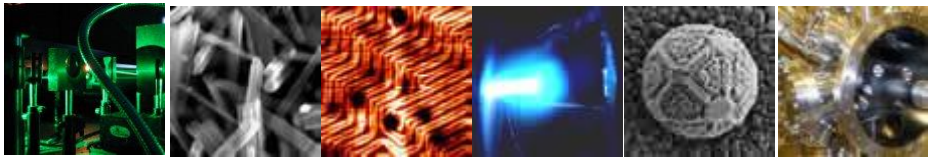
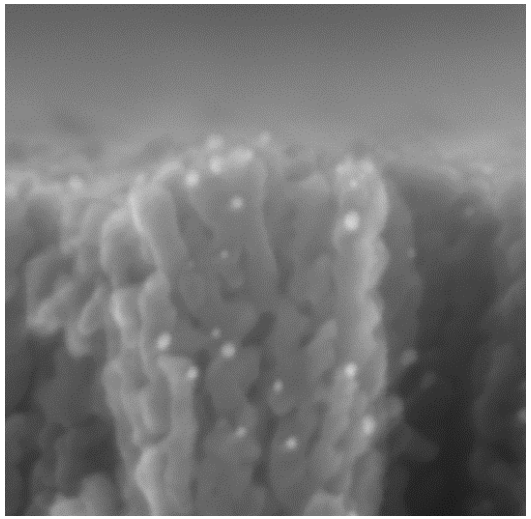


Master Thesis Projects at NanoLab

Micro and Nanostructured Materials Lab - NanoLab
Department of Energy (Cesnef site Building 19) Leonardo Campus
NEMAS – Center for NanoEngineered Materials and Surfaces
Politecnico di Milano - Leonardo Campus
Via Ponzio 34/4 20133 Milan, Italy

Lab website: *www.nanolab.polimi.it*



Pulsed Laser Deposition of novel functional nanostructured thin films

Possible thesis topics include:

- development of novel transparent conducting oxide (TCO) electrodes through doping, e.g. Ta:TiO_2 or similar;
- synthesis of tunable noble metal plasmonic nanoparticles;
- development of hybrid metal nanoparticle-hierarchical oxide systems for light harvesting via plasmonic effects;
- synthesis of binary metal nanoglasses or amorphous metal thin films with enhanced mechanical and functional properties.

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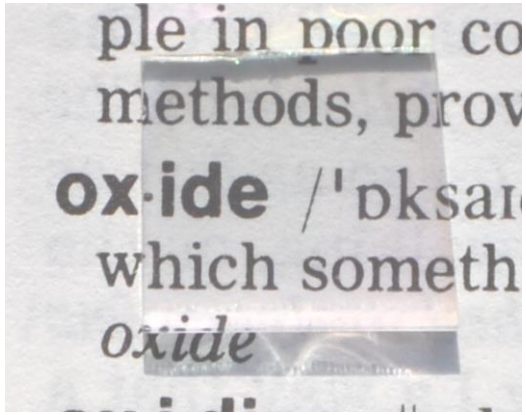

Hierarchical oxide systems for increased light harvesting or photoconversion

Development of nanoarchitectures with controlled morphology, composition and structure for tuning light scattering and photconversion processes, in view of advanced photovoltaic or photocatalysis applications.
The activity may include synthesis via Pulsed Laser Deposition (PLD); attention will be devoted to the investigation and control of the structure-property relation (with particular focus on structural, electronic and optical properties), and in selected cases to the test of functional properties in prototype devices through external collaborations.

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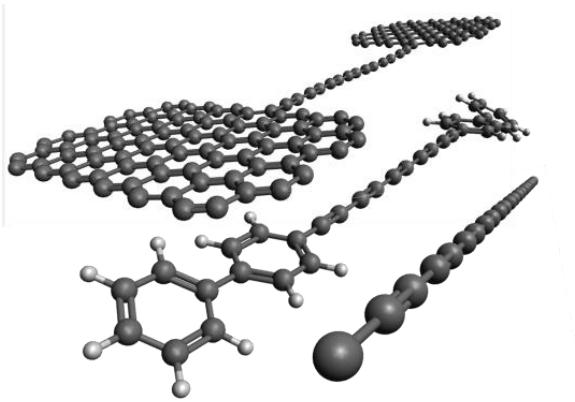

Novel materials and nanostructures based on carbon wires

Novel functional carbon coatings, films and nanocomposites based on sp-hybridized carbon-atom wires to fill the existing gap between fundamental science and engineering. Synthesis of 1-D carbon structures with sp^1 hybridization (Carbon-Atom Wires) and nanostructured hybrid sp^1-sp^2 systems by physical vapour depositon methods. Study of the structural, vibrational and electronic properties by Raman and Surface Enahnced Raman Scattering (SERS). Development of methods for film deposition. Study of optical and electronic properties and charge transport.

(In collaboration with Univ. of Erlangen (Germany); Dept. of Chemistry Materials and Chem. Eng., Politecnico di Milano, European Research Council - ERC)

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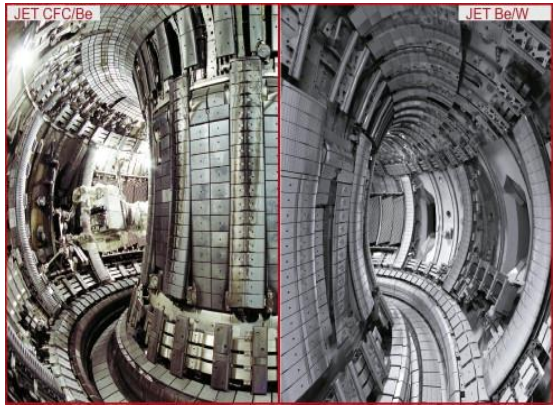

Materials and surfaces for nuclear fusion machines

Pulsed Laser Deposition (PLD) of nanostructured systems, surfaces and coatings for applications in nuclear fusion research. In particular:

• Production of W-based films and coatings, oxides, to investigate H permeation/retention properties and their behavior under plasma irradiation.

• Production and laser cleaning of Rh, Mo surfaces, for the development of diagnostic “first mirrors” in magnetic nuclear fusion machines

(Collaboration with: IFP-CNR Milano; ENEA Frascati; IPP-Max Planck Garching (Germany); Basel University (Switzerland); EURATOM)

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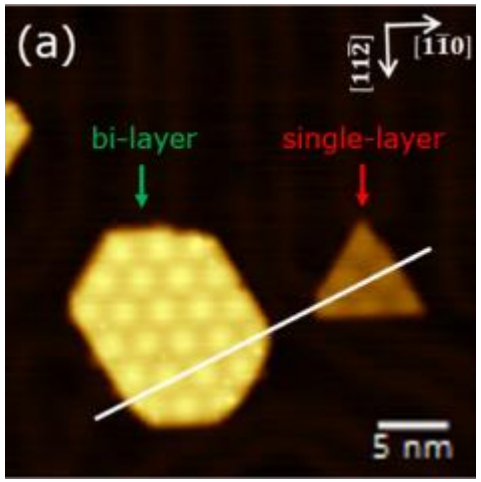

Atomic and nanoscale studies of 2D nanostructures on surfaces

Fabrication and investigation of 2D materials and nanostructures:

- monolayer or few-layer systems of metal oxides (e.g. TiO_2 and ZnO), or 2D oxide-semiconductor (e.g. ZnO-MoS2) heterostructures; *in situ* characterization by Scanning Tunneling Microscopy and Spectroscopy (STM/STS) to unveil the structural and electronic properties at the nano- and atomic scale
- STM/STS investigation of 1D *sp* carbon chains on surfaces or carbon chain self-assembled layers on surfaces via STM/STS.

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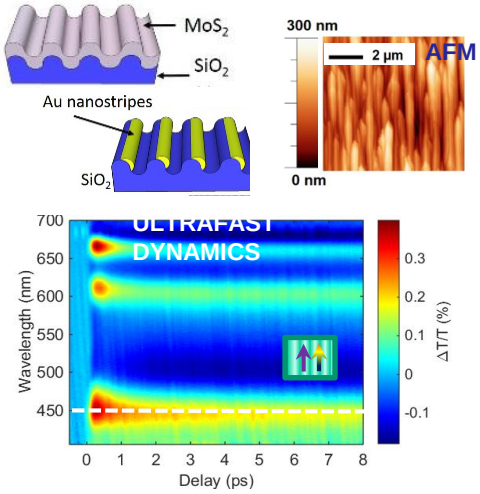

Hot-electrons in self-organised plasmonic metasurfaces coupled to semiconducting MoS_2 nanosheets for photovoltaic devices

- Growth of large area MoS_2 nanosheets with a controlled number of layers on nanostructured and plasmonic metasurfaces, by chemical vapour deposition.
- Characterization of MoS_2 and hybrid MoS_2-plasmonic metasurfaces (composition, structure, strain, morphology, charge transport and screening, surface potential) by X-ray photoelectron spectroscopy, micro-Raman spectroscopy, atomic force microscopy (AFM), conductive AFM, Kelvin probe AFM, electrostatic force spectroscopy AFM.
- Experimental study of optically induced ultrafast processes in MoS_2 and hybrid MoS_2-plasmonic nanosheets (dynamics of photogenerated charges and dynamics of plasmonic processes) by spectroscopy techniques with fs time resolution, using fs lasers.

(Collaboration with MDM – Istituto per la Microelettronica e Microsistemi - CNR)

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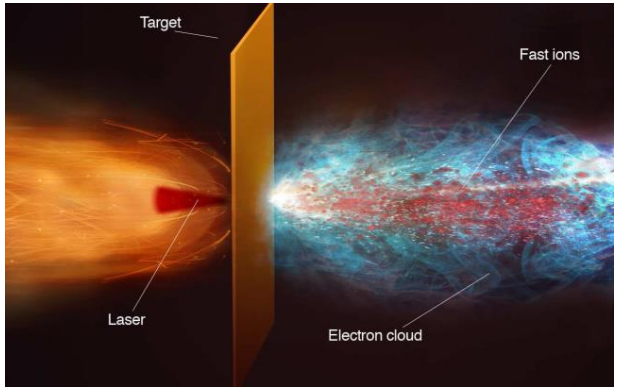

Theoretical and experimental investigation of the superintense laser-plasma interaction

• Theoretical/numerical investigation of the superintense laser-driven ion accelation in laser-solid interaction experiments.

• Production and characterization, by Pulsed Laser Deposition, of novel nanostructured targets for superintense laser-matter interaction experiments

(Collaboration with: Gwangju Institute of Science and Technology (Korea); HZDR Dresden (Germany), European Research Council)

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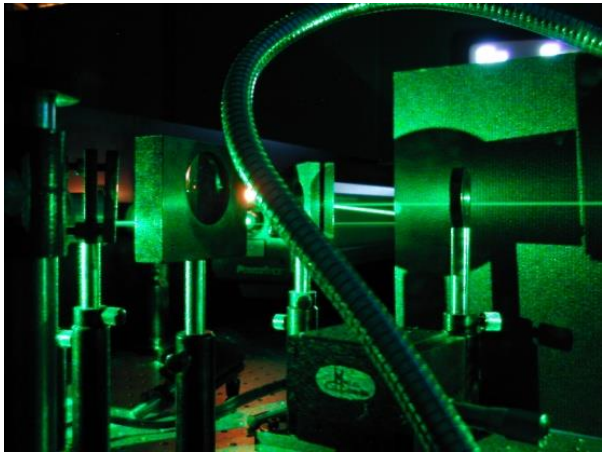

Thermomechanical properties of films and multilayers

Experimental investigation of the elastic properties of compact and nanostructured films and coatings, by Brillouin spectrometry.

• Experimental investigation of the thermal expansion of coatings, by a new optical, contactless, apparatus

• Computational simulation of the temperature and stress fields induced in a coated surface by an intense laser pulse.

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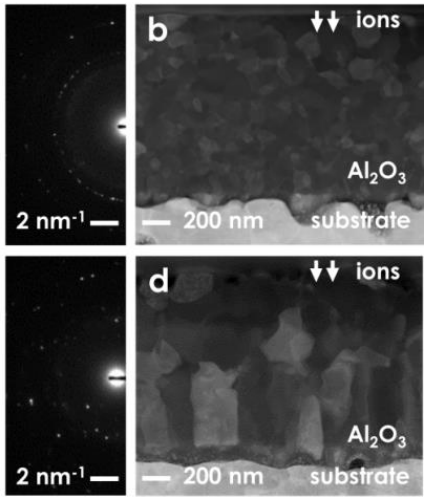

High-Performance Coatings for Advanced Nuclear Systems

- Metal-Ceramic Multilayer Coatings for Accident Tolerant Fuels (ATFs), for current (Gen. II) and advanced light water reactors (Gen. III, Gen. III+).
- Oxide Nanoceramic Coatings for Gen. IV systems: corrosion and irradiation resistant coatings for Lead-cooled Fast Reactors (LFRs).
- Tritium Permeation Barriers for Fusion Tokamaks. In tokamaks, Pb-16Li eutectic is used as a liquid breeder of tritium in Tritium-breeding Blanked Modules (TBM). Tritium permeation from the breeder to the coolant is a fundamental safety issue.

(Collaboration with: Italian Institute of Technology, CNST-IIT@PoliMI)

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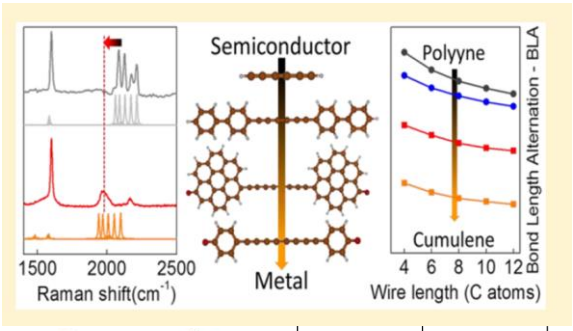

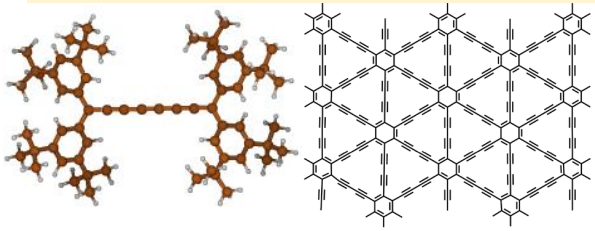

First-Principles Simulations of sp-Carbon Wires and Graphdyines

Density Functional Theory (DFT) calculations of the structure, vibrational properties (IR, Raman and SERS response) and electronic properties (UV-Vis absorption) of finite-length polyynes and cumulenes and rationalization of the experimental data available.
Periodic Boundary Condition DFT calculations of two-dimensional graphyine and graphdyine systems and of finite-length fragments: structural properties, spectroscopic characterization and detailed investigation of pi-electron delocalization as a function of the molecular structure.

(In collaboration with Dept. of Chemistry Materials and Chem. Eng., Politecnico di Milano, European Research Council - ERC)

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