NANOSCALE MATERIALS FOR SELECTED APPLICATIONS

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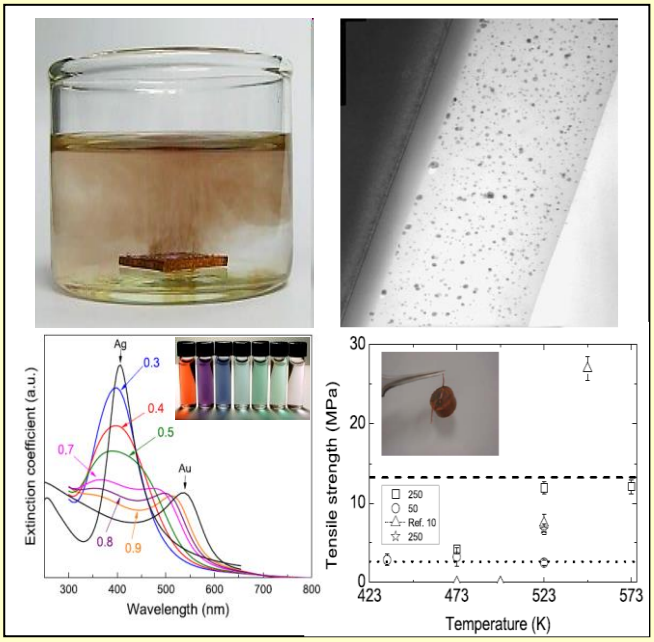

Top: nanoparticles embedded in a liquid (left) and in a polymer thin film (right). Bottom: Typical extinction spectra of metal nanostructures (left), applied as nano-tailored structural adhesive bonds (right).
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Understanding the peculiar properties of nanomaterials is one of the major tasks of modern science and technology. Our group is involved in some activities connected with the synthesis and characterization of many structures with reduced dimensionalities such as nanoparticles, nanowires and 2D materials. The strong interaction and collaboration with national and international research and industrial institutions has favoured the application of basic research results to many technological fields such electronics, biomedicine and energetics.

Keywords: Nanoparticles, nanowires, spectroscopy, surface science

1. Carbon based nanomaterials

Many aspects of modern materials science and technology at the nanometric level involve a plenty of different carbon based nanostructures with a variety of different properties and functions.
Our group has a long tradition in topics related to the production and characterization of a large number of one dimensional and two dimensional carbon based nanomaterials such as nanotubes, nanowires and graphenes. We are involved in the individuation of new synthetic strategies and in the study of fundamental properties which are also focused to evaluate the potential impact in many applicative fields.
As an example, the introduction of the concept of graphene and the recent experimental observation has opened new challenges because of the outstanding properties of such a two-dimensional sheet

of carbon atoms arranged in a honeycomb lattice. Basic studies have been initiated in order to understand the origin some peculiar properties of graphene such as chemical and mechanical stability and those which involve the electronic system.
Effort has been also given to the study of carbon nanotubes, nanowires and to the formation of many carbon hybrids. In particular our group is involved in national and international projects devoted to the production of these systems by using plasma processes in liquid environments.
A particular emphasis is given to understand the effect of intentionally introduced defects and impurities since this is of crucial importance to understand and predict the behaviour of the above mentioned entities, integrated in industrial devices.

2. Nanostructures produced by plasma processes in liquids
Our research group is leader in developing a large number of plasma processes, such as laser ablation and arc discharge, devoted to the formation of selected nanostructures in liquid environments. These processes provide a direct strategy to obtain nanoparticles and nanowires, avoiding chemical precursors and to propose them in applications where high purity is often required.
Few examples are reported below:

- Gold nanomarkers that are lasting and biocompatible
- Nano-coatings of individual workpieces.
- Volume embedding of metal nanoparticles in polymers (polymer-metal nanocomposites)
- Carbon based nanomaterials
- Large-scale and low-cost production of inorganic fullerene-like (WS_2, MoS_2) nanoparticles for tribological applications

Collaborations and Research Grants

Collaborations
Trinity College (Dublin)
Experimental Astrophysics Laboratory - Catania
Department of Physics and Geology, University of Texas - Pan American
Istituto per la Microelettronica e Microsistemi – CNR
Actinium Chemical Research
ST-Microelectronics (visit PackGroup at www.ccr.unict.it/packgroup/)
Oxford Materials, University of Oxford (UK)
Jozef Stefan Institute Ljubljana (Slovenia)
Laser Zentrum Hannover (Germany)
University of Waterloo (Canada)

Research Grants
MIUR (PRIN Project)
European Science Foundation (COST Project)

Selected Publications

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