Nanowires (R)Evolution: from VLS vertical nanostructures to SAG Quantum Networks

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The lack of mirror symmetry in binary semiconductor compounds turns them into polar materials, where two opposite orientations of the same crystallographic direction are possible. Interestingly, when semiconductor nanostructures are grown by following the VLS mechanism, their physical properties (e.g.: electronic or photonic) and morphological features (e.g.: shape, growth direction, etc.) strongly depend on the polarity. Tailoring complex free-standing nanostructures by VLS has been used in the last 2 decades as model systems to study basic physics, e.g.: electronic, photonic and quantum phenomena at the nanoscale, with high detail and precision.[1,2,3] However, scaling up this technology has become a nightmare due to the difficulty to design large circuits and networks. Positioning and contacting the different VLS grown nanobuilding blocks (e.g.: nanowires) in a reproducible manner is not an easy task. Fortunately, the development of new growth methodologies such as the guided-growth (GG), selected area growth (SAG) or template-assisted selective epitaxy (TASE) allow the direct growth of horizontal nanowires on top of a selected substrate with high accuracy and the possibility to obtain high quality contacts, enabling the design of complex circuits and networks. This is the case of the newly designed quantum hybrid nanowire networks. [4,5]

We will explore the different growth mechanisms that led to the latest (r)evolution in NWs growth at the atomic scale and understand the related physical properties of the nanostructures. We base our study on a detailed aberration corrected scanning transmission electron microscopy and related spectroscopies methodology. From the structural data obtained we create 3D atomic models that are used as input data for the further electronic/photonic/quantum properties simulations and correlation to the experiments.

References

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Figures

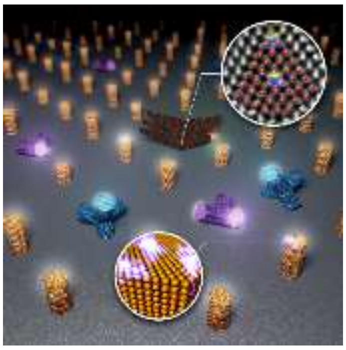

Figure 1. VLS growth

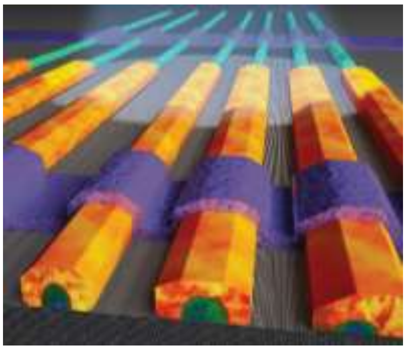

Figure 2. Guided growth

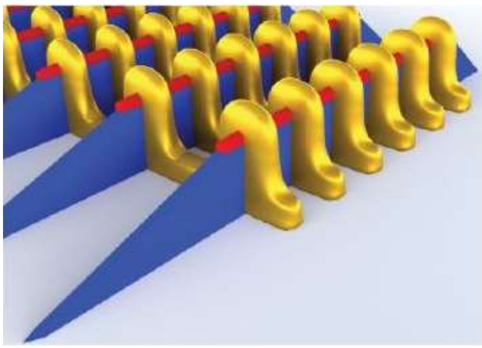

Figure 3. Selected Area Growth