



AVVISO DI SEMINARIO

Il giorno 3 novembre alle ore 12:00

in Aula Seminari Lorenzo Stella

la **Prof.ssa Katarzyna Siuzdak**

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(IMP PAN),
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terrà un seminario dal titolo

From Ordered Titania to MXenes: How Electrochemistry Creates Functional Nanomaterials

Proponente: Prof.ssa Fabiana Arduini

Abstract

From Ordered Titania to MXenes: How Electrochemistry Creates Functional Nanomaterials

Electrochemistry is not only a tool for studying interfacial processes, but also a powerful route for synthesizing, transforming, and functionalizing nanomaterials with tailored morphology, composition, and properties. This seminar will present two representative material families, ordered titanium dioxide nanotube arrays and two-dimensional metal carbides known as MXenes, and show how electrochemical methods enable their design for energy- and environment-related applications.

The first part will focus on self-organized TiO₂ nanotube arrays (TNAs) prepared by electrochemical anodization of titanium. This scalable approach allows control over nanotube diameter, length, wall thickness, ordering, and surface morphology through the choice of electrolyte and anodization conditions. The resulting one-dimensional architectures offer high accessible surface area, chemical stability, tunable semiconducting properties, and favourable charge transport. These characteristics make TiO₂ nanotubes attractive for photoelectrochemical water splitting, photocatalytic pollutant degradation, electrochemical sensing, and functional coatings.

The seminar will discuss selected strategies to extend the performance of pristine titania nanotubes, including the incorporation of conducting polymers and the cycle-controlled deposition of metal oxides and metal sulfides using Successive Ionic Layer Adsorption and Reaction (SILAR), Atomic Layer Deposition (ALD) and thermal annealing in hydrogen atmosphere induces partial reduction and enhances conductivity. Such modifications can improve light harvesting, charge separation, conductivity, catalytic activity, and selectivity toward target analytes. The nanotube architecture can therefore serve as a versatile platform for constructing functional heterostructures.

The second part will introduce MXenes, an emerging family of two-dimensional transition-metal carbides and nitrides, typically produced by selective removal of the A-element from layered MAX phases. Electrochemical approaches offer opportunities for controlled MXene synthesis without HF usage, delamination, surface engineering, and integration into functional electrodes. With their high electrical conductivity, hydrophilicity, layered structure, and tunable surface chemistry, MXenes are highly promising for electrochemical sensing, energy storage, catalysis, and photoelectrochemical systems.

Despite their different structures and electronic properties, TiO₂ nanotubes and MXenes share a crucial feature: their performance is strongly governed by interfaces. By linking ordered oxide nanotubes with conductive two-dimensional materials, this seminar will demonstrate how electrochemistry enables the rational design of advanced nanomaterials for sustainable energy conversion, environmental remediation, and chemical sensing.



Biography

Katarzyna Siuzdak (Prof., DSc, PhD, Eng.) is a Professor at the Institute of Fluid-Flow Machinery, Polish Academy of Sciences (IMP PAN) in Gdańsk, Poland, where she heads the Department of Physical Aspects of Ecoenergy and the Laboratory of Functional Materials. Her research focuses on the fabrication, modification, and characterization of nanostructured materials—including titanium dioxide nanotubes, MXenes, metal sulfides, and carbon-based nanomaterials—for applications in electrochemical sensing, photoelectrochemical energy conversion, photocatalysis, and water splitting. She has authored more than 100 scientific publications and has been listed among the Stanford/Elsevier Top 2% Scientists worldwide. She is a recipient of the START Fellowship of the Foundation for Polish Science, a scholarship from the Polish Ministry of Science for outstanding young researchers, and the Walther Nernst Prize, awarded in recognition of contributions to the development of hydrogen technologies. She has also recently been awarded a scholarship from the Chinese Academy of Sciences.

Katarzyna currently leads the M-ERA.NET project “Innovative Nano-Carbon-Based Electrochemical Monitoring of Female Hormones.” The project develops miniaturized electrochemical sensor platforms based on MXenes and carbon quantum dots for the detection of hormones in microlitre-volume samples of biological fluids and environmental waters.