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Centre for Research in NanoEngineering (CRnE-UPC)

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Soon after the discovery of X-rays by Röntgen, in 1895, the idea that crystals could be used as a diffraction grating for X-rays was proposed by Ewald and von Laue, developed a law that connects the scattering angles and the size and orientation of the unit-cell spacings in the crystal. Just a few months later, in 1912, William Lawrence Bragg and his father presented the mathematical relationship which relates the periodicities in the crystal to the scattering observed. Although simple, Bragg's law confirmed the existence of real particles at the atomic scale, and provided a powerful new tool for studying crystals. These early developments, together with the construction of the first practical transmission electron microscope by Prebus and Hillier in 1938 (using concepts developed earlier by Knoll and Ruska in 1933) can be considered as the prehistory of characterization of matter at nanoscale, a discipline therefore close to its 100th birthday.

Then, in his famous lecture at the Annual Meeting of the American Physical Society in 1959, Richard Feynman offered a $1000 prize (from his own pocket!) to "… the first guy who can take the information on the page of a book and put in on an area 1/25,000 smaller in linear scale in such manner that in can be read by an electron microscope." And, in 1981, Binnig and Rohrer of IBM's Zurich Lab in Switzerland were able to show mono-atomic, double-atomic and triple-atomic surface steps with their new scanning tunneling microscope. The road of technology became paved for the rise of nanotechnology.

This new and exciting area has been exponentially growing in the past decade, and today the word "nanotechnology" goes much beyond characterization at nanoscale with sophisticated apparatus. The control of matter at the scale of nanometers is perceived by many experts as a transversal knowledge that will impregnate many areas of science and technology. Terms like "nanobiotechnology", "nanophotonics", "nanoelectronics", or "nanomaterials" have become of common use among scientists; and others such as "nanothermodynamics", "nanofabrication", "nanosystems", "nanomechanics", or "nanofluidics" will also be familiar to most of us in the (very) near future. It is foreseeable that a significant part of the industrial activity will be affected by the "nano" revolution. Not only the electronic components of the circuits are getting smaller and smaller every day … nanotechnology has already commercial applications in coatings, cosmetics, textiles, sports equipment, medical diagnostics, drug delivery, clean energy technologies, building materials, or aeronautics.

Governments, public funding agencies and scientific and technological universities all over the world are harnessing their activity in nanotech because, important as it is to take profit of the opportunities that will appear in new fields, it is essential not to loose the new possibilities that are opened in traditional ones.

In this general context, the Spanish support to research in nanotechnology is still low compared to the EU standards. It should be recalled that the first action specifically devoted to nanotech research projects, three years ago, has not be continued and its continuity is not clear by now. Even though many initiatives are growing, in particular in Catalonia we should mention the new Institute of Research in Nanoscience and Nanotechnology (CIN2) and the initiative of the University of Barcelona with the creation of the Institute of Nanoscience and Nanotechnology (IN^{2}UB)

The Technical University of Catalonia (UPC) wants to join the global Catalan effort in the development of nanotechnology-related research infrastructures with the creation of the Center for Research in Nanoengineering (CRnE). This new initiative has been launched with the aim to provide a technological base for applications of nanotechnology, with a special focus on engineering and product related research. Since most of the "nano" research in Spain is devoted to nanosciences, UPC through the CRnE wants to bank on nanotechnological research. Two strategic issues are followed: To profit the strong industrial relationship of the UPC to promote industrially and technologically relevant "nano" research and symmetrically to promote the "nano" aspects of the classical UPC research.

This effort is organized at two different levels:

a) Assembling the different groups at the UPC working in nanotech related subjects. Giving access to state of the art equipment and strengthen the synergies between them. 75 researchers from 22 different research groups have joined the Center covering a large scope of engineering fields: Electrical engineering, materials science, chemical engineering, computing science and applied physics.
b) Creating a nanoengineering core formed by small groups, composed of PhD students and post-doctoral research-

ers each one of them led by a "senior" scientist. Each group will be independent to choose, search for funding and develop their own topics of research in accordance with CRnE's focus areas. Equipments will be typically operated on a shared cost basis, and research technicians will span their activities to offer equipment maintenance and utilization tutorials to students and young researchers.

Located in a branded new 4-floor building, the CRnE will share the grounds with other important science research and development infrastructures in the city of Barcelona, including several faculties of science and engineering of both UPC and the University of Barcelona, the Scientific-Technical Services, and the Barcelona Science Park, thus contributing to the consolidation of a high-technology campus at the west entrance to the city through the Diagonal Avenue.

The CRnE will host a wide variety of sophisticated scientific equipments, some of which are currently installed in different departments of the UPC. Relocation of laboratories and research staff to the new building will optimize maintenance and availability to the scientific community. An additional investment of 3 M€ in new equipments is already in course in order to incorporate further state-of-the-art facilities. The Center is expected to be operational before the end of 2008.

A further step to promote the nanoengineering capabilities at UPC, will be the integration of the technological facilities of the CRnE together with the Clean Room of the Department of Electronic Engineering and the Nanophotonics Laboratory at ICFO (Institute of Photonic Sciences) constituting a powerful nanofabrication platform.

1. About CRnE

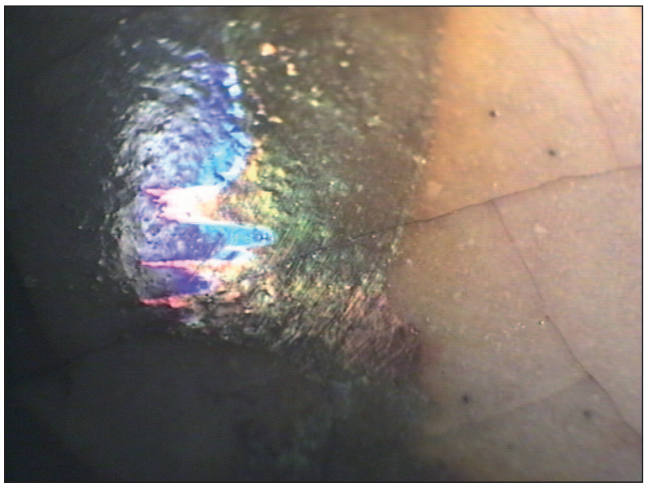
1.1. Research topics of the CRnE include

- Manipulation and dynamics study of nanoparticles for applications in electronics, communications and sensors.
- Mechanical, electrical and electronical properties of nanodevices, nanostructures and biological systems.
- Multiscale analysis of coupled processes: Complex system behaviour.
- Nanoscale analysis of surfaces and reactivity.
- Simulation and modelling of nanometric systems and nanostructured materials.
- Fabrication, characterization and applications of micro and nanometric layers.
- Nanometric scale fabrication and design of devices, circuits and systems.
- Nanometric devices integration in micro and mesoscopic systems.
- Energy applications of nanoparticles and nanostructures.
- Equipment design for obtaining, manipulate and characterise nanomaterials and nanostructures.

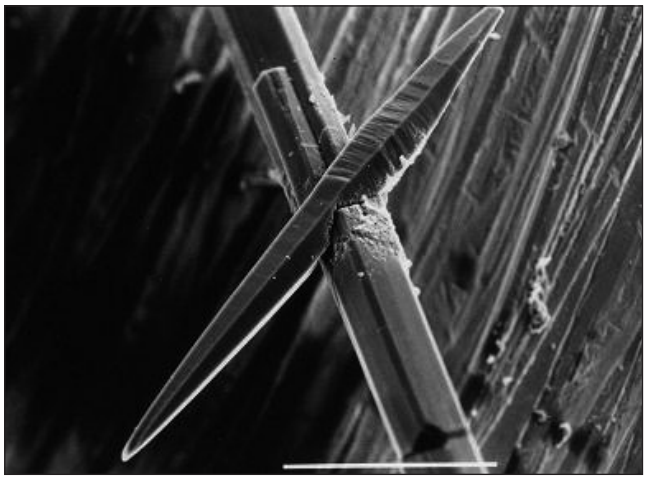
1.2. Research Groups

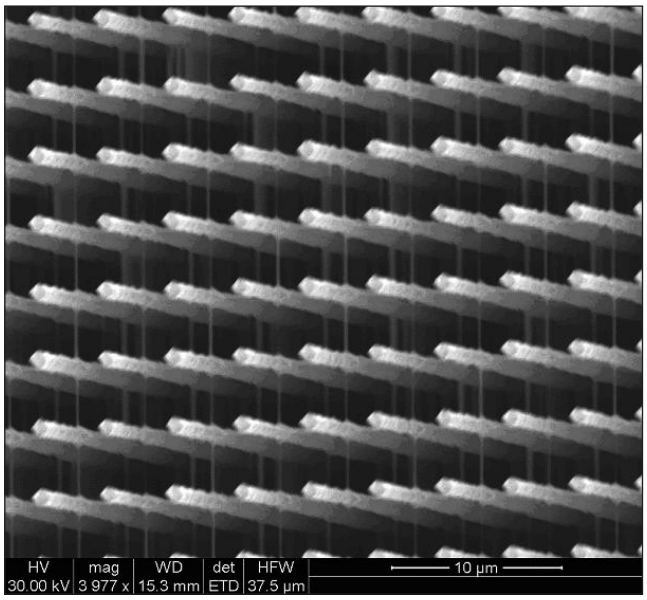
CRnE has an international orientation where researchers of more than twenty UPC research groups work together:

AHA - Advanced Hardware Architectures
ALBCOM - Algorithms, Computational Biology, Complexity and Formal Methods
BIBITE - Biomaterials, Biomechanics and Tissue Engineering
CDAL - Light Alloys and Surface Treatments Design Centre



Ag nanoparticles in a glass matrix.





CIEFMA - Group for Structural Integrity, Micromechanics and Reliability of Materials
DONLL - Nonlinear dynamics, nonlinear optics and lasers
FMPE - Physics of materials: electrical properties
GBMI - Molecular and Industrial Biotechnology Group
GCM - Group of Characterization of Materials
GREC - Knowledge Engineering Research Group
HIPICS - High Performance Integrated Circuits and Systems
IEB - Electronic and Biomedical Instrumentation
IMME - Innovation in Materials and Molecular Engineering
LACÀN - Laboratory of Computational Methods and Numerical Analysis. LaCàN
LARCA - Laboratory of Relational Algorithmics, Complexity and Learnability
MECMAT - Mechanics and Nanotechnology of Engineering Materials
MNT - Micro and Nanotechnologies Research Group
POLQUITEX - Polymeric Materials and Textile Chemistry
QINE - Low Power Design, Test, Verification and Fault Tolerance
SC-SIMBIO - Complex systems. Computer simulation of materials and biological systems
SPPT - Surfaces, Products and Textile Processes
TERFIQ - Group of Thermodynamics and Physical-Chemistry

185 papers were published in International indexed papers in 2007.

The objectives of the CRnE have been designed with three main cornerstones: people, excellence in research and service to society. The center aims to attract worldwide young, clever and motivated PhD students and post-doctoral researchers, to offer to these young people the best conditions to achieve significant scientific an technological contributions with the highest impact, and then to facilitate their incorporation to industry, as highly-qualified employees and/or managers of their own entrepreneurial activities. On the other hand, the activities of the center will help the nucleation of current research efforts at UPC, with a clear focus on nanoscale engineering. Nanolithography and nanoelectronics, advanced analytical devices for aerospace applications, nanoparticles and colloids in building materials, molecular dynamics of self-assembling systems, more efficient and environmentally-friendly catalytic methods, and high-performance coatings for metals and ceramics are among the current research activities that will benefit directly from such an initiative. And finally, in the best of UPC's tradition of technological service to society, an ambitious plan of diffusion of capabilities and results will be conceived to provide expertise through interaction with industrial partners.

More details at: *http://www.upc.edu/crne*