

# CHEMICAL ENGINEERING RESEARCH & INNOVATION DAY (ChERID) – 2026

February 14<sup>th</sup>, 2026

Venue - A.N. Roy Seminar Hall, Dept. of Chemical Engineering



Department Of Chemical Engineering  
INDIAN INSTITUTE OF TECHNOLOGY KHARAGPUR



# ABOUT US



Step into the future of Chemical Engineering excellence at IIT Kharagpur!

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# ABOUT ChERID



ChERID-2026

We are delighted to welcome you to the Chemical engineering research and innovation day, hosted by the Department of Chemical Engineering at IIT Kharagpur.

This is a platform for research scholars within the department to engage with distinguished professionals from industry and academia, gaining insights from their experiences in diverse fields of Chemical Engineering.

ChERID 2026 aims to be an informative and engaging event, featuring a diverse program Expert talks, student interactions, and poster presentations. Delegates from both industry and academia have been invited to participate in what we envision to be interactive and insightful panel discussions.

We are deeply grateful to our sponsors for their generous financial support, which has been instrumental in organizing this event. We also extend our sincere thanks to the faculty, staff, and students of the department for their invaluable help and guidance to the organizing team.

We hope you find the day insightful and expand your professional network with like-minded researchers and enjoy the event. We wish all attendees a rewarding and enjoyable day.

To know more:

<https://sites.google.com/view/cherid-2026/>

# **TECHNICAL ADDRESS BY DIGNITARIES**



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## Gen-Next Inventions and Inventions in Precision Healthcare

Dipankar Bandyopadhyay<sup>a</sup>

<sup>a</sup> Professor, Department of Chemical Engineering, IIT Guwahati

### Biography:

Dipankar Bandyopadhyay is B.Tech in Chemical Engineering from Calcutta University and M.Tech from IIT Kanpur. He served ANSYS – Fluent before completing PhD from IIT Kanpur. Presently, he is a Professor in the Department of Chemical Engineering and Centre for Nanotechnology, at IIT Guwahati and Director of AAHII – Assam Advanced Healthcare Innovation Institute. He had served as Head, Centre for Nanotechnology and Jyoti and Bhupat Mehta School of Health Sciences and Technology at IIT Guwahati. His research areas encompass Thin films, Smart Materials, Microfluidics, POCT Devices, Microrheology, CFD, and Complex Fluids. He has authored more than 170 research publications and filed 28 Indian and 9 international patents. He is the PI of multiple Centre for Excellences at IIT Guwahati sponsored by MeitY, ICMR, and BIRAC. He has received NCL's Prof. K Venkataraman CHEMCON Award 2016, Gandhian Young Technology award 2016 and 2019, BIRAC-SRISTI Appreciation Award 2017 and 2021, ICMR Extramural research Excellence Award 2024. He is a nominated member of ACS, RSC, and IChE.

### Abstract:

The vision of improving quality of global health requires attention to the four major verticals – diet, diagnostics, decision and therapeutics, accessible even for the ‘last mile’ population. The emergence of precision medicine is directed toward this end, which focuses on the use of biological data – e.g. biomarkers, genes, environment, lifestyle to tailor treatments for the patients while identifying the optimal approach. In this regard, the conventional technologies face limitations with their centralized way of operation, costly installation-operating-maintenance, expert dependency in analysis, and limited accessibility. The talk will hover around a few examples of research, innovation and translation on, diet monitoring, diagnostics, therapeutics, and decision support systems, to explore the possibilities in precision medicine for the budding engineers, researchers, and entrepreneurs. In bits and pieces, we may join many of these dots to explore some of the gen-next-techs to cater the dream of “State-of-Art Healthcare for a Billion”.



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## Challenges in Fertilizer Industry

Palanisamy Velusamy<sup>a</sup>

<sup>a</sup> Chief Manufacturing Officer and Unit Head of the Paradeep manufacturing facility at Paradeep Phosphates Limited

### Biography:

Palanisamy Velusamy is the Chief Manufacturing Officer and Unit Head of the Paradeep manufacturing facility at Paradeep Phosphates Limited, a key phosphate fertilizer producer in India. With nearly three decades of experience in nitrogenous and phosphatic fertilizer production as well as the broader petrochemical industry, Mr Palanisamy brings extensive technical, operational and leadership expertise to one of the country's major fertilizer manufacturing hubs.

In his current role, he oversees all aspects of plant manufacturing — including production planning, process optimization, quality assurance, maintenance, safety and environmental compliance. Mr Palanisamy's leadership is central to ensuring high levels of operational reliability, product quality and manufacturing efficiency at the Paradeep unit. He has also played a leading role in sustainability initiatives and on-ground programs, including large-scale plantation drives and environment stewardship efforts that align industrial operations with community and ecological goals.

Prior to his current assignment, he held leadership roles in fertilizer and chemical production, including international responsibilities managing major phosphate and acid manufacturing assets. Mr Palanisamy holds a bachelor's degree in Chemical Engineering and an MBA, blending technical knowledge with strategic operational management. His deep insights into large-scale manufacturing and plant leadership enrich conversations on production resilience, industrial best practices and the role of robust manufacturing systems in supporting national agricultural input security.

### Abstract:

Fertilizer industry is one of the oldest chemical manufacturing industry and it has overcome most of challenges from Rawmaterial to finished product; Transformation journey of the industry is very interesting and the presentation covers the major challenges industry faced last several decades.



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## Transforming Global Indian Energy Landscape: From Emissions to Net Zero

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**Biography:** Sarvesh Kumar is the Executive Director (Hydrotreating Technical Services) at Indian Oil Corporation Limited (IOCL) Research Development Centre. With over 30 years of experience in refining, petrochemicals, and gasification, he has played a pivotal role in the development and commercialization of hydroprocessing technologies. His key contributions include technologies such as INDAdeptG, indeDiesel® (DHDS DHDT), indeSelectG®, indJet®, indDSK®, indDSN®, LPGTU, and Continuous Film Contactor (CFC), along with pioneering work in the co-processing of non-edible oils. He has led the development of 14 indigenous technologies, with more than 30 commercial units deployed across refinery and petrochemical sectors. His research leadership extends to futuristic areas such as net-zero technologies, sustainable aviation fuel (SAF), biomass valorization, advanced carbon materials, needle coke, specialty products, and novel catalysts. Mr. Kumar holds 74 national and international granted patents and has received numerous prestigious awards from ICMA, FICCI, NPMPL, NRDC, WPC, Petrofed, MoPNG, and CHT, including the CHT Innovation Award 2024–25 for ISOM Catalyst.

**Abstract:** Global energy systems face a defining inflection point as the need to sustain economic growth converges with the urgency of climate action. Energy-related CO emissions reached approximately 37.8 gigatonnes in 2024, with global warming nearing 1.5°C above pre-industrial levels. At the same time, primary energy demand is projected to grow by around 10% by 2035, driven largely by emerging economies. This paradox—expanding energy access while pursuing near-zero carbon pathways, defines the central challenge shaping the global transition. India is the world's third-largest energy consumer and greenhouse gas emitter, yet per capita consumption is only one-third of the global average, its development trajectory demands substantial expansion in energy consumption. As per BP Energy Outlook 2025 (India Insights) report, India's energy demand is projected to nearly double from 1000 Mtoe in 2023 to 1900 Mtoe by 2050. Balancing this growth with commitments to reduce carbon intensity by 45% by 2030 and achieve net-zero emissions by 2070 represents a multidimensional transformation challenge. Strategic direction is anchored in the PANCHAMRIT commitments, including achieving 500 GW of non-fossil capacity and 50% renewable penetration by 2030, reducing cumulative emissions by one billion tonnes, and scaling long-term decarbonization pathways. The pathways for achieving NetZero for the Energy Sector requires accelerated deployment of renewables, green hydrogen ecosystems, introduction of green molecules in current energy system (sustainable aviation fuels (SAF), E20, Biogas, etc.), e-mobility, energy efficiency measures, circular economy, and carbon capture utilization. While renewable capacity expansion is advancing rapidly, however Natural gas acts a clean transition fuel bridging the gap between the energy demand and the technology advancements. Fossil fuels, particularly coal oil, shall remain integral to energy demand, necessitating equitable transition strategies that account for regional socio-economic dependencies. However, faster pace of technology advancement is required for decarbonization of conventional energy system.

The transition demands unprecedented investment, estimated at nearly USD 10 trillion through 2070, alongside coordinated policy, technology innovation, and institutional collaboration. Resolving the energy trilemma of accessibility, sustainability, and affordability will depend on integrated system transformation that aligns developmental priorities with global climate objectives and positions India as a pivotal contributor to a resilient net-zero future.

# **RESEARCH SCHOLAR ABSTRACTS**



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**Abstract ID: RID26O1**



## **Harnessing bio-based cellulose nanocrystal scaffolds combined with TiO<sub>2</sub> nanoparticle to create dual-light-active photocatalysts for water remediation**

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Water pollution caused by pharmaceutical contaminants has become a critical environmental challenge, with antibiotics emerging as a significant concern due to their persistence and the associated rise of antimicrobial resistance, which often described as a “silent pandemic.” Azithromycin (AZM), widely prescribed in the last five years, has been increasingly detected in water, where resistant pathogens are evolving. Addressing this issue requires sustainable and efficient remediation strategies. This study presents a bio-based photocatalyst using cellulose nanocrystals (CNCs) and titanium dioxide (TiO<sub>2</sub>). While TiO<sub>2</sub> is a widely recognized photocatalyst, challenges related to aggregation and recovery hinder its direct use in aqueous systems. Here, CNCs act as renewable scaffolds, enhancing electron–hole separation in TiO<sub>2</sub>. This synergy significantly boosts the photocatalytic activity of the prepared nanocomposite, representing a scalable alternative for water treatment. The composites were synthesized through a simple, cost-effective method and were characterized using various analyses. The bandgap value confirmed dual-light activity. Photocatalytic degradation of AZM was investigated under controlled UV and natural sunlight conditions. Optimized parameters revealed >99% degradation within 180 min under UV (170 mg/L catalyst, pH 3) and 98.8% removal under sunlight in 5 h (175 mg/L catalyst). Radical scavengers study identified hydroxyl and superoxide radicals as the dominant contributors to degradation. LC–MS/MS proposed the degradation pathways, while toxicity assessments demonstrated the reduced ecological risks of the byproducts. This work shows the potential of CNC– TiO<sub>2</sub> nanocomposites as sustainable, dual-light-active photocatalysts for efficiently removing antibiotics from contaminated waters and can be used as environmental remediation technologies.

**Keywords:** *azithromycin, CNC-TiO<sub>2</sub> nanocomposites, photocatalysis.*



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**Abstract ID: RID26O2**



## **Effect of salts and electric field perturbations on the internal droplet dynamics of bio-colloidal solutions**

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The evaporation-driven pattern formation in bio-colloidal sessile droplets has gained significant attention for its relevance in disease diagnostics, biosensing, and healthcare applications. While prior studies have explored the evaporation dynamics of individual components such as salts, micro-sized colloidal particles, and protein-laden fluids, the coupled influence of salts and externally applied electric fields on desiccation patterns remains largely unexplored. In this study, we systematically examine the role of salt-mediated electrical double layer (EDL) interactions in colloidal suspensions, using droplet desiccation as a model phenomenon, and extend our investigations to electrowetting-on-dielectric (EWOD) platforms to assess the influence of applied electric fields on evaporation and deposit morphology.

Our experiments reveal three key regimes: (i) At high salt-to-particle concentration ratios, an initial constant contact radius (CCR) mode transitions to a constant contact angle (CCA) mode, leading to large grid-like salt crystallites with single nucleation sites. As evaporation progresses, inward Marangoni recirculation drives colloidal particles toward the crystal interfaces, forming centralized depositions and subsequently orthoradial cracks emanating from the compaction band. (ii) As the particle concentration decreases, the compaction band width and crack density are significantly reduced, with fewer stress-relieving fractures. (iii) At sufficiently low colloidal loading, crack-free deposits are observed across all salt concentrations. These findings are further analysed under EWOD conditions, where an applied electric field significantly modulates droplet evaporation dynamics, desiccation morphologies, and salt crystallization kinetics. This study provides a quantitative physicochemical framework for understanding salt-induced colloidal interactions and electric-field-assisted drying, with potential applications in biosensing, microfluidics, and lab-on-a-chip technologies.

**Keywords:** *Electrowetting-on-dielectric (EWOD), Electrical double layer (EDL) interactions, Desiccation morphologies.*



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**Abstract ID: RID26O3**



### **Improvement of DSSC performance through co-sensitization of dye using perovskite QDs**

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Dye sensitized solar cell (DSSC) is the third generation solar cell and have various advantages such as low making cost, simple to fabricate and devoid of non-toxic materials. However, the maximum efficiency for DSSC is only limited to 12.14 % till now. In addition to that the efficiency of module based DSSCs are even below for real scale application. In this context a systematic study to improve the efficiency of DSSC is needed. In this work, we have studied the performance of DSSCs, ultimately aiming towards improve its efficiency. We have used N-719 dye and semi-conductive material TiO<sub>2</sub> for DSSC fabrication. Here we used perovskite quantum dot (PQDs) as a co-sensitizer and hole transport material (HTM) to improve the performance of dye sensitized solar cell. TiO<sub>2</sub> nanoparticles and PQDs are synthesized by sol-gel method and characterized using FESEM, HRTEM, XRD, FTIR, UV-DRS, PL and XPS spectroscopy. Key photovoltaic properties i.e. short circuit current density, open circuit voltage, fill factor and power conversion efficiency (PCE) of the DSSCs were measured. The maximum power conversion efficiency(PCE) obtained as 16.23 % for 4mm<sup>2</sup> aperture area based DSSC. This study will pave the way for a standard testing protocol for DSSCs and their further potential applications.

**Keywords:** *Dye sensitized solar cell (DSSC), Short circuit current density (Isc), Open circuit voltage (Voc) and fill factor (FF), power conversion efficiency (PCE), Perovskite Quantum dots(PQDs).*



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**Abstract ID:** RID26O4



## Molecular Perspectives on the Multilayered Polyelectrolyte-Based Electrodes Performance in Supercapacitors

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The layer-by-layer (LBL) deposition of polyelectrolytes presents a promising approach for designing advanced electrode materials for energy storage devices such as supercapacitors. This study employs coarse-grained molecular dynamics (CGMD) simulations to investigate LBL polyelectrolyte-based electrodes' structural formation and electrochemical performance in supercapacitor applications. The impact of polyelectrolyte ionization degree on multilayer formation, interdiffusion, and stratification is systematically analyzed. The findings reveal that a higher degree of ionization leads to enhanced layer separation and surface charge density, significantly influencing the electrical double-layer (EDL) formation and charge storage capability in supercapacitors. Electrochemical analyses, including charge density profiles, electrostatic potential distributions, and integral capacitance calculations, demonstrate that electrodes with higher degrees of ionization exhibit increased capacitance and energy density. Additionally, variations in electrolyte ion size impact charge accumulation and EDL thickness, influencing the overall supercapacitor performance. The study provides critical insights into the molecular mechanisms governing LBL-assembled polyelectrolyte electrodes and establishes guidelines for optimizing electrode design for next-generation energy storage technologies.

**Keywords:** *Electrical charge storage devices, polyelectrolytes, layer-by-layer assembly, supercapacitor, energy density.*



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**Abstract ID:** RID26P1



## Semi-Batch Synthesis of Copper Nanowires in a Stirred Tank Reactor: Process Optimisation and Sustainability Considerations

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This work presents a systematic study on the synthesis of copper nanowires (CuNWs) using a semi-batch stirred tank reactor, aiming to enhance process efficiency and sustainability in nanomaterial production. The influence of critical operating variables, including reaction temperature, precursor feed rate, and stirring speed, was thoroughly investigated to determine the optimal synthesis conditions. The experimental system was designed with continuous magnetic stirring and precisely controlled reagent addition through syringe pumps to ensure homogeneous mixing and controlled reaction kinetics. The formation of well-defined, high-aspect-ratio CuNWs was confirmed through Field Emission Scanning Electron Microscopy (FESEM), Energy-Dispersive X-ray Spectroscopy (EDX), and X-ray Diffraction (XRD) analyses. Among the tested conditions, a stirring speed of 800 rpm was found to promote uniform particle growth and effective dispersion within the reactor. Temperature optimisation studies further revealed that a reaction temperature of 60 °C is most favourable for producing long and structurally consistent CuNWs. The average diameter and length of nanowires are 250 nm and 33.9 μm (aspect ratio 135). Recycling unreacted reagents to maximise resource usage and reduce waste formation was a major emphasis of this study. Copper (CuNWs) was dispersed in ethylene glycol (EG) to prepare Cu-EG Nanofluids. Polyvinylpyrrolidone (PVP) is used as a stabiliser, and it also helps prevent surface oxidation of CuNWs in EG. Prepared nanofluids are highly stable for at least ten days and show an 18% enhancement in thermal conductivity compared to the base fluid (EG+PVP) with 0.15 vol% copper loading.

**Keywords:** Copper nanowires; Nanopowder; Recycle; Semi-batch; Stirred-tank Reactor; Nanofluid; Thermal conductivity enhancement.



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**Abstract ID: RID26P2**



## Infiltration inside Flexible Nanochannels

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Capillary forces at the liquid interface can become dominant in microscale and nanoscale systems, often rivalling or even exceeding the elastic resistance of solid materials. Common phenomena illustrating this effect include the coalescence of wet hair, demonstrating how capillary forces can significantly alter or deform solid geometries. This study investigates the infiltration of liquid into nanochannels and specifically examines the influence of capillary forces on flexible channel walls. Molecular dynamics (MD) simulations are employed, using water as infiltrating liquid and graphene as material for channel walls. From the simulation data, key parameters such as infiltration length and meniscus radius are calculated. The behavior of liquid infiltration in nanochannels with rigid (fixed) and flexible walls is compared. The simulations explore how deformation of the channel walls affects the infiltration process and how capillary forces contribute to that deformation. Additionally, the study examines the role of wall wettability, elastic stiffness of the walls, and channel width in influencing infiltration dynamics and wall bending. A theoretical approach combining Lucas- Washburn equation and Euler Beam theory can be developed which effectively captures both the deformation of the walls and the progression of the liquid front. The findings of this study have important implications for technologies where capillary and elastic forces interact, such as self-assembled nanostructures, soft robotics, and waterborne microscale devices.

**Keywords:** *Capillary infiltration, Elastocapillary, Molecular dynamics.*



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**Abstract ID:** RID26P3



### **Influence of nanofluids on rate of reaction during biphasic liquid flow**

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In recent years, nanofluids have gained significant attention for their enhanced heat transfer characteristics. However, their influence on reaction mass transfer has been relatively unexplored. It is well established that flow morphology influences the mass transfer and overall reaction in fast and instantaneous reactions. Accordingly, the present study investigates the influence of nanofluids (NFs) on flow morphology in a 2.38 mm conduit and 1 m long capillary, where an aqueous phase (water or nanofluid) containing 0.5 M NaOH co-flows with an organic phase containing 0.01 M iodine dissolved in toluene (T). The nanofluid (NF) comprises 0.01 vol% Al<sub>2</sub>O<sub>3</sub> nanoparticles stabilized with 0.2 wt% sodium dodecyl sulfate (SDS). Both phases are introduced using a high-precision syringe pump with flow rates varying from 1 to 80 mL/min. Iodine from organic phase reacts instantaneously with sodium hydroxide. The results reveal that (i) plug flow is found to be the dominant flow pattern over the entire range of flow experiments. (ii) Nanofluids extend the range of plug flow, which is desirable for enhancing mass and heat transfer processes. (iii) Inverted droplet flow (ID) is favoured due to toluene flow towards the conduit wall assisted by the diffusion of iodine from the organic to aqueous phase. The range increases at higher flow rates of NF-T flow. (iv) The conversion reaches 85-90% with nanofluids, compared to 60-70% with water as the aqueous phase. The results are useful for exothermic reactions, fast and instantaneous reactions relevant for pharmaceuticals, food, and cosmetics industries, where enhanced mass transfer and reaction control are crucial.

**Keywords:** *Nanofluids, Plug flow, Inverted droplet flow, and Conversion rate.*



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**Abstract ID:** RID26P4



## **Chemical and Environmental Characterization of Bio-Oil Using FTIR, GC-MS, NMR, and LCA**

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The finite nature and environmental challenges of fossil fuels have accelerated global interest in environmentally friendly, and renewable substitutes. Agricultural waste biomasses such as sugarcane bagasse and tops offer a sustainable and abundant feedstock for thermochemical conversion. This study investigates the pyrolysis behavior of sugarcane bagasse in a fixed-bed tubular reactor to produce bio-oil, biochar, and syngas. The effects of particle size (0.40–1.00 mm), heating rate (20 °C/min), inert gas flow (100 cm<sup>3</sup>/min), and temperature (400–600 °C) were examined. Maximum yields of bio-oil (54.73%), biogas (31.94%), and biochar (36.85%) were achieved at 600, 500, and 400 °C, respectively. The bio-oil was characterized using ultimate, FTIR, GC-MS, and NMR, and exhibited a molecular formula of CH<sub>0.23</sub>O<sub>0.24</sub>N<sub>0.008</sub> with a higher heating value of 25.92 MJ/kg. Its viscosity showed a strong temperature dependency, decreasing significantly from 25 °C to 40 °C, indicating improved flow properties and handling at elevated temperatures. The resulting bio-oil, possessing an HHV of 25.92 MJ/kg, demonstrated potential as a solid renewable fuel. A preliminary Life Cycle Assessment was carried out to assess the pyrolysis system's environmental performance. The results indicated substantial greenhouse gas emissions that are lower than those from fossil fuels pathways, emphasizing the sustainability benefits of converting sugarcane residues into renewable fuels. Overall, the study highlights sugarcane residues as a promising feedstock for producing cleaner fuels and chemicals through pyrolysis, offering both energetic and environmental advantages.

**Keywords:** *Bio-oil, FTIR, GC-MS, NMR.*



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**Abstract ID:** RID26P5



## **Chemochromic Hydrogen Sensor Integrated with Composites for Safe Hydrogen Storage and Distribution Infrastructures**

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Hydrogen is increasingly recognized as a critical component in the global transition toward sustainable and low-emission energy systems, offering both zero carbon emissions and superior energy efficiency compared to conventional fossil fuels. As countries incorporate hydrogen into their energy infrastructure to support decarbonization goals, the safety and reliability of hydrogen storage, transport, and distribution have become key concerns. Despite its advantages, hydrogen presents significant safety challenges due to its wide flammability range (4–75%), extremely low ignition energy (0.018 mJ), and undetectable nature (colourless and odourless), making leak detection particularly difficult.

This study tackles these difficulties by developing chemochromic hydrogen sensors that can visually detect hydrogen leaks without the need for external power sources or intricate instrumentation, thereby offering a straightforward and dependable safety solution for hydrogen systems.

The innovation lies in embedding the sensing mechanism directly into composite materials commonly employed in hydrogen storage and distribution systems due to their high strength-to-weight ratio, corrosion resistance, and structural integrity. The sensing elements are composed of titanium, zinc, and magnesium oxides, activated by a palladium oxide (PdO) catalyst. Upon exposure to hydrogen, these particles induce a rapid and visible colour change. A systematic study was conducted to optimize particle size, catalyst concentration, and water content, to evaluate sensor response time and the extent of colour change under varying hydrogen concentrations using image processing techniques. This integrated approach presents a significant advancement in the development of intelligent, self-indicating composite materials and contributes to the creation of safer and more reliable hydrogen infrastructure.

**Keywords:** *Chemochromic Hydrogen Sensor, Smart Composites, Hydrogen Safety.*



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**Abstract ID:** RID26P6



## Nanoscale S-Scheme Dual-Redox Powerhouse: NiMoO<sub>4</sub>/Mg-Al LDH Heterojunction for Ultra-Efficient Pollutant Removal

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A dual-functional S-scheme NiMoO<sub>4</sub>/Mg-Al Layered double hydroxide (LDH) heterojunction (NMO / LDH) photocatalyst was developed for simultaneous visible-light-driven reduction of hexavalent chromium and degradation of the antibiotic chloramphenicol in water. The optimized 0.6 NMO/LDH composite, featuring intimately interfaced NMO nanorods on mesoporous LDH nanosheets, delivered nearly complete removal of both pollutants within 2 h and retained 98% efficiency over seven consecutive cycles due to its robust nanorod–nanosheet architecture. Comprehensive XRD, XPS, BET, PL/TRPL, Mott–Schottky and EPR analyses confirmed successful S-scheme band alignment, efficient interfacial charge separation, and superoxide-radical-dominated pathways, enabling strong redox potentials for concurrent oxidation and reduction processes. This work highlights a stable and recyclable S-scheme LDH-based heterojunction platform for advanced photocatalytic wastewater treatment under visible light.

**Keywords:** *S-scheme, photocatalyst, LDH.*



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**Abstract ID:** RID26P7



## **Remediation of ibuprofen from aqueous medium using metal organic framework (ZIF-90) incorporated polysulfone mixed matrix beads**

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Zeolithic imidazole frameworks (ZIFs) have demonstrated potential in the removal of non-steroidal anti-inflammatory medications (NSAIDs), like, ibuprofen (IBU) from contaminated aqueous medium, though it is still difficult to recycle these from mixtures. In order to remove ibuprofen from groundwater or surface water, this study used a straightforward and environmentally friendly technique to prepare ZIF-90 integrated polysulfone (PSF)-based mixed-matrix beads (ZMB) for real-life application. Excellent adsorption capacity and faster kinetics are evident by the synthesized ZIF-90 crystals and ZMB beads, which are also readily separable and regenerable. Interestingly, at ambient temperature (303 K) and in acidic pH ( 5), ZIF-90 crystals and ZMB beads achieved equilibrium adsorption capacity of 335 mg/g and 111 mg/g, respectively. The adsorption of IBU was demonstrated by Langmuir isotherm model and exhibited spontaneous and endothermic in nature. The removal of IBU (feed concentration: 2 to 100 mg/L) was affected by different anions and humic acid in water, with adsorption extent of 79 to 94% and 52 to 65%, respectively. In contrast, various cations marginally reduced the IBU adsorption (91 to 96% removal). Five (5) sequential adsorption-desorption cycles were also performed with the ZMB beads; and more than 90% of IBU was removed after the 5th cycles. Different surface functional groups, like, imidazolate, aldehyde, hydroxyl, and sulfone groups of ZMB beads attracts the metal nodes facilitate the adsorption process through electrostatic interaction, H-bonding and coordination interactions.

**Keywords:** *Adsorption, ZIF-90, Ibuprofen, Pharmaceutical waste water treatment, Mixed matrix beads.*



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**Abstract ID: RID26P8**



### A novel device for energy-efficient pipeline transportation of high viscous oil

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Decline in availability of lighter crude have led to the focus on transportation and utilization of heavier oils having substantially high viscosity (few 100-10,000 centipoise). Water lubricated pipeline transportation using core annular flow (CAF) configuration has long been attempted to reduce the pumping energy. However, this method has not gained much popularity, primarily due to the difficulties in maintaining stable CAF over long distance horizontal pipelines. In particular, CAF gets disrupted after passing through pipe fittings. The fraction of water required to ensure stable CAF should also be minimum for reducing the load on downstream dewatering and related facilities.

This study presents a novel, static, in-line device for stabilizing and re-establishing CAF. The principle governing its operation is rationalized using a two fluid model. Lab-scale experiments using lubricating oil (density = 886.8 kg/m<sup>3</sup>, viscosity = 0.314 Pa.s) and tap water in a horizontal pipe are used to evaluate the device performance. Its effectiveness for re-establishing CAF is also demonstrated by fitting it downstream of a partially open gate valve (50% and 20% valve opening). In all cases, CAF forms downstream of device irrespective of the upstream flow pattern. Experiments reveal a major reduction in pressure gradient ( 57%) and savings up to 93% of pumping energy at higher oil flow rates. Since CAF forms at a lower water cut ( 5% v/v) downstream of the device, the cost of separation, treatment and disposal of water at the destination end also reduces substantially.

**Keywords:** *pipeline transportation, heavy oil, core annular flow, energy-efficient.*



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**Abstract ID: RID26P9**



## **A Flexible, Lead-Free Piezoelectric Nanogenerator for Environmentally Friendly Energy Harvesting**

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Energy harvesting is the process of converting one form of energy into more usable forms, such as electrical energy. The rapidly growing energy demand, the limitations of fossil fuels, and increasing environmental concerns have promoted the development of new technologies in the field of energy harvesting. Among these, piezoelectric-based systems have attracted significant attention due to their ability to directly convert mechanical energy into electrical energy. The development of energy harvesting technologies that utilize the piezoelectric effect to generate electrical energy is the main focus of this research. The term piezoelectric is derived from two Greek words: piezein, meaning "to press," and electricity. Piezoelectric devices generate electrical energy when mechanical stress is applied to the material. This study focused on advancing the design and performance of Piezoelectric Nano Generator (PENG). By developing flexible, lead-free piezoelectric materials and optimizing device architecture, this work seeks to invoke environmentally friendly, efficient, and durable energy harvesting systems suitable for deployment in real-world conditions. This work introduces a novel lead-free piezoelectric ink based on barium titanate ( $\text{BaTiO}_3$  nanoribbons, exploiting the strong piezoelectric and dielectric properties of this environmentally benign perovskite oxide. Early experimental observations indicate that the fabricated PENG (100 nm thick) can generate a peak output voltage of 6 V when subjected to mechanical impact. Additionally, the device is capable of charging a 2.2  $\mu\text{F}$  capacitor up to 0.15 V within 5 seconds, demonstrating its practical applicability for micro-energy storage and low-power electronic applications.

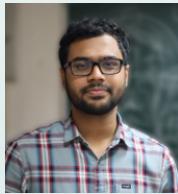
**Keywords:** *Nano energy, Flexible Nanogenerator, Piezoelectricity.*



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**Abstract ID:** RID26P10



## Spatially Decoupled Cellular Segregation and Capillary Extraction for Whole Blood Processing

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We present a synergistic integration of sessile droplet dynamics with paper-based microfluidics for rapid and selective plasma isolation from whole blood. The platform exploits natural convection within a sessile droplet to induce rapid cell aggregation outside the paper matrix, followed by capillary-driven transport of cell-free plasma into detection zones via a dipped paper strip. Efficient plasma isolation is critical for biomarker monitoring, yet existing approaches are often labour-intensive, slow, or prone to clogging and inconsistent performance, particularly in resource-limited settings. Using only 6  $\mu\text{L}$  of blood, the hybrid system achieved plasma separation within 70 s, demonstrating 98 % separation efficiency and 95 % purity, as quantified from high-resolution microscopy (Leica DM6000M) and image analysis. Performance remained consistent across varying hematocrit levels, indicating robustness against physiological variability. Clinical validation using samples from patients with glycemic, albuminemic, and diabetic conditions showed over 90 % sensitivity when benchmarked against an automated biochemistry analyser (DiaSYS 400). This unification of complementary passive microfluidic mechanisms offers a rapid, low-volume, and reproducible strategy for plasma isolation, enabling more reliable biosensing in complex biofluid environments.

**Keywords:** *Paper Microfluidics, Blood Plasma Separation, Sessile Droplet Assay, Hybrid Microfluidic Systems, Glucose and Albumin Detection.*



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**Abstract ID:** RID26P11



**Adsorptive removal of Cr(VI) from aqueous solutions using a substrate-free and electrochemically active Ni/CNF synthesized via catalytic chemical vapour deposition**

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When chromium contaminates water, it poses serious health risks to both humans and aquatic life. Toxic hexavalent chromium (Cr(VI)) in wastewater can be mitigated through various treatment methods, including precipitation, adsorption, ion exchange, membrane filtration, and redox processes. Among these, adsorption is often preferred due to its simplicity, cost-effectiveness, and scalability for heavy metal removal from wastewater.

This study evaluates the efficiency of Ni/CNF in adsorbing Cr(VI) from both wastewater and Cr(VI)-spiked river water. Comprehensive characterizations, including FESEM, FTIR, XRD, and XPS, were conducted to analyse the adsorbent's surface morphology, functional groups, and crystalline phases. The adsorption performance of Cr(VI) was found to be influenced by contact time, pH, and initial metal concentration. Optimal adsorption conditions were determined as a contact time of 180 minutes, pH 2, adsorbent dosage of 0.25 g/L, Cr(VI) concentration of 100 mg/L, and a temperature of 30 °C. The maximum adsorption capacity, estimated using the Liu isotherm, was  $98.18 \pm 7.85$  mg/g. Kinetic studies indicated that the adsorption process follows a pseudo-second-order kinetic model. Electrostatic attraction (pH PZC), presence of different functional groups and pore filling are mainly the reason behind the adsorption of heavy metal on adsorbent. Notably, this material demonstrates a high adsorption capacity compared to many adsorbents reported in previous studies. The electrochemical behaviour of the synthesized carbon-based material was investigated using cyclic voltammetry (CV) and electrochemical impedance spectroscopy (EIS). The electrochemical surface area of the electrode was calculated as 0.82 cm<sup>2</sup> according to the Randles–Sevcik equation. The obtained Randle's circuit parameters for Ni-CNF were, Solution resistance ( $R_s$ ) = 17.9, Charge transfer resistance ( $R_{ct}$ ) = 7.31, Warburg impedance  $W = 12.5 \text{ mMho}\cdot\text{S}^{(1/2)}$ , and Double layer capacitance ( $C_{dl}$ ) = 25.3  $\mu\text{F}$ . These findings suggest that the synthesized carbon material retains favourable electrochemical characteristics and accessible active sites, supporting its application for energy storage application. These findings suggest that Ni/CNF holds significant potential for the removal of other dyes and heavy metals from wastewater.

**Keywords:** *Carbon nanofiber; Chromium; Toxic; Adsorption; Wastewater remediation.*



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**Abstract ID:** RID26P12



## Influence of Bulk Viscosity on the Interfacial Properties of Highly Viscous Extended Liquid Thin Films

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Extended thin films have been extensively studied in the context of interfacial and microscale fluid transport, yet the behavior of polymeric fluids at this scale has remained largely unexplored. This gap is addressed in this study, which investigates the interfacial characteristics of polymeric fluids, with a particular focus on how rheological properties, such as viscosity and power-law behavior, influence thin film dynamics. Experimental investigations are conducted using image analysis interferometry, through which the extended liquid film thickness, slope, and curvature are observed, providing key insights into interfacial behavior. Hamaker constant is determined using established techniques, allowing for the quantification of van der Waals interactions. A numerical model is developed to understand the dynamics of extended thin films. The model integrates the augmented Young–Laplace equation and serves as a foundation for more advanced theoretical models. Experimental data are used to validate the theoretical predictions, revealing that viscosity plays a significant role in governing extended liquid thin film behavior, particularly in spreading dynamics, and interfacial properties. Through the combination of experimental and theoretical approaches, the understanding of polymeric extended thin films is enhanced, providing a foundation for applications in areas such as point-of-care diagnostics, microfluidics, and heat transfer technologies.

**Keywords:** *Extended liquid thin films; Polymeric fluids; Interferometry; Interfacial properties, Hamaker constant; Young-Laplace equation.*



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**Abstract ID:** RID26P13



## Mid-Web Anomaly in Dense Suspensions: Role of Particle Migration

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Dense suspensions used in solid propellant casting often exhibit non-uniform particle distributions across the web thickness, commonly known as the mid-web anomaly, which can adversely affect material performance. This study investigates the role of particle migration in the development of this anomaly using a mechanistic computational framework. A CFD-based model is employed to analyse particle transport in a Hydroxyl-Terminated Polybutadiene (HTPB) matrix loaded with Ammonium Perchlorate and aluminium particles, accounting for particle size, shape, inertia, and web thickness. The results indicate that particle inertia governs long-range migration, while viscosity primarily influences early-stage dynamics. Larger particles and thicker webs enhance non-uniformity, whereas broader particle size distributions help suppress segregation by introducing competing settling velocities. Particle morphology is found to significantly influence local concentration gradients through its effect on drag.

The study provides a mechanistic basis for understanding mid-web anomalies in dense suspensions and offers guidance for improving microstructural uniformity in propellant processing and related multiphase systems.

**Keywords:** *Mid-web anomaly, Particle migration, Microstructural uniformity, Multiphase flow simulation.*



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**Abstract ID:** RID26P14



## Oxidative desulfurization-denitrogenation of a model fuel using a Ti-beta catalyst

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Oxidative desulfurization and denitrogenation of a model dodecane fuel was accomplished by a titanium silicate-beta (Ti-beta) catalyst. The catalyst was synthesized by hydrothermal method carried out at 165 °C for 48 h. The Ti-beta achieved a high conversion of benzothiophene, dibenzothiophene and quinoline in individual and simultaneous oxidative desulphurization and denitrogenation reactions due to its excellent specific surface area (150.87 m<sup>2</sup>/g). The catalyst achieved 73.46% benzothiophene conversion in 75 min, 99.83% dibenzothiophene conversion in 60 min, and 74.55% quinoline conversion in 75 min. The Ti-beta's morphology was determined by FESEM analysis, its crystallinity, by XRD analysis, and its elemental composition and chemical structure by EDS and FTIR analysis.

**Keywords:** *Ti-beta, Oxidative desulfurization-denitrogenation, Model oil, Reaction kinetics.*



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**Abstract ID:** RID26P15



**Sustainable remediation of cephalexin-contaminated wastewater using  $\text{FeCl}_3$ -modified magnetic biochar: Insights from experimental and statistical physics and environmental impact assessment**

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The current study focuses on the removal of the widely used antibiotic cephalexin using a novel magnetic biochar adsorbent and evaluates the environmental impact of its synthesis. The adsorbent was prepared via a single-step pyrolysis of  $\text{FeCl}_3$ -impregnated waste sawdust at 800°C, with  $\text{FeCl}_3$  as the only activating agent in minimal quantity. Characterization using BET, SEM, FTIR, and VSM confirmed a large surface area (611.9 m<sup>2</sup>/g), a well-developed porous structure, abundant functional groups, and magnetic behavior (saturation magnetization = 10.5 emu/g), which enable easy magnetic separation and minimize secondary pollution. A batch adsorption study was conducted to assess the effects of pH, adsorbent dose, contact time, and temperature. Cephalexin adsorption followed pseudo-second-order kinetics and the Langmuir isotherm, with a maximum uptake of 143.9 mg/g. Advanced statistical physics modeling, specifically the monolayer with one energy model (M1), provided molecular-level insights into the adsorption mechanism. The adsorption occurs via a multimolecular, monolayer process dominated by physical interactions, with adsorption capacity and affinity increasing with temperature, and the model accurately describes this endothermic process. Furthermore, a life cycle assessment (LCA) using OpenLCA evaluated the environmental implications of the adsorbent synthesis, considering electricity from coal, diesel, and natural gas. Fourteen environmental impact indicators were analyzed, revealing coal-based electricity had the highest impact (climate change, GWP100 = 10.1 kg CO<sub>2</sub>-eq) while natural gas had the lowest (GWP100 = 0.72 kg CO<sub>2</sub>-eq). The study demonstrates the high efficiency of SD-MBC for cephalexin removal and highlights the environmental benefits of biochar synthesis.

**Keywords:** *Cephalexin adsorption, Wastewater treatment, Environmental impact, Advanced statistical physics, Life cycle assessment, Magnetic biochar.*



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**Abstract ID:** RID26P16



## **Transport modelling of the anion exchange membrane electrolyser: performance prediction and design scale-up**

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Anion exchange membrane (AEM) water electrolysis is a promising pathway for cost-effective green hydrogen production, yet its performance is governed by strongly coupled electrochemical kinetics and transport processes within the membrane–electrode assembly (MEA). In this work, an integrated first principal based one-dimensional through-plane multiphysics model of an AEM system is developed and validated against the experimental data under voltage-controlled operation. The model resolves individual MEA layers, enabling layer-wise quantification of activation, ohmic, and transport losses. Model-predicted polarization curves agree well with experiments over the temperature range of 50–70 °C, with deviations within  $\pm 5\%$ . Increasing temperature enhances hydroxide-ion conductivity and reaction kinetics, increasing the current density at 1.9 V from 0.42 to 0.46 A cm<sup>2</sup>. Parametric analysis shows that higher exchange current densities and balanced charge-transfer coefficients ( $\alpha_a \approx \alpha_c \approx 0.5$ ) reduce activation losses, with performance more sensitive to anode-side kinetics. Through-plane ionic potential distributions identify the membrane as the dominant source of ohmic losses, with membrane thicknesses above 50 µm causing a significant reduction in current density. Catalyst layer thickness exhibits an optimal range of 10–50 µm, while electrolyte concentration improves performance up to 0.3 M KOH, beyond which gains become marginal. Efficiency analysis reveals a trade-off between hydrogen production and energy efficiency, with overall efficiency decreasing from 96.9% at 1.5 V to 46.8% at 1.9 V. The validated framework provides quantitative guidance for optimizing MEA design and operating conditions in AEM electrolyzer.

**Keywords:** Anion exchange membrane; water electrolysis; hydrogen production; charge transport; mathematical modelling.



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**Abstract ID:** RID26P17



## **Performance evaluation of binder-free castor oil-derived carbon soot electrodes for supercapacitor application**

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The present study unveils a novel approach in the facile fabrication of carbon soot-based electrodes for supercapacitor application. We utilize castor oil as a precursor material, a unique choice that has not been explored in this context. The soot derived from castor oil, with a major carbon composition of 95.5%, having a specific surface area of 114.99 m<sup>2</sup> g<sup>-1</sup>. This work delves into the structural characteristics and electrochemical performance of the castor oil-derived soot-based electrodes for supercapacitors. The carbon soot electrode-based symmetric electric double-layer capacitor exhibits a specific capacitance of 50 F g<sup>-1</sup> at 0.5 A g<sup>-1</sup>, with a remarkable capacitance retention of 95% and a columbic efficiency of 97% over 2000 cycles with excellent cyclic stability. It also has a high energy density of 4.44 W h kg<sup>-1</sup> at a power density of 400 W kg<sup>-1</sup>. This study not only sheds light on the viability of castor oil-derived soot as a cost-efficient and sustainable material for supercapacitor technology but also introduces a new perspective by examining the effect of soot on device's capacitance, charge-discharge properties, and overall efficiency.

**Keywords:** *Carbon Soot, Supercapacitor, Castor Oil, Electric Double-Layer Capacitor.*



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**Abstract ID:** RID26P18



## Numerical Model for Fabrication, Thermal-Mechanical Analysis of Ni Wicks for Spacecraft Applications

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In the realm of thermal management for electronic components, the loop heat pipe (LHP) stands out as a passive heat transfer system. Enhancing the heat transfer capabilities of LHPs requires net shape wicks. In this work, a nickel wick has been fabricated using the metal injection molding (MIM) technique, specifically tailored for a bi-porous structure. A wick mainly generates capillary pumping pressure necessary to move the working fluid inside a two-phase heat transfer loop. The bi-porous wicks in a near-net shape have been used to eliminate additional machining to create vapor removal channels or grooves on the outer surface. Nickel powder, polypropylene (PP), and a thermoplastic binder comprising paraffin wax (PW) and low-density polyethylene (LDPE) have been used to produce the feedstock for injection molding. The weight percentages (wt.%) i.e., 87.5 wt.% of nickel and 12.5 wt.% of binder and space holder have been used to obtain feedstock and injected in MIM at 180°C. The green compacts of the wicks, fabricated by injection molding, were then debound and sintered at 900°C for 60 minutes to yield the final porous structure. DSC measurements, mercury porosimetry, and FESEM characterization have been carried out for thermal and mechanical study of sintered Ni wick. Results revealed a level of porosity of 56.67 vol%, with diameters of smaller capillary pores being 2.6  $\mu\text{m}$  and larger ones distributed between 25–35  $\mu\text{m}$ . FESEM analysis confirmed the well-connected microporous network, which is fundamental for generating the capillary pumping pressure critical to the operation of LHP.

**Keywords:** *Loop heat pipe; Bi-porous; Porosimeter; Thermal and mechanical properties.*



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**Abstract ID:** RID26P19



## **Electrocoalescence Of Identical Droplets Under An External Electric Field**

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The coalescence of identical droplets is commonly expected to proceed symmetrically when the system is prepared under nominally symmetric initial and boundary conditions. In this work, we investigate the electrohydrodynamic coalescence of equal-sized droplets suspended in an immiscible fluid and demonstrate that the coalescence process can undergo a spontaneous symmetry-breaking transition, resulting in asymmetric deformation and coalescence dynamics. We employ a coupled Cahn–Hilliard–Navier–Stokes framework to resolve the interfacial evolution and fluid motion, augmented by electrohydrodynamic effects. The electric field is obtained from Gauss's law using a conductivity-dependent formulation, which enables charge transport and interfacial charge accumulation characteristic of leaky dielectric systems. The resulting electrical body force, represented through the Korteweg–Helmholtz force, is incorporated as a source term in the momentum equation, allowing for a consistent coupling between electric stresses and hydrodynamics. The model captures classical electrohydrodynamic droplet deformation behavior and is validated against established theoretical predictions. A systematic parametric study is performed to examine the influence of electric field strength, interfacial tension, and fluid rheology on the coalescence process. Remarkably, despite the droplets being identical and initially arranged symmetrically, nonlinear electrohydrodynamic interactions amplify weak perturbations, leading to asymmetric neck formation, flow recirculation, and biased coalescence pathways. These results reveal that symmetry breaking is an intrinsic feature of electrohydrodynamic droplet interactions rather than a consequence of imposed asymmetry. The study provides new physical insight into instability-driven droplet coalescence and has implications for electro-coalescence processes, droplet microfluidics, and electrically controlled multiphase systems.

**Keywords:** *Electro-hydrodynamics, Leaky dielectric model, Droplet coalescence, Phase field method, Numerical simulation.*



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**Abstract ID:** RID26P20



## **Hydrogen-Doped MoO<sub>3</sub>: Unlocking High-Rate Al<sup>3+</sup> Storage in Aqueous Batteries**

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With the marvelous advancement of batteries as an efficient energy storage and conversion device, the world is witnessing a paradigm shift in the energy sector towards clean energy from conventional fossil fuel-based systems. The resurgence of lithium-ion batteries revolutionized this transition, making the lithium-ion-based batteries a household name. But in the present-day scenario, despite the widespread popularity of the lithium-based energy systems, the longevity of the lithium-ion system is encumbered by its availability and supply chain. Considering the abundance, low flammability, and its three-electron per cation redox electrochemistry leading to its high theoretical capacity, aluminium is gaining popularity in present-day battery research. The aluminium battery research primarily focuses on positive aluminium hosting electrode materials and the electrolyte system. But the research attempts in developing proper electrode materials have encountered various complications like inadequate cycle life with capacity fading after several cycles, lower cell discharge voltage, dissolution of the host materials etc. Herein, the electrochemical Al<sup>3+</sup> ion storage behavior in H<sub>x</sub>MoO<sub>3</sub> in an aqueous electrolyte is illustrated, which underscores the influence of H- doping in significantly enhancing the specific capacities and long-term cycling stability even at very high current rates.

**Keywords:** *Energy storage, aluminium, doping, capacity, high rate, performance.*



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**Abstract ID: RID26P21**

## **Port Number and Location Optimization of Mould Gates-Vents using In-House Coded Stochastic Multi-Objective Optimization Algorithms**

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An in-house coded multi-objective stochastic optimization (MOSO) and non-dominated sorting differential evolution (NSDE) algorithms were developed to optimize the mould-fill phase of resin transfer moulded (RTM) composite parts. Glass fibre-vinyl ester-based automotive bonnet and carbon fibre-RTM6-based aircraft wing flap composite parts were used as the case studies. Initially, the NSDE algorithm was developed for simultaneous optimization of dry spot content and mould-fill time by changing the locations of mould gates and vents with a constraint of pre-fixed port numbers. Then, the MOSO algorithm was developed for the simultaneous optimization of dry spot content, mould-fill time and total number of ports by changing both the numbers and locations of gates and vents. Subsequently, a comparative assessment was made between NSDE and MOSO algorithms to examine the efficacy of the proposed algorithms. From the results, it was found that the MOSO algorithm predicted better Pareto front between mould fill time, dry spot content and port numbers for both composite parts when compared to the NSDE algorithm.

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