

**Nanotechnology In Chile: Experiences And Industry Potentials**

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Nanotechnology in Chile is mainly present at a research stage, it is not a massive field, and is mostly developed in universities and sponsored by government funds. The National Commission for Scientific and Technology Research, CONICYT, the leading organization which defines the politics and provides the financial support for research in Chile, has defined this area as one of the seven primary fields of work for the scientific and technological development of the country. Recently, during year 2005, the Bicentennial Program for the Science and Technology Development (BPSTD), which ends in 2010, has also included nanotechnology within the important areas of research, since the objectives of the program are aimed at developing science and technology towards a knowledge-based economy, which can only be possible through the investment in science focused on innovation, with an adequate integration of the industrial sector of the country and the world's networks related with the science and technology production.

This work summarizes the science and technology research activities in nanotechnology in Chile. The first part exhibits the main groups working in the country, identifying their areas and experiences. Then, the activities of the group are described, placing an emphasis in the areas of material characterization and electrochemical research of Universidad Austral de Chile in Valdivia, Chile.

In recent years, nanotechnology has shown an important growth in Chile (Nanoindex: A01.02, A01.04; B01, B02, B03, B10, B11; C01, C03; D01, D03; E04; F02; H01; I01, I09), concentrating the interest of large research centers, and which can be summarized as follows:

- Millenium Scientific Nucleus, a joint group of several universities led by Universidad Federico Santa María, in charge of promoting the physics of condensed matter or nanotechnology, emphasizing the magnetism in low dimensions, relaxation and anisotropy.
- Groups of Physics at Universidad de Chile involved in various disciplines such as: synthesis and chemionic properties of supramolecular organic-inorganic aggregates generated by self-ordering of metal derivatives on laminar mesophases. These researches are being conducted on laminar organic-inorganic nanocomposites, where the inorganic phase is a semiconductor species of the sulfur type of elements of Al, Zn, Cd, and Hg, intended to obtain quantum materials capable to reach an adequate size and dimension to produce detectable confinement effects in their ionic, electronic, and photonic properties.
- Another group in this university is dedicated to the surface physics, and is performing several works related with surface characterization and preparation of oxygen-deficient oxide nanopowders by condensation in hydrogen. Also, in the field of nanoparticles, another group of scientists is devoted to the production of copper nanoparticles for the elaboration of electric conductivity polymers. Finally, the group assuming the study on thin films is working on the influence of electron-surface scattering on the charge transport mechanisms in thin metallic films bounded by rough surfaces.
- Research groups from Pontificia Universidad Católica de Chile have proved to be outstanding in two fields: (1) the study on electric conductivity in thin copper and palladium films oxidized with oxygen plasma, and (2) the phenomenon of magnetic exchange bias. Both of these areas are of enormous importance for their application in the recording of information in computers, and are supported by theoretical and experimental works.
- Universidad de Santiago de Chile has important research works relating the nanocrystalline microstructural evolution taking place during the processes of mechanic alloying and consolidation of copper-based powders. On the other hand, university-industry joint shops in nanotechnology, sponsored by the PSTD, are being created this year, in order to provide new national and international R&D collaboration opportunities, with an emphasis in the mining sector.
- Universidad de Concepción has several study centers dedicated to the nanotechnology research in advanced polymers and composites, such as the production of copper nanoparticles by electrodeposition for the industry and with an application in the energy field; the creation of new nanostructured surfaces based on cellular membranes, and their biological and chemical effects; colloidal nanoparticles; and the preparation and study of the properties of new materials. Another research team is working on the synthesis and application of organic compounds, i.e., anisotropic macromolecular matrixes including metal nanoparticles.

## Keynotes

- Universidad Católica del Norte has a vast experience in the synthesis of titanium oxide and ternary oxides nanotubes, with application in nanoelectronics, allowing the manufacturing of ultrasensitive instruments to measure hydrogen leakages.

The research group committed to the material characterization and electrochemistry studies at Universidad Austral de Chile, is involved in the research on metal-polymer sheets with ultrathin interface layers, in the order of nanometers, influencing the adherence of such substrates. On the other hand, has carried out interrelated works with other universities of the country in the field of nanotechnology. Regarding characterization, our experience is mainly related with the groups at Universidad de Chile, in the field of copper nanoparticles obtained by means of ultra high vacuum chambers; characterization of oxygen-deficient molybdenum nanoparticles by hydrogen condensation; and characterization of grain borders in gold films on mica, to evaluate transport properties by comparing TEM with tunnelling effect microscopy techniques. Also, works on the characterization of Cu-Mo nanoparticles, obtained by means of mechanical microalloying to produce advanced materials, have been developed with the cooperation of Universidad de Santiago de Chile. The results of these researches have been employed to improve the properties of concretes by nanotechnology. In this sense, nanoparticles of quercetin have been synthesized at a parasite plant with the capacity to absorb ultraviolet radiation. This material has been applied on concrete surfaces, and important results concerning UV radiation absorption have been achieved, allowing lower radiation reflection of concrete and constructions employing it, and reducing the harmful effects on human health. On the other hand, the accumulation of radiation makes possible the energy saving in heating systems of cold regions. Another achievement is the photocatalyst effect on concrete surfaces, by adding titanium oxide nanoparticles through innovative methods, obtaining materials resistant to pollution and environmental degradation.

At the moment, our group is beginning a new line of research aimed at the production of soluble polymer membranes incorporating silver nanoparticles in their structure. These studies are employing, chitosan and carragenin, a product obtained from marine algae. The addition of silver to the membranes, according to previous studies, has proved to be an effective biocide, and in the conservation of foods, it has improved the resistance to oxidation. Also, it is potentially useful for employment in pharmaceutical containers, which however requires further studies.

In summary, scientific and technological researches in nanotechnology in Chile are increasing in a sustained form. In addition to the universities mentioned and the topics herein described, a dedicated effort in new materials involving nanotechnology is being performed; these research teams are diverse and can be found at the frame program of the European Union, the group for the Interamerican collaboration in materials (CIAM/NSF), the national network of doctorate programs in sciences of materials, and the center for the advanced interdisciplinary research in material science (CIMAT). The above mentioned groups are mainly devoted to biorelated materials, mechanics of complex materials, catalysts and polymers, and organic materials. Possible applications for nanotechnology in the near future in Chile, according to the experiences mentioned, are biomedicine, electric and electronic devices, new materials for the packing of agriculture and aquiculture export products, new bone and dental implant materials, new uses for copper, and new materials to be employed in the construction area, among others.

## References

1. <http://www.conicyt.cl>
2. J. Sánchez: Nanotecnología en España. Fundación Madrid, Nº 21, Ed. Comunidad de Madrid, España (2005).
3. D.E. Diaz, L.G. Argomedo, V. M. Fuenzalida, E. Zumelzu. Synthesis of  $M_0O_3$  nanoparticles by means of inert gas condensation (IGC). Pan-American Advanced Studies Institutes on Micro Electro Mechanical Systems (MEMS), San Carlos de Bariloche, Argentina, June 21-30, 2004.
4. R.C. Muñoz, R. Henríquez, M. Robles, G. Kremer, L. Moraga, D. Chen, E. Zumelzu. Measurement on the Grain Size of Thin Gold Films Deposited on Preheated Mica, Using TEM and STM. Journal Applied Physics (2005). Submitted.
5. V.M. Fuenzalida, E. Zumelzu, D.E. Diaz – Droguett. Copper and  $M_0O_3$  - X. Nanoparticles Grown by Condensation in Hydrogen and Inert Gas. 12<sup>o</sup> Latin American Congress of Surface Science and its Applications, CLACSA, Rio de Janeiro, Brasil, December 5-9 (2005).
6. E. Zumelzu, C. Cabezas and R. Alvarado. Evaluation of the Degradation of Traditional and ECCS Canning Tins in Acetic-Acetate Medium. Science and Engineering of Composite Materials 13, 13-19 (2006).
7. E. Zumelzu, F. Rull and A. Boettcher (2006). Characterization and Micro and Ultra. Structural Analysis of PET – Based Co-rolled Composite Electrolytic Chromium Coated Steel (ECCS). Journal Materials Processing of Technology . 173, 34-39 (2006). Project Nº 1040144 Fondecyt / Conicyt-Chile.