2D semiconductor nanostructures at atomic scale

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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, chemical sensing, 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 this work, it has been demonstrated that how atomic resolution high angle annular dark field (HAADF) scanning transmission electron microscopy (STEM) can help to understand the growth mechanisms of complex 2D nanostructures such as nanomembranes, nanoflakes or nanobelts. The presentation will combine the visualization of 3D atomic models recreating the growth of these 2D nanostructures, as well as a direct correlation between their structure and chemical composition at the atomic scale, with their local properties at the nanoscale, electronic and photonic and how they can be arranged as perfect templates for quantum nanowire networks. In addition, this work shows the in-situ dynamic reconstruction processes of monolayer grain boundaries in MoS_2 at atomic scale under the electron beam as well as the sulfurization evolution that drive the transformation of a MoO_2 nanomembrane to a MoS_2 nanoflake.

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