Nanostructured Interfaces and Surfaces

nis
Centre of Excellence

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What is a Centre of Excellence?

The Italian National Plan for Research includes initiatives aimed at fostering research teams of high scientific profile. One of the main instruments to this purpose is the creation of national "Centres of Excellence". The excellence qualification is obtained by presentation of a three-year research project, subject to national and international peer review.

The Proposers

The Centre of Excellence **"Nanostructured Interfaces and Surfaces"** originates from the joint effort of several research groups of the University of Torino and of the University of Eastern Piedmont, in the fields of Chemistry, Physics and Biology. These groups are involved since a long time in a network of interdisciplinary research collaborations and form the teaching body of the Degree Courses in Materials Science of the University. **(www.scienzadeimateriali.unito.it)**

Nanotechnology of surfaces

Nanotechnology enables the synthesis of a wide range of materials with peculiar mechanical, chemical, optical, electrical and magnetic properties. In many cases, the most relevant properties of materials depend on the structure of their surfaces or of the interfaces between their domains. The physical and chemical properties of the interface between materials and the environment and between different phases in the bulk determine the final properties in many technical applications.

The Centre "Nanostructured Interphases and Surfaces" has the dual mission of **pursuing basic research and offering applied research services.** It will enable non-academic researchers and technicians, in particular from the industry, to take advantage of the competence and the instrumentations of the affiliated groups. The Centre offers a multi-disciplinary laboratory equipped with the most advanced techniques in microscopy and spectroscopy, and it will promote consultancy to external researchers to enforce collaboration with academic research labs. These services are addressed both to large companies, with whom several collaborations and synergies are already in place, and to the small and medium enterprises lacking their own research infrastructures.

- ***Mechanical applications:*** Preparation and investigation of nanocrystalline alloys, nano-composites with metallic, ceramic and polymeric matrix, protective thin films. Adhesion and abrasion studies. Tuning of the mechanical properties of materials by nanostructuring, for better technical properties. Modification of surface properties of materials by means of nanoscale surface modification (e.g.: protective and lubricating coatings, surfaces with controlled hydrophobicity/oleophobicity, photo-active self-cleaning surfaces). Analysis of fracture surfaces of materials.
- ***Applications to biomaterials:*** Design and preparation of bio-glasses, membranes and nanostructured micellar systems. Investigation of adhesion of cells to materials. Toxicity of dispersed solids (aerosols) and bio-compatibility of materials. New devices based on neurons and chromaffin cells on silicon, diamond and silica substrates. Metallic, polymeric and carbon materials for medical protheses.
- ***Catalysis and Photocatalysis:*** Design and synthesis of nanostructured catalysts, functionalized micro- and mesoporous materials, supported metal nanoparticles, photo-active films and nanostructured selective photocatalysts.
- ***Synthesis and self-assembling of novel nanostructured materials:*** Design and synthesis of novel materials: porous materials, polymeric films, micellar systems. Synthesis and characterization of porous materials for the storage and separation of hydrogen and other gases. Alloys and intermetallic compounds for hydrogen absorption.
- ***Conservation of cultural heritage:*** Characterization of pigments, binders, stones and metals for their conservation and restoration. Gem characterization. Protective polymeric films and materials consolidants.

Instrumentation and Laboratories

Structural analysis. X-ray diffraction from single crystals and powders, electron microscopies HRTEM and SEM, Atomic Force Microscopy, optical and metallographic microscopy.

Spectroscopy. Infrared: FTIR spectrophotometers operating in the range 15000-100 cm-1; measurement under controlled atmosphere at variable temperature (12-300K) in transmission, diffuse reflectance and ATR mode. Raman: spectrophotometers with NIR sources (FT-Raman), visible and UV-sources. IR and Raman microscopies. EPR measurement of radicals and paramagnetic centers in the X band between 4 and 400K. Surface composition and contaminant detection with ESCA-XPS, PIXE and cathodolominescence.

Thermal analysis - calorimetry. Calvet microcalorimetry; thermal analysis (TG, DTA, DSC at low and high temperature), microgravimetry.

Modelling. Development of computer codes for the quantum mechanical description of solid matter. Applied computational chemistry and molecular graphics. Structural databases. Simulation of phase diagrams and phase transitions.

Other techniques.

Tensiometry. Analytical and preparative chromatography. Mass spectrometry. Dynamic-mechanical testing of materials. Conductivity and photo-conductivity measurement. Laser light scattering. Patch-clamp unit for current and voltage measurement from single cells. Volumetric adsorption techniques (physical and chemical adsorption).

Synthesis and Reactivity.

Advanced organic synthesis laboratory. Sol-gel materials synthesis laboratory. Coatings and thin films laboratory: deposition of metallic, semiconducting, superconductiong, insulating and hard materials by CVD and PVD. Laboratory of advanced metallurgy for alloys and coatings. Catalysis and photocatalysis laboratory. Laboratory for radiative treatments of materials. Cellular and molecular biology laboratory, with cell cultures and equipment for PCR and mRNA/cDNA amplification.

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