



PHONONIC AND PHOTONIC NANOSTRUCTURES

Led by ICREA Prof. Dr. Clivia Sotomayor Torres, the Phononic and Photonic Nanostructures Group investigates the interaction of phonons, photons and electrons in nano-scale condensed matter underpinned by research in nanofabrication, especially nanoimprint lithography. The long term aim is to develop new information technology concepts where information processing is achieved with non-charged state variables.

BACKGROUND

The P2N group carries out research on nanoscale thermal and acoustic effects in both confined systems and phononic crystals; on methods to control the exciton-plasmon coupling targeting enhanced light extraction in light sources; and on the optimisation of the optical gain of printed polymer-based photonic structures. Targeted applications are, among others, tunable systems for information technology and compact energy efficient devices.

In order to facilitate the uptake of nanotechnology innovations by industry the group is also advancing nanoimprint lithography towards the realisation of 3D nanostructures and hybrid structures including polymer-metal, polymer-oxide, semiconductor-polymer and polymers-self assembled nanostructures among others. For the latter structures efforts are focused on acoustic-field assisted self-assembly of nano and mesoscopic particles, to realise heterostructures and to deposit them selectively on patterned and or surface-functionalised substrates.

RESEARCH ACTIVITIES INCLUDE:

Nanophononics. Design, fabrication, measurement and modelling of propagating and confined phonons in phononic crystals and phononic cavities, and development of methods to quantify thermal transport in the nanoscale. The Group has research projects targeting thermal and acoustic effects in materials including Si, SOI, SiO₂, polymers, graphene, protein crystals on Si and on graphene, inorganic nanostructures for ultracapacitors and thermoelectric materials with enhanced ZT.

Nanophotonics. Design, fabrication, measurement and modelling of photonic

cavities and resonators as well as metamaterials and plasmonic structures. The Group is researching methods for the control of the exciton-plasmon coupling targeting enhanced light extraction applications in light sources, and the optimisation of the optical gain of printed nanocomposite-based polymer-based photonic structures. Another line of research concerns the simultaneous confinement of photons and phonons at the nanoscale which gives rise to optomechanical interactions where light can be used to tailor vibrational properties of nanoscale objects.

Nanofabrication. Development of new 3D nanofabrication techniques including combinatorial ones using nanoimprint lithography and self-assembly to realise structures for nanophononics and nanophotonics. The Group focuses on developing nanoimprint lithography towards the realisation of 3D nanostructures and of hybrid structures (polymer/metal, polymer/oxide, semiconductor/polymer, polymers/self assembled nanostructures among others. In self-assembly the Group researches acoustic-field assisted self-assembly of nano and mesoscopic particles, to realise heterostructures and to deposit them selectively on patterned and or surface-functionalised substrates. The growth of nanowires by electron beam deposition is also used to produce nanowires of unprecedented high conductivity and optical transparency.

Nanometrology. Development of new methods for in-line monitoring of manufacturing of nanoscale objects or of objects with nanometer-scale features. Work focuses on the development of sub-wavelength diffraction tools for inspection of patterned structures, ultrafast acoustic reflectivity for nanometrology and methods to determine and measure ordering in 3D and 2D in self-assembly processes.



ICREA PROF. DR. CLIVIA M. SOTOMAYOR TORRES
GROUP LEADER

Prof Dr Clivia M. Sotomayor Torres has held academic positions at the University of St. Andrews, at the University of Glasgow, both in Scotland, and at the University of Wuppertal, Germany, where she held the chair of Materials Sciences in Electronics from 1996 to 2004. From 2004 to 2007, she was research professor at the University College Cork, Tyndall National Institute, Ireland. Currently she is an ICREA Research Professor and group leader of the Phononic and Photonic Nanostructures Group at the Catalan Institute of Nanotechnology (ICN) in Barcelona, Spain.

Her research interests are in the field of science and engineering of phonons and photons in confined systems and of electron-phonons, photon-phonons and exciton-plasmon interactions. This is sustained by the development of nanofabrication and nanometrology methods and by the extension of light scattering techniques to nanostructures made out of polymers, semiconductors, oxides, metals and combinations thereof.

Prof Sotomayor is author of over 370 scientific publications and has edited six books (ResearcherID E-8418-2010). Her team is currently coordinator of the FP7 project NANO-TEC and the CONSOLIDER – INGENIO 2010 project nanoTHERM, and is partner in the FP7 projects: NANOPACK, NANOICT, NAPANIL, TAILPHOX, LAMAND, SEAL, NANOFUNCTION and NANOPOWER. She contributes to the European Technology Platforms Photonics21 and Nanoelectronics (ENIAC) - in the latter as member of the Management Team of the Scientific Community Council, working in the Domain "Beyond CMOS". Her team has collaborations with the University of Chile and UTEM also in Chile.