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Free-Standing nanostructures at atomic scale: From growth mechanisms to local properties at the nanoscale

Technology at the nanoscale has become one of the main challenges in science as new physical effects appear and can be modulated at will. Superconductors, materials for spintronics, electronics, optoelectronics, sensing, energy applications and new generations of functionalized materials are taking advantage of the low dimensionality, improving their properties and opening a new range of applications. As developments in materials science are pushing to the size limits of physics and chemistry, there is a critical need for understanding the origin of these unique physical properties (optical and electronic) and relate them to the changes originated at the atomic scale, e.g.: linked to changes in (electronic) structure of the material. In the present work, I will show how combining advanced electron microscopy imaging with electron spectroscopy, as well as cathodoluminescence in an aberration corrected STEM will allow us to probe the elemental composition and electronic structure simultaneously with the optical properties in unprecedented spatial detail. The talk will focus on several examples in advanced nanomaterials for optical, plasmonic and energy applications. In this way the latest results obtained by my group on direct Visualizing and modeling materials at atomic scale will help to understand their growth mechanisms (sometimes complex) and also correlate their physical properties (electronic and photonic) at sub-nanometer with their atomic scale structure. The examples will cover a wide range of nanomaterials: quantum structures self-assembled in a nanowire: quantum wires (1D) and quantum dots (0D) and other complex nanowire-like morphologies for photonic and energy applications (LEDs, lasers, quantum computing, single photon emitters, water splitting cells, batteries), nanomembranes and 2D sheets; as well as metal multiwall nanoboxes and nanoframes for 3D plasmonics.

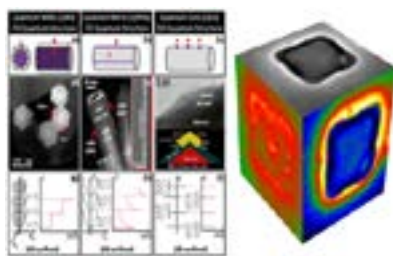


Figure 1: (left) Sketches of different quantum structures: (a) Quantum Wells or 2D structures (QWs); (b) Quantum Wires or 1D structures (QWRs); (c) Quantum Dots or 0D structures (QDs). (d-f) Experimental STEM and HRTEM images of the quantum structures. (right) Sub-nanometer Plasmon analysis on a 3D Au/Ag nanobox.

Biography

Jordi Arbiol graduated in Physics at Universitat de Barcelona (UB) in 1997, where he also obtained his PhD (European Doctorate and PhD Extraordinary Award) in 2001 in the field of transmission electron microscopy (TEM) applied to nanostructured materials. He was Assistant Professor at UB. From 2009 to 2015, he was Group Leader at Institut de Ciència de Materials de Barcelona, ICMA-B-CSIC. He is President of the Spanish Microscopy Society (SME), was the Vice-President from 2013 to 2017. Since 2015 he is the Leader of the Group of Advanced Electron Nanoscopy at Institut Català de Nanociència i Nanotecnologia (ICN2), CSIC and The Barcelona Institute of Science and Technology (BIST). He has been awarded with the 2014 EMS Outstanding Paper Award, the EU40 Materials Prize 2014 (E-MRS), listed in the Top 40 under 40 Power List (2014) by The Analytical Scientist and the PhD Extraordinary Award in 2001 (UB).

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