Electric-field-assisted phase switching in GaAs nanowires

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The formation of crystal phase quantum dots (CPQDs), i.e. insertion of segments of one phase within a nanowire of a different phase, is of great interest to nanowire community, since they possess unique optical and electronic properties. In this work, we control the formation of CPQDs by introducing an external parameter: electric field (E-field). Compared with most comment methods like flux and temperature modulation, our method is able to achieve quasi-instantaneous crystal phase switch, therefore creating heterostructures with monolayer precision. The switching process is monitored in real-time using in-situ transmission electron microscopy (TEM). Thanks to our micro-fabricated Si substrate and custom-made holder, GaAs nanowires are grown epitaxially on Si(111) by chemical vapor deposition inside in-situ TEM. The substrate is shaped as a micro capacitor which allows us to apply an E-filed up to several V/nm in the direction parallel to the nanowire growth, and this strong E-field allows to achieve phase switching faster than monolayer formation. We will present high resolution videos showing the controlled phase switching induced by the E-field in GaAs nanowires, the formation of single and multiple CPQDs. Finally, we will discuss the E-field-induced phase switching mechanisms and propose a model to explain the experimental results based on theoretical calculations and finite element simulations.