

## Free-standing nanostructures at atomic scale: from growth mechanisms to local properties

Jordi Arbiol

ICREA & Catalan Institute of Nanoscience and Nanotechnology (ICN2), CSIC & BIST  
 Barcelona, Catalonia, Spain  
[arbiol@icrea.cat](mailto:arbiol@icrea.cat)

Technology at the nanoscale has become one of the main challenges in science as new physical effects appear and can be modulated at will. Materials for spintronics, electronics, optoelectronics, sensing, energy and quantum applications 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 related spectroscopies 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, quantum 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 [1,2]) 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) [3] and quantum dots (0D) [4,5] and other complex nanowire-like morphologies for photonic and energy applications (LEDs, lasers, quantum computing, single photon emitters, water splitting cells, batteries) [7-13], nanomembranes and 2D sheets [8,14,15].

### References

- [1] M. de la Mata, et al., Nano Letters, 14, (2014) 6614.
- [2] M. de la Mata, et al., Nano Letters, 16, (2016) 825.
- [3] J. Arbiol, et al., Nanoscale, 4, (2012) 7517.
- [4] E. Uccelli, et al., ACS Nano, 4, (2010) 5985.
- [5] M. Heiss, et al., Nature Mater., 12, (2013) 439.
- [6] J. Arbiol, et al., Materials Today, 16, (2013) 213.
- [7] M. de la Mata, et al., J. Mat. Chem. C 1, (2013) 4300.
- [8] P. Tang, et al., Nano Energy, 22, (2016) 189.
- [9] P. Tang, et al., Energy Environ. Sci., 10, (2017) 2124.
- [10] F. Urbain, et al., Energy Environ. Sci., 10, (2017) 2256.
- [11] S. Vaitiekėnas, et al., Physical Review Letters, 121, (2018) 147701.
- [12] F. Krizek, et al., Physical Review Materials, 2, (2018) 093401.
- [13] P. Aseev, et al., Nano Letters, 19, (2019) 218.
- [14] G. Tutuncuoglu, et al., Nanoscale, 7, (2015) 19453.
- [15] M. Friedl, et al., Nano Letters, 18, (2018) 2666.