Seminar

==

Institute for Plasma Research

==

Title: Synthesis and Characterization of Nanomaterials for Energy Applications

Speaker: Dr. Mahima Sheoran
Amity Institute of Nano Technology, Noida, Uttar Pradesh

Date: 12th September 2025 (Friday)

Time: 10:30 AM

Venue: Seminar Hall, IPR

Abstract

The growing global energy demand and depletion of fossil fuels necessitate the development of sustainable energy storage technologies. Among various alternatives, supercapacitors have emerged as promising candidates due to their high-power density, rapid charge–discharge ability, long cycle life, and eco-friendliness. However, achieving high energy density while maintaining stability remains a critical challenge, which is strongly dependent on the design of electrode materials. This work focuses on the synthesis and characterization of nanostructured materials—metal oxides, carbon-based materials, and metal sulfide/carbon composites—for efficient and sustainable supercapacitor applications. Emphasis was placed on scalable, cost-effective, and environmentally friendly synthesis routes, with a particular interest in utilizing natural and waste-derived precursors.

In the first study, Mg-doped ZnO/carbon nanotube nanocomposites were synthesized via a blending-assisted hydrothermal method. The optimized nanocomposite exhibited a specific capacitance of 458.5 F/g at 0.1 A/g, demonstrating excellent stability over 1200 cycles. In the second approach, biowaste-derived carbon spheres from different vegetable peels were prepared hydrothermally, achieving a remarkably high capacitance of 2221.3 F/g with robust cyclic stability up to 6000 cycles, highlighting the potential of sustainable waste-derived electrodes. In the third study, NiS/potato-peel carbon composites were fabricated, demonstrating outstanding electrochemical performance with a specific capacitance of 2617.5 F/g at 0.1 A/g and excellent cycling stability retained over 20,000 cycles.

The systematic comparison across these materials reveals that hybrid composites, especially metal sulfide–biocarbon systems, exhibit superior capacitance and longevity due to synergistic effects of pseudocapacitance and double-layer capacitance. Overall, this work establishes the feasibility of utilizing earth-abundant, eco-friendly, and low-cost nanocomposites for next-generation high-performance supercapacitors. The findings not only advance electrode design but also open pathways toward sustainable energy storage technologies for electric vehicles, portable electronics, and grid applications.
