PLATHINIUM
PLASMA THIN FILM INTERNATIONAL UNION MEETING
22-26 September 2025
Antibes, French Riviera
www.plathinium.com

Tutorial #2

Plasma for synthesis on nanostructures and their use in advanced applications

Uros Cvelbar

Jožef Stefan Institute, Ljubljana (Slovenia)
uros.cvelbar@ijs.si

This tutorial lecture will present the strategic use of plasma processes for the synthesis of nanostructures and their integration into advanced applications, with a focus on addressing key challenges in energy and environment. Emphasis will be placed on how tailored plasma conditions influence nanomaterial growth mechanisms, enabling template-free synthesis of 1D, 2D, and hierarchical nanostructures with controlled morphology, crystallinity, and surface functionality. Case studies will highlight the formation of carbon nanostructures, metal oxides, and hybrid materials using techniques such as plasma-assisted CVD, direct gas-phase plasma synthesis and plasma-liquid interactions, with special attention to in-situ surface modification and post-processing. The tutorial will explore applications in energy storage and conversion, such as batteries, supercapacitors, fuel cells, and electrocatalysis, where plasma-fabricated nanostructures offer high surface areas, enhanced charge transport, and catalytic activity. Environmental sensing, pollutant degradation, and water purification platforms based on plasma-synthesized nanomaterials will also be addressed, demonstrating their role in building cleaner technologies. In the context of the European Green Deal, plasma nanomanufacturing will be discussed as a sustainable, scalable, and low-energy alternative to conventional chemical synthesis, supporting objectives in carbon neutrality, circular economy, and clean energy transitions. The compatibility of low-temperature and atmospheric plasmas with flexible substrates and eco-friendly processes positions plasma technology as a key enabler for green innovation. Furthermore, the lecture will introduce emerging trends such as plasma-assisted additive nanomanufacturing, miniaturized plasma reactors, and AI-augmented plasma process design, pointing toward industry-relevant scalability and integration. Attendees will gain insights into how plasma-driven defect engineering, interface tuning, and self-organization contribute to functional properties in electronic, photonic, and biomedical devices. Through the lens of advanced applications and sustainable impact, this talk aims to bridge interdisciplinary domains and inspire future developments at the convergence of plasma science and nanotechnology.