Seminar/Talk

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

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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, their physical properties (e.g.: electronic or photonic) and morphological features (e.g.: shape, growth direction, etc.) also strongly depend on the polarity. It has been observed that nanoscale materials tend to grow with a specific polarity, which can eventually be reversed for very specific growth conditions. In addition, polar-directed growth affects the defect density and topology and might induce eventually the formation of undesirable polarity inversion domains in the nanostructure, which in turn will affect the photonic and electronic final device performance.Here, we present a detailed study on the polarity-driven growth mechanism at the nanoscale, highlighting suitable future possibilities of polarity engineering of semiconductor nanostructures from VLS vertical complex heterostructures to the newest selected area growth hybrid quantum networks. The present study has been extended over a wide range of semiconductor compounds, covering the most commonly synthesized III-V (GaN, GaP, GaAs, GaSb, InN, InP, InAs, InSb) and II-VI (ZnO, ZnTe, CdS, CdSe, CdTe) nanowires and other free-standing nanostructures (tripods, tetrapods, belts and membranes). This systematic study allowed us to explore the parameters that may induce polarity-dependent and polarity-driven growth mechanisms, as well as the polarity related consequences on the physical properties of the nanostructures. The tools used to study the polar nanostructures at the atomic scale will be mainly based on aberration corrected scanning transmission electron microscopy and related spectroscopies. From the structural data obtain we will create 3D atomic models that will allow us to understand the growth mechanisms as well as be used as input data for the further electronic/photonic properties simulations.[1] M. de la Mata, et al., Nano Letters, 12, 2579 (2012) / [2] M. de la Mata, et al., Nano Letters, 14, 6614 (2014)[3] M. de la Mata, et al., Nano Letters, 16, 825 (2016) / [4] M. de la Mata, et al., Nano Letters, 19, 3396 (2019)[5] M. Heiss, et al., Nature Mater., 12, 439 (2013) / [7] M. de la Mata, et al., J. Mat. Chem. C, 1, 4300 (2013)[11] S. Vaitiek?nas, et al., Physical Review Letters, 121, 147701 (2018) / [12] F. Krizek, et al., Physical Review Materials, 2, 093401 (2018)[13] P. Aseev, et al., Nano Letters, 19, 218 (2019). / [14] G. Tutuncuoglu, et al., Nanoscale, 7, 19453 (2015)[15] M. Friedl, et al., Nano Letters, 18, 2666 (2018) / [16] P. Aseev, et al., Nano Letters, 19, 9102 (2019)[17]Y. Liu, et al., Nano Letters, 20, 456 (2020)

Thursday, March 26, 2020 04:00pm - 05:00pm

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