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Editorial

Electrochemistry: Enabling Sustainable Energy, Advanced Materials and Emerging Technologies

This issue of the *Journal of the Electrochemical Society of India* (JECSI) brings together a diverse collection of research contributions that highlight the expanding scope of electrochemical science and its applications. The articles span bioelectrochemical hydrogen production, advanced battery technologies, corrosion behaviour of engineering materials, electrochemical synthesis of alloys, composite coatings and surface modification of biomedical materials. Collectively, these contributions demonstrate how fundamental understanding and innovative electrochemical approaches can be translated into solutions with significant technological relevance.

The two featured articles address important challenges in sustainable energy conversion and storage. The article entitled **"Harnessing Cyanobacteria for Hydrogen Production from Light Through Bio Electrochemical Route"** explores the potential of cyanobacteria as biological platforms for hydrogen generation using light energy through a bioelectrochemical pathway. Harnessing biological systems for solar-to-hydrogen conversion represents an exciting research direction at the interface of biotechnology and electrochemistry. Such approaches could contribute to the development of large-scale bio-photoconversion devices, offering new possibilities for clean and efficient energy conversion.

The second featured article, **"MXene Coating for High Capacity Anode Free Lithium Battery,"** addresses an important challenge in the development of next-generation lithium batteries. Anode-free lithium-metal batteries offer the prospect of higher energy density and simplified cell architecture, but their practical implementation is often limited by lithium deposition instability and associated interfacial issues. The use of MXene coatings to modify the current collector surface presents a promising strategy for regulating lithium deposition and improving battery stability. This work highlights the growing significance of two-dimensional materials and surface engineering in advancing electrochemical energy-storage technologies.

The main articles in this issue further demonstrate the versatility of electrochemical approaches in addressing materials-related challenges across diverse industrial sectors. The study entitled **"Influence of Water Contamination on the Corrosion of Nickel Alloy in Biodiesel"** investigates the effect of water contamination on the corrosion behaviour of nickel alloys in biodiesel environments. Understanding the interaction between fuel composition, contaminants and structural materials is essential for ensuring the reliability of biodiesel storage and transportation infrastructure. The mechanistic insights provided by this work are relevant to material selection, corrosion mitigation and long-term integrity management in emerging biofuel applications.

The article **"Microstructural, Mechanical and Corrosion Assessment of Ti-Cu Alloys Prepared by Molten Salt Electro-Deoxidation Process"** explores an electrochemical route for the synthesis of titanium-copper alloys. The proposed reduction mechanism provides valuable insight into the formation of these alloys through molten salt electro-deoxidation. Such processes are of considerable interest for developing alternative and potentially more efficient routes for the production of advanced metallic materials. The investigation of their microstructural, mechanical and corrosion characteristics further establishes the relationship between processing, structure and properties.

Surface engineering and functional coatings constitute another important theme of this issue. The article **"Synergistic Role of Ceria and Titania in Enhancing the Microhardness and Corrosion Resistance of Electrodeposited Ni-Ceria-Titania Composite Coating"** demonstrates the potential of incorporating ceria-titania composite particles into electrodeposited nickel coatings. The improved microhardness and corrosion resistance, together

with the potential for enhanced wear performance, underline the importance of selecting appropriate ceramic reinforcement phases for developing multifunctional composite coatings. Such approaches offer opportunities for extending component life and improving the performance of engineering surfaces.

In a related contribution, **"Surface Modification of Cast Iron Rotary Engine Apex Seals Using RoHS-Compliant Electroless Ni-P Coatings"** addresses the need for durable and environmentally compliant surface treatments for engineering components. The investigation demonstrates the potential of electroless Ni-P coatings for improving the durability of cast iron rotary engine apex seals. The emphasis on RoHS-compliant coating technology is particularly relevant in the context of increasing environmental regulations and the need for sustainable manufacturing practices. The study also illustrates the importance of surface modification in enhancing the service performance of components used in demanding engineering applications.

The final article, **"Electrophoretically Modified 316L Stainless Steel: A Promising Approach for Durable and Biocompatible Bone Implants,"** explores the use of electrophoretic deposition for modifying the surface of 316L stainless steel. Since implant performance depends not only on the bulk mechanical properties of the substrate but also on its surface characteristics, the development of suitable composite coatings is an important area of research in biomedical materials. The reported improvements in the coated material point towards the potential of electrophoretic surface modification for developing durable and biocompatible orthopaedic implants. This work exemplifies how electrochemical processing techniques can contribute to advances in healthcare and biomedical engineering.

Taken together, the contributions in this issue reflect the remarkable diversity of electrochemical science and its growing relevance to contemporary technological challenges. The research spans the entire spectrum, from harnessing biological systems for clean hydrogen generation and engineering interfaces for high-performance batteries to developing corrosion-resistant alloys, multifunctional coatings and biomedical implant surfaces. A common thread running through these studies is the importance of controlling electrochemical reactions and material interfaces to achieve enhanced functionality and performance.

As we move towards a future driven by clean energy, resource efficiency, advanced manufacturing and sustainable technologies, electrochemistry will continue to play a pivotal role. Emerging areas such as green hydrogen, electrochemical energy storage, recycling of critical materials, advanced surface engineering, bioelectrochemical systems and electrochemical manufacturing offer exciting opportunities for researchers and technology developers. Equally important will be the translation of laboratory-scale research into scalable processes and industrially relevant technologies.

Through JECSI, we endeavour to provide a vibrant platform for disseminating high-quality research, encouraging interdisciplinary collaborations and promoting the translation of electrochemical science into meaningful technological outcomes. I sincerely appreciate the contributions of all the authors and the efforts of the reviewers and editorial team in maintaining the scientific quality of the journal. I hope that the articles presented in this issue will stimulate further research, foster new collaborations and inspire innovative solutions to emerging scientific and technological challenges.

I invite researchers, academicians and industry professionals to continue engaging with JECSI and contribute to its growth as a significant platform for advancing electrochemical science and technology in India and beyond.

ST Aruna
Editor-in-Chief