Séminaire LIONS

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Seeing Atoms in Three Dimensions by Atomic Resolution Electron Tomography

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Nanosystems that are being investigated within the field of physics, biology and chemistry are becoming smaller and more complex. As a consequence, higher demands are being put to microscopic and nanoscopic characterization techniques as well. New developments within the field of transmission electron microscopy (TEM) allow investigating these systems at the atomic scale, not only structural, but also from chemical and electronic point of view. However, one should never forget that all these techniques only provide a two-dimensional (2D) projection of a three-dimensional (3D) object. To overcome this problem, electron tomography has been used in an increasing number of studies over the last decennium. Nevertheless, it is still not straightforward to push the resolution below the nanoscale in 3D. This relies on the combination of state-of-the-art electron microscopes and advanced computational procedures to transform the 2D images into a 3D reconstruction.

One of the possibilities to perform electron tomography with atomic resolution is by applying reconstruction algorithms based on compressive sensing. We hereby exploit the fact that nanomaterials at the atomic scale are sparse. The methodology was applied for Au nanorods and the crystal lattice of the nanorods could be reproduced without using prior knowledge on the atomic structure! From these reconstructions, the boundary facets of different rods have been precisely determined and the reconstruction can serve as a starting point to investigate strain in 3D [1]. More recently the technique was applied to visualize crystal defects at the atomic scale and to distinguish between different types of atoms [2]. These investigations will yield more insight on the connection between properties and structure of a broad range of nanostructures.

[1] B. Goris, S. Bals, W. Van den Broek, E. Carbo-Argibay, S. Gomez-Grana, L. M. Liz-Marzan, G. Van Tendeloo, Nature Materials 11 (2012) 930

[2] B. Goris, A. De Backer, S. Van Aert, S. Gómez-Graña, L. M. Liz-Marzán, G. Van Tendeloo, S. Bals, Nano Lett. 13 (2013) 4236