Seventh International Symposium on
MATERIALS, ELECTROCHEMISTRY & ENVIRONMENT
cimee-science.org

7th International Symposium on Materials, Electrochemistry and Environment – CIMEE25

Advancing sustainability through Materials, Electrochemistry & Green Energy

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Thematic Area: Materials, Electrochemistry, & Environment

Abstract

In the face of the triple global crisis, a fundamental transformation of economic and environmental systems is necessary to ensure a sustainable future. Thus, integrating decarbonization, the circular economy, and sustainable energy will be a key strategic response, including waste reduction, pollution treatment, and ecosystem restoration, essential for strengthening ecological resilience and environmental sustainability. Achieving sustainability through materials, electrochemistry, and green energy involves leveraging innovative technologies to address environmental challenges and support sustainability. It's in the fields of materials, electrochemistry, and green energy relies on a profound transformation of industrial processes, guided by the principles of the circular economy and the objective of decarbonization. Innovation in the principal sectors, particularly in the design of more sustainable materials and low-impact production processes, is essential to achieving global climate goals. These advances are generally part of a global approach aimed at replacing fossil resources with renewable materials, optimizing energy consumption and designing products so that they are harmless at the end of their life. All this will be developed through three key areas: •.Sustainable materials: Research is moving towards bio-sourced and biodegradable polymers, particularly from waste or biomass, to reduce dependence on oil and plastic pollution. • Electrochemistry and Energy Storage: Approaches aim to reduce greenhouse gas emissions by developing efficient processes for wastewater treatment and sludge [1], environmental remediation, and carbon capture and storage. Innovations such as renewable organic electrodes and molecularly imprinted polymers are also being explored [2]. • In green energy, the decarbonization of industries is supported by levers such as decarbonized hydrogen, carbon capture and storage, and the optimization of energy processes. Bioenergy thus represents an essential short- and medium-term solution to combat climate change by replacing fossil fuels and contributing to sustainable development. It is essential for the transition to sustainable energy systems, while meeting global energy demand and supporting sustainability. The integration of green energy is central to these advances, as electrochemical systems, particularly electrolysis devices, convert renewable electrical energy into green hydrogen, a key solution to addressing the challenges of the energy transition and a clean fuel for transportation and industrial processes. Fuel cells, meanwhile, efficiently convert hydrogen into electricity. Finally, the transition from laboratory research to industrial applications requires interdisciplinary collaboration and the optimization of catalysts, electrode materials, and system design. Ultimately, the convergence of materials science, electrochemistry, and renewable energy is essential to creating a sustainable environment.

Keywords: Sustainability, Materials, Electrochemistry, Energy Storage, decarbonization, circular economy.

References :

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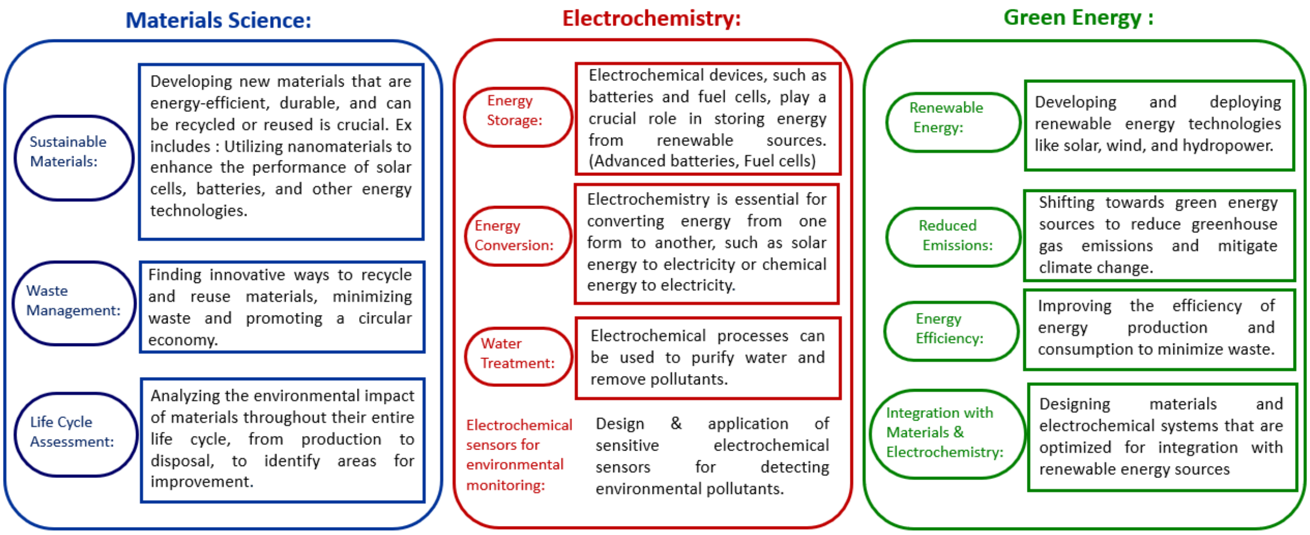
[2] Ahmad El Moll, 2025, Valorization of wastewater and sludge for green hydrogen production, (Chap 4) in the Book: Accelerating the Transition to a Hydrogen Economy: Achieving Carbon Neutrality, Elsevier



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