conversion efficiencies (IPCE) of up to 58%. The incorporation of $Co^{2+}$ enhances visible light absorption through d–d transitions, reducing the bandgap from 3.13 eV to 2.45 eV, and validates the successful integration of $Co^{2+}$ into the ZnO lattice [3,4]. Under 1-sun illumination, the optimized Co-ZnO photoanodes deliver photocurrents of ~0.5 and 2.7 mA $cm^{-2}$ for water splitting, demonstrating significant improvement over undoped ZnO.Electrochemical impedance spectroscopy (EIS) demonstrated reduced charge transfer resistance, indicating improved interfacial kinetics, confirming enhanced charge transport at the electrode/electrolyte interfaceupon incorporation of Co [5]. This work highlights the potential of gradient-doped Co-ZnO as a cost-effective, high-performance material for PEC water splitting, paving the way for scalable green hydrogen production.

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EIHE 2025: CP 211

# Interpretation of electrode reaction mechanism in High Temperature Steam Electrolysis cells by deconvolution of impedance spectra

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## Abstract

High temperature steam electrolysis is a promising technology for hydrogen production using advanced reactors and renewable energy sources in an efficient manner. Performance of an electrolysis cell depends on the optimizationin cell dimensions, flow management, system heat management, operating voltage, cell material, and microstructure. Impedance analysis of the electrolyser cell provides pivotal information on different parameters contributing towards performance.In our study half cells of NiO-YSZ integrated with YSZ electrolyte are prepared and different air electrodes are used for evaluating the electrolysis performance.Impedance of symmetric cells prepared using different air electrodes are also analysed get valuable information.

Polarization resistance and series resistances are deconvulated from the impedance plot based on the measurement conditions. Electrochemical circuits are meticulously chosen based on frequency dependant and time dependant (DFRT) impedance spectra. Different parameters contributing to different resistances are corelated to physical processes. Two reaction pathways are proposed for oxygen reduction/oxidation process; electrochemical oxidation/reduction of oxygen at the triple phase boundary and oxygen exchange at the air electrode/gas interface. Outcome from this analysis of impedance spectra gives direct feedback in the direction to improve over all performance of an electrolyser cell.

EIHE 2025: CP 212

# Electrodeposition and Characterization of Fe-Ni thin films for functional Applications

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## Abstract

Electrodepositon of alloys of Fe-Ni is one of the most recent developments in the field of metal finishing, these Fe-Ni alloys are distinguished by their unique and highly promising magnetic, mechanical and chemical properties. Fe-Ni alloy deposits possess technologically beneficial properties, namely, outstanding ductility, excellent levelling, bright and pore free.

Fe-Ni alloy electrodeposition is classified as ‘anomalous’ co-deposition, It is known that oxygen containing (citrate, tartrates etc.) and nitrogen containing (amines, sodium salts of EDTA etc.) are potential complexing agents for iron group metals. Fe-Ni alloy films were electrodeposited under potentiostatic conditions using the bath solution containing $NiSO_4$, FAS, TAC, EDTA along with $H_3BO_3$ and NaCl with variable concentration plating bath components, pH and temperature. X-ray diffraction (XRD) pattern obtained using Fe-Ni alloy film reveals the non-porous nature of the film and the absence of occluded hydroxides/hydrogen in the film. The surface analysis by SEM of the alloy film deposited at -850mV shows the nanocrystallites resulting in the smooth deposit. TEM of the Fe-Ni alloy film is shown in no distinct grain pattern is observed in the Nano crystalline matrix of Fe-Ni alloy film. Alloy thin films were deposited with different Ni / Fe composition and have been used for magnetic property measurements. CV experiments were carried out at different sweep rates using the solution containing FAS, TAC, EDTA along with $H_3BO_3$ and NaCl. pH 8.5 and temperature 303K to study the role of plating bath components.

**Keywords:** Electrodepositon, Fe-Ni alloys, magnetic, mechanical, chemical properties, plating bath components, pH and temperature. SEM, TEM and CV studies

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### EIHE 2025: CP 213

# Facile Synthesis of Tantalum-Doped $WO_3$/Carbon Composite Sensors for Electrochemical Detection of Diuron and Dichlone

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## Abstract:

The utilization of doped $WO_3$ nanostructures as active components in electrochemical sensors presents a promising strategy for achieving highly sensitive and stable detection. In this study, a nanostructured tungsten trioxide ($WO_3$) with a combination of nanoparticle and one-dimensional (1-D) architectures, doped with tantalum (Ta), was synthesized via a hydrothermal reaction for electrochemical sensor applications. Doping of tantalum (Ta) at tungsten oxide lattice positions results in polymorphic crystals exhibiting n-type characteristics. An optimized doping concentration of 2.02 at. % (atomic percent) Ta in $WO_3$ was employed for detailed electrochemical analysis of diuron (DIU) and dichlone (DCN). An electrochemical sensor was constructed by incorporating the mechanically intercalated Ta-$WO_3$/carbon matrix into a teflon tube. The developed Ta-$WO_3$/carbon paste electrode (CPE) demonstrated selective and sensitive electrocatalytic determination of DIU and DCN, even in the presence of cationic surfactant CTAB. The CTAB-mediated Ta-$WO_3$/CPE exhibited excellent linearity with remarkable detection limits of 5.2 nM for DIU and 0.4 nM for DCN. Additionally, the sensor displayed high sensitivity, with values of 4.8 $\mu A \cdot \mu M^{-1} \cdot cm^{-2}$ for DIU and 38.7 $\mu A \cdot \mu M^{-1} \cdot cm^{-2}$ for DCN. Real-time efficiency was confirmed by successfully determining DIU and DCN in spiked soil and water samples, yielding satisfactory results.

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**EIHE 2025: CP 214**

# Development of Electroanalytical Methodology And Interactions in Curcumin

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## Abstract

Functionalised carbon nano spheres are synthesised and the glassy carbon (GC) electrode was modified with the functionalised carbon nano-spheres, which was used as the working electrode for the standardization of this electrochemical system. Analytical studies of curcumin were carried out using square wave voltammetry in the studies potential range of 0.0 to 0.4 V.It was observed from the SQWV plots that electrochemical signal from curcumin for oxidation could be obtained even from a very low concentration of 10 µM as evidence in **Figure 1**.

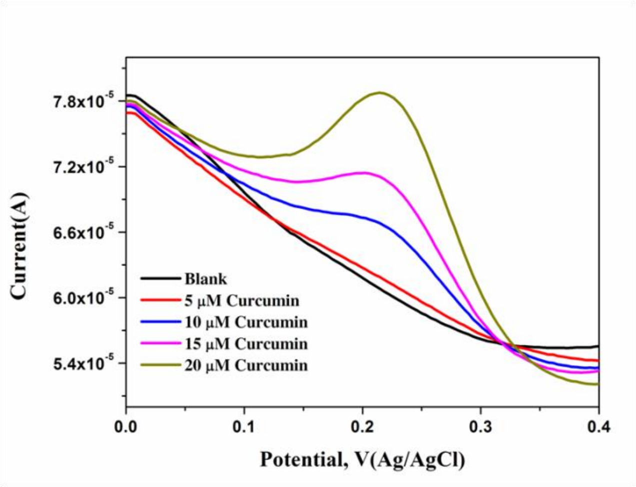

**Fig 1: Square-wave voltametric plot for curcumin**

One more important aspect of carbon coating on GCE was to increase the current as compared to bare GCE. Bare GCE showed electrochemical signal for curcumin in SQWV from 50 µM concentration whereas carbon coating increased the sensitivity by 10 times i.e. a 10 times lower concentration could be detected. The increase in response with the addition of curcumin indicated the enhanced electrochemical response could be generated from the carbon nano sphere modified electrode. The enhancement in the redox response is due to the better anchoring of curcumin through carbon nano spheres and also to be due to enhanced electron transfer process.

**EIHE 2025: CP 216**

# Efficient Water Splitting with a Semi-conductor based Supramolecular Catalyst: A computational study

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## Abstract

Photo-electrochemical water splitting is a promising approach for the sustainable production of hydrogen fuel using the solar energy. However, a major challenge lies in identifying an efficient catalyst for overall water splitting reaction, as the multi-electron transfer processes associated with water oxidation are kinetically slow over most of the semi-conductor catalysts. Consequently, integrating photoactive semi-conductors with an active co-catalyst for water oxidation is widely regarded as an effective strategy to enhance catalytic efficiency. In this study, we focus employing a host-guest supramolecular co-catalyst anchored on Bismuth Vanadate ($BiVO_4$), an efficient photo-anode material due to its favorable band gap as an oxygen evolution reaction (OER) catalyst. Cucurbiturils (CB), macrocyclic compounds have the ability to coordinate with metal ions through its carbonyl portals, is selected as a host molecule. We consider CB[5], which is physiosorbed onto the $BiVO_4$ surface and subsequently functionalized with earth-abundant metal ions ($Co^{2+}$, $Fe^{2+}$, and $Ni^{2+}$) immobilized at its carbonyl portals, resulting in a robust catalytic system for enhanced photo-electrochemical water splitting. Among the three metal ions considered, $Co^{2+}$ containing system is found to have the better catalytic activity with lowest overpotential for OER. Our computed energy profiles for water oxidation provide valuable insights to experiments.

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EIHE 2025: CP 217

# High-performance anti-corrosive coatings based on rGO-$SiO_2$-$TiO_2$ ternary nanocomposites for superior protection for mild steel specimens

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## Abstract

Corrosion is the impairment of metal which typically generates the oxides of the original metal and results in a destruction of the surface and loss of mechanical properties like strength, ductility, impact strength so it is considered to be a serious issue. To regulate this, we have synthesized an anticorrosive ternary nanocomposite coating. We have prepared (GO/rGO-$SiO_2$-$TiO_2$) binary and ternary nanocomposite coating with incorporation of organic resin (Cashewnut resin). GO was derived from graphite powder by hummers method whereas rGO was obtained by the reduction process of GO. $SiO_2$ and $TiO_2$ were prepared by wet chemical process. The nanoparticles were subjected for its size, structural and morphological characterization. The nanoparticles are mixed with natural resin for building up of nanocomposites coating. The composite mixture was deposited on the mild steel panel and the coated panels were subjected to contact angle analysis, salt spray testing and electrochemical studies to analyse the hydrophobic, roughness, corrosion resistivity etc. The ternary composite coating rGO/$SiO_2$/$TiO_2$ shows high performance of corrosion resistivity, the corrosion rate obtained from anticorrosion study is 0.0187 mm/year after 152 h of immersion in aggressive saline environment, thus the nanocomposites coating exhibits high anticorrosion activity.

Keywords: Go/rGO, Anti-corrosion, Nanocomposites, Nanomaterials.

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EIHE 2025: CP 218

# Enhancement in PEC efficiency and modulation of surface states in $BiVO_4$ through $TiO_2$ Atomic Layer Deposition

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## Abstract

Owing to several important properties, $BiVO_4$ is the promising photoanode material for the photoelectrochemical (PEC) water oxidation reaction, however the poor charge transfer, transport and slow surface catalytic activity limits to achieve the expected high theoretical efficiency. In the present investigation thin films of $TiO_2$ has been formed over the $BiVO_4$ photoanode surface using atomic layer deposition technique (ALD). Films are formed at 5, 50 and 150 nm thicknesses and the PEC performances have been evaluated. Enhancement in the performance has been observed upon inclusion of the ALD/$TiO_2$ films over $BiVO_4$. The performance has been observed to be higher in the case of 50 nm ALD/$TiO_2$ films. The ALD/$TiO_2$ films have several important roles in the enhancement in the PEC efficiency other than only the enhancement of stability through retardation of the photocorrosion process.

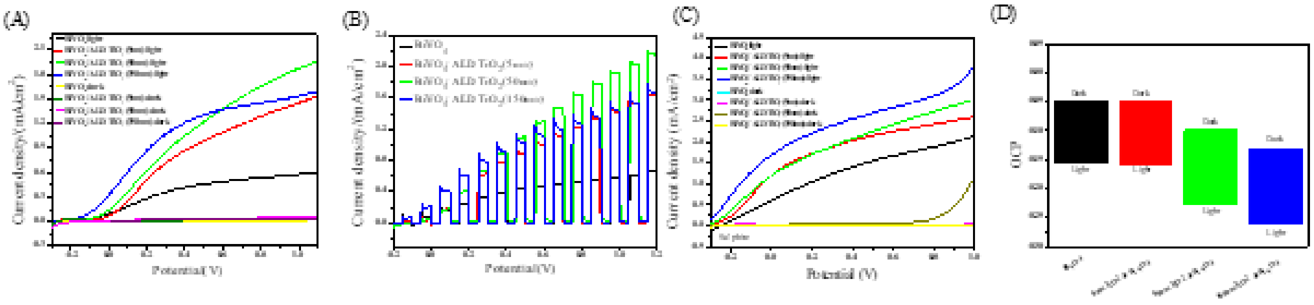

Fig 5. (A) Linear Sweep Voltammetry, (B) Chopped light Voltammetry and (C) Linear Sweep Voltammetry (Sulphite) for $BiVO_4$ (black), $BiVO_4$/ ALD $TiO_2$(5 nm) (red), $BiVO_4$/ ALD $TiO_2$(50nm) (green), $BiVO_4$/ ALD $TiO_2$(150nm) (blue) (D) Open circuit Potential of $BiVO_4$ (black), $BiVO_4$/ ALD $TiO_2$(5 nm) (red), $BiVO_4$/ ALD $TiO_2$(50nm) (green), $BiVO_4$/ ALD $TiO_2$(150nm) (blue)

**EIHE 2025: CP 219**

# Electrodeposited prussian blue over Ni-foam for enhanced Electrochemical energy storage devices

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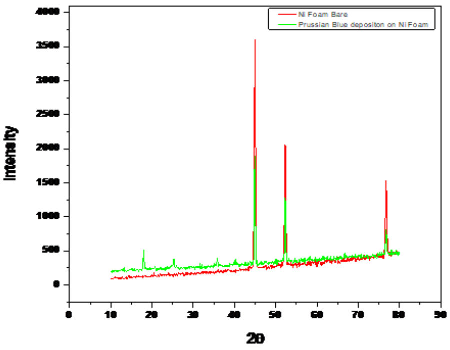
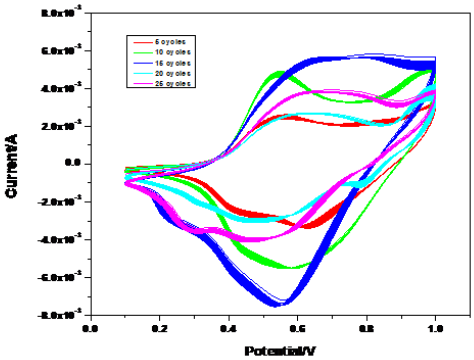
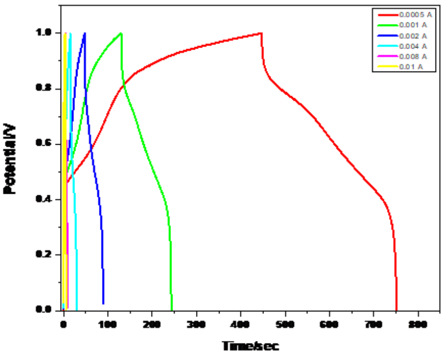
## Abstract:

Supercapacitors are an important research topic asthe devices offer high power density, rapid charge/discharge rates, and long cycle life, making them ideal for a wide range of applications from electric vehicles to renewable energy systems. Additionally, ongoing advancements in materials and designs are continuously improving their performance and expanding their potential uses. Prussian blue is as a good supercapacitor material due to the redox flexibility. Moreover, its adjustable structural and electronic properties enable the creation of advanced electrode materials. A uniform layer of Prussian Blue has been successfully deposited on Nickel foam sheet using simple and easy one - step electrodeposition technique using cyclic voltammetry in neutral medium leading to superior electrochemical performance and scalability. Electrochemical performance was studied with the help of Cyclic Voltammetry (CV), Charge – Discharge cycles (GCD), and Impedance Spectroscopy (EIS). The capacitance was evaluated through cyclic voltammetry and charge-discharge tests and electrode maintained a stable capacitance even after 2000 cycles and delivered current output of 7 mA with low charge transfer resistance. Morphology and crystal structure were characterized using SEM and XRD, functional groups and vibrational characteristics were identified using ATR and Raman spectroscopy, microstructural analysis using SEM. These findings confirm robust electrochemical performance, excellent structural integrity, uniform morphology, making Prussian blue coated Nickel - Foam suitable for supercapacitor applications.







**EIHE 2025: CP 220**

# Chronoamperometric Response on Rotating Disk Electrode for Reversible Redox System with Uncompensated Solution

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## Abstract:

A modular theory is developed for the transient and steady-state chronoamperometric response of a reversible redox system on a platinum rotating disk electrode (RDE). The main focus is to study the combined effects of diffusion, convection, surface roughness, and uncompensated solution resistance. The current transientsare recorded for different media with varying viscosity and many concentrations of supporting electrolyte at different rotation rates of electrode. Recently developed soft ionic atmosphere model is used to estimate the diffusion coefficient and conductivity for different viscosity media and supporting electrolyte concentrations. Our analysis of experimental data explains: (i) short time ohmic suppression of Cottrellian current with inclusion of roughness, (ii) intermediate time shows the enhancement of roughness of electrode, and (iii) convective crossover to a steady state current response. Our formulation included ionic strength and viscosity dependent contribution to the limiting Levich current. The concentration of supporting electrolyte change from 0.5M to 1.5 M enhancing the screening with a factor of 1.5 which results in reduction of about 16% the diffusivity of electroactive species.The characteristic crossover time to steady state response is dependent on kinematic viscosity, diffusion coefficient and rotation rate of electrode. The crossover time is directly related to the cube root of kinematic viscosity and inversely related with rotation rate and cube root of diffusion coefficient. Finally, experimental data shows the excellent agreement with the modular equation.

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EIHE 2025: CP 221

# Advanced Kinetic Analysis of Hematite for Solar Water Splitting Using Intensity-Modulated Spectroscopy

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## Abstract:

Hematite is a promising photoanode material for solar-driven water splitting due to its abundance, stability, and suitable bandgap [1]. However, its efficiency is often limited by poor charge carrier mobility, fast recombination, and sluggish interfacial charge transfer. This study presents an advanced kinetic analysis of hematite photoanodes utilizing Intensity-Modulated Photocurrent Spectroscopy (IMPS) and Intensity-Modulated Photovoltage Spectroscopy (IMVS) to unravel the intricate dynamics of charge separation, transfer, and recombination under operational conditions. IMPS and IMVS measurements were conducted across a range of applied potentials and light intensities to extract key parameters, including the charge transfer rate constant ($k_{ct}$), recombination rate constant ($k_{rec}$), and charge carrier lifetime [2]. The results reveal the influence of applied bias and catalyst coatings on enhancing surface charge transfer efficiency and mitigating recombination losses. Additionally, the Nyquist and Bode plots derived from these techniques provide critical insights into the interplay between bulk and interfacial kinetics, enabling a decoupling of limiting processes. This comprehensive kinetic analysis highlights the effectiveness of IMPS and IMVS as diagnostic tools for optimizing hematite photoanodes. The findings underscore the importance of interfacial engineering strategies, such as surface passivation and co-catalyst integration, in overcoming kinetic barriers and achieving efficient photoelectrochemical water splitting. These insights pave the way for the rational design of high-performance hematite-based systems, advancing the development of sustainable solar hydrogen production technologies.

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*The Journal of Physical Chemistry C*, DOI: 10.1021/acs.jpcc.4c04819

**EIHE 2025: CP 222**

# ZIF-67 templated cobalt doped $MoS_2$ for bifunctional electrochemical water splitting

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## Abstract:

Metal organic framework template has been used to synthesize cobalt doped $MoS_2$ catalyst. The catalyst shows promising activity for water-splitting in both acidic and alkaline medium to produce hydrogen and oxygen, thereby acting as bifunctional catalyst. Cobalt concentration has been optimized for best performance. Hydrodynamic and temperature dependent studies have been carried out along with impedance spectroscopy to understand the mechanism of water splitting. Best performing catalyst shows current density of 90mA/cm$^2$ at -0.6V vs Ag/AgCl for HER and 75 mA/cm$^2$ at 0.8V vs Ag/AgCl for OER.

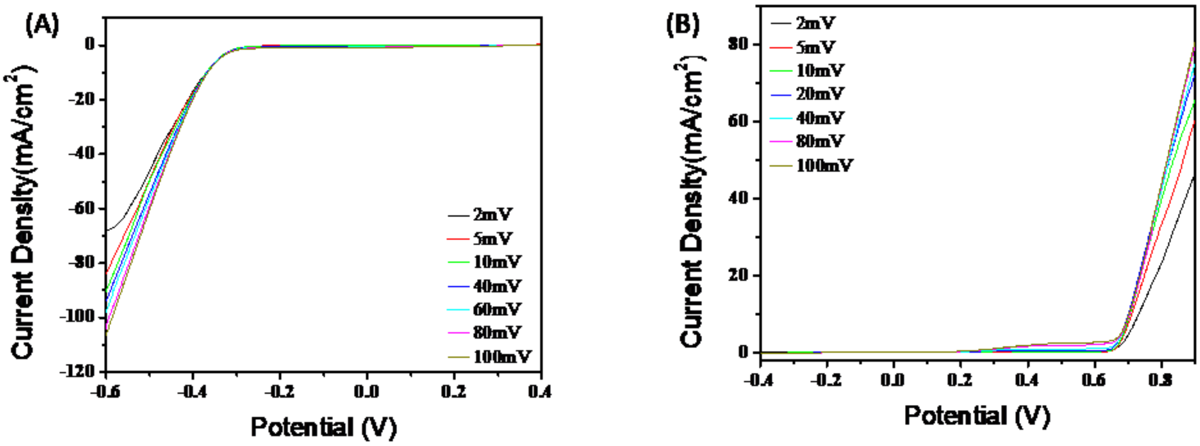

Fig. 1: Linear sweep voltammetry plot at different scan rates (A) hydrogen evolution in 0.5M $H_2SO_4$ (B) oxygen evolution in 0.1M KOH

**EIHE 2025: CP 223**

# Electrochemical Investigation of Cysteine and its interaction with 6-MP and BSA

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## Abstract

Cysteine (Cys) has typical electrochemical nature and tends to adsorb over electrode during electrochemical oxidation process thus it is challenging in getting the full electrochemical response from the molecule. Under the present investigation, it has been targeted to probe the oxidation process of cysteine using conventional glassy carbon electrode (GCE). The GCE was specifically cleaned, which in turn functionalized the surface and the three oxidations peak of cysteine could be observed.

Electrochemical in combination with spectroscopic techniques are utilised to probe the interactions of cysteine with an anticancer drug 6-Mercaptopurine (6-MP). The differential pulse voltammetry plot of Cyswith different concentrations of 6-MP is shown in Fig.1. The first oxidation peak (at 0.45 V vs. Ag/AgCl) of Cys has undergone a cathodic shifting indicating the enhanced oxidative adsorption of Cysteine in presence of 6-MP. The other two oxidation peaks of Cysh as been anodically shifted, which indicates the complexation of Cys and 6-MP in the aqueous phase. At higher 6-MP concentration a new peak of 6-MP has been observed at around 0.65 V.

In addition to the investigation of interaction with 6-MP with redox behaviour of Cys, the effect of bovine serum albumin (BSA) with Cyshas been probed along with the variation of the pH of the media.

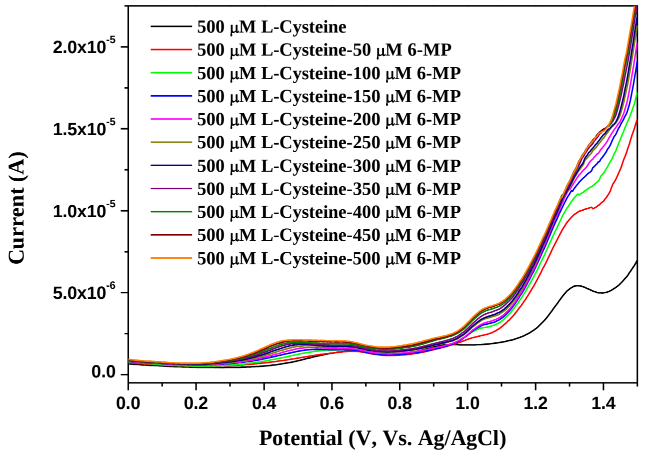

**Figure 1.** Differential pulse voltammetry (DPV) of Cys with addition of different concentrations of 6-MP in the solution.

**EIHE 2025: CP 224**

# Nitrogen-Doped Reduced Graphene Oxide/NiO Nanocomposites for High-Performance Supercapacitor Applications

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## Abstract:

Graphene-based metal oxide nanocomposites have emerged as promising materials for energy storage applications due to their unique combination of high electrical conductivity, large surface area, and superior electrochemical performance. The synergistic combination of Nitrogen-doped reduced graphene oxide (N-rGO) and nickel oxide (NiO) nanocomposites exhibits excellent double layer and pseudocapacitivebehaviour,resulting in enhanced energy storage performance. This study highlights the synthesis of N-rGO/NiO nanocomposites via a facile hydrothermal method, followed by characterization using techniques such as XRD, SEM, TEM, and electrochemical measurements. Fig (1A) shows the SEM image ofspherical urchin like structure of theN-rGO/NiO nanocomposite. The composite material exhibited a high specific capacitance of 366 F/g at a current density of 1A/g. Additionally, it demonstrated excellent cycling stability, retaining its performance even after 500 cycles and it is shown in Fig (1B).The N-rGO/NiO nanocomposite material enhances the overall electrochemical performance by contributing high specific capacitance, energy density, and excellent cycling stability.The introduction of nitrogen dopants into the graphene lattice not only improves the conductivity but also introduces additional active sites, facilitating better ion adsorption and charge transfer. The N-rGO/NiO nanocomposites exhibit a high specific capacitance, excellent rate capability, and superior cycling performance, making it a promising candidate for next-generation energy storage devices.

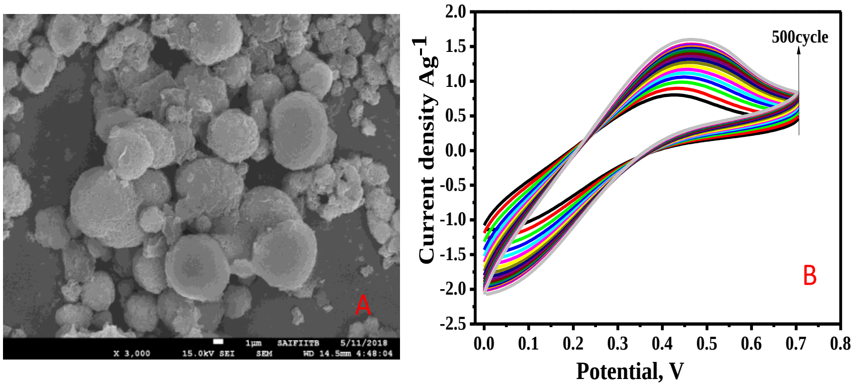

Figure 1: (A) SEM image (B) Cyclic voltmetry plotofN-rGO/NiO nanocomposites

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[2] S. Sahoo, A. K. Satpati, J.Electroanal Chem., 801 (2017) 416–424.

EIHE 2025: CP 225

# Fabrication of DSSC by incorporating Gel- electrolyte

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## Abstract:

Exploration of innovative and environmentally friendly options has risen due to the increased worldwide demand for energy. As a result, developments in solar energy technology have advanced to the point in which dye-sensitized solar cells (DSSC), can make the biggest contribution to the creation of sustainable solutions. In DSSC, the electrolyte durability turns out to be the main disadvantage. Therefore, polymer-based gel electrolyte use instead of traditional liquid electrolytes to increase its durability and overall cell stability. As a result, zinc-based materials were created, which are known for their stability, abundance, and simplicity of manufacture. Consequently, the impact of switching from liquid to gel electrolyte on efficiency was examined. As a result, this work explores the synthesis of zinc oxide nanoparticles and examines how variations in the type of electrolyte utilized in the device affect the overall device efficiency. The crystalline structure of the ZnO was confirmed by structural study using XRD. Its shape and particle size was determined by scanning electron microscopy (SEM). The Band gap of ZnO was studied by the UV-VIS spectroscopy. Through the efficiencies, the effects of various electrolytes were asserted through the examination of J-V (current density-voltage) curves.

**Keywords**: Solar cell technology, DSSC, liquid electrolyte, gel electrolyte, J-V characteristics

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EIHE 2025: CP 226

# Electrochemical deposition of Pt, Pd over SS, Cu and Al coupons

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## Abstract

Hydrogen generated in severe accidental condition poses threat to nuclear containment once it exceeds flammability limit in air. Passive Autocatalytic Recombiner (PAR) device is one among the others as best alternative to deal with this scenario. In view of this, we are trying to develop a novel breed of bimetallic Pt-Pd wire mesh supported nanoparticles as catalysts by electrochemical deposition. They are find to be catalytically active for $H_2$ and $O_2$ recombination in air and as well as in presence of various respective poisons viz. $CO_2$, $CH_4$, CO, relative humidity and catalyst wetness.

## Result & Discussion:

Bare working electrodes (SS, Cu, Al) were tested using CV in acidic medium to identify oxidative or reductive peaks. Based on these records, Pt and Pd were deposited on the surfaces to detect additional peaks compared to the bare electrode CVs, helping optimize deposition processes. Amperometry was used to monitor voltage and current over time after establishing the operational voltage range. During initial trials, the current increased with scan rate changes and stabilized at steady state. Reversing the scan rate caused a current sign reversal. In the potential range of -1.0 to 0 V, peaks for cathodic ($iP_c$) and anodic ($iP_a$) currents were observed: -0.81 to -0.75V for SS, and -0.30 to -0.65V for Cu. Similar data were recorded for Al. Pd deposition on SS was measured via cyclic stripping voltammetry, with oxidation onset at -0.82V and reduction at 0.030V. Pt-Pd co-deposition was tested at various potentials, while Pt alone was deposited at 0.4V using chloroplatinic acid at pH 8.

| Pt-Pd deposition over SS | Pt-Pd deposition over Al | Pt-Pd deposition over Cu | Pt-Pd deposition over Cu & SS |
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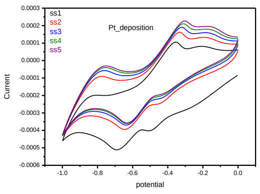
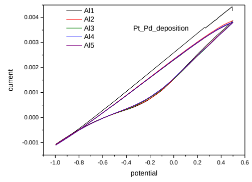
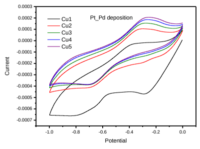
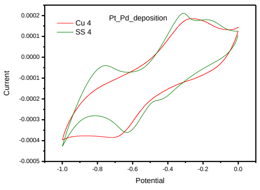
|  |  |  |  |

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**EIHE 2025: CP 227**

# Ultra-trace detection of As(III) using AuNPs/V2C Mxene modified electrode by Voltammetry

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## Abstract

A novel method has been developed for the ultra-trace detection of arsenic using gold nanoparticles (AuNPs) electrochemically deposited onto a two-dimensional vanadium carbide (2D $V_2C$) modified electrode. The combination of 2D $V_2C$ with AuNPs enhances the electrode's sensitivity and selectivity, providing a synergistic platform for efficient arsenic detection. The modified electrode exhibits excellent electrochemical properties, including increased active surface area, enhanced electron transfer kinetics, and strong adsorption capacity for arsenic species. Detection limit of 0.21 µg $L^{-1}$ for As(III) was obtained using AuNPs/$V_2C$ modified glassy carbon electrode in 0.05 M $H_2SO_4$ solution. The high surface ares of $V_2C$ along with the significantly enhanced charge transfer kinetics of AuNPs are utilised for the excellent detection limit using the modified electrode. Voltammetric plot is shown in Fig.1. The proposed method achieves ultra-low detection limits, demonstrating its potential for monitoring arsenic in environmental and biological samples with high precision and reliability, tested in real water samples and synthetic samples.

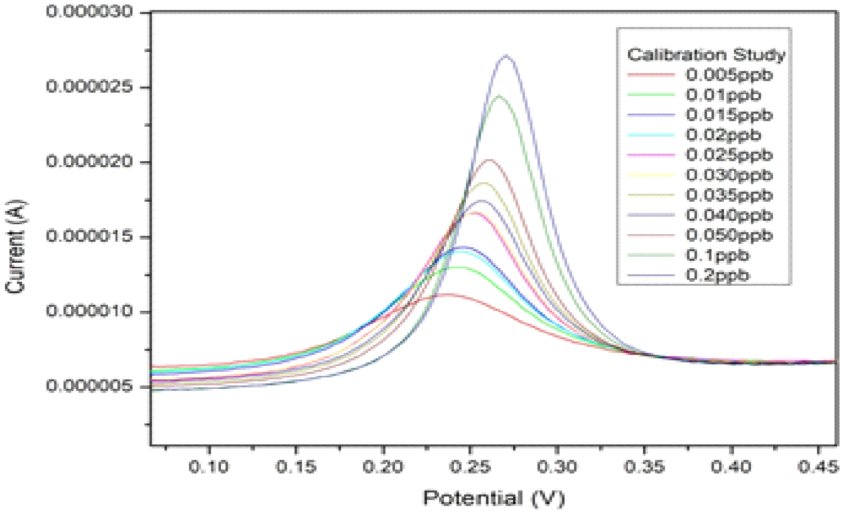

Fig.1 Voltammetric response of trace As(III) using the AuNPs/$V_2C$ modified glassy carbon electrode

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