Growth and Characterization of Semiconductor Nanowires

Stefan Heun

NEST, Istituto Nanoscienze-CNR and Scuola Normale Superiore, I-56127 Pisa, Italy

I will first give a general overview of the nanowire growth activities at NEST and review the research in Pisa related to nanowire devices. The growth activities, using chemical beam epitaxy (CBE), focus so far on InAs nanowires and InAs-InP and InAs-InSb nanowire heterostructures. Besides gold, the use of new catalyst particles (like Pd) is investigated. Nanowire-based devices are studied by transport measurements. Quantum dots realized in semiconductor nanowires allow a manipulation of their electron orbitals by side-gating. Another research line investigates the properties of hybrid nanowire-superconductor junctions.

Next I will report in detail the Pd-assisted CBE-growth of zinc blende InAs nanowires which are grown on InAs(111)A substrates by employing Pd octane- and hexadecane-thiolates as catalyst precursors. The structural properties of these nanowires are investigated by scanning and transmission electron microscopy. Furthermore, we demostrate the growth of InAs nanowires on patterned substrates by employing Pd hexadecylthiolate precursors as a direct-write resist in electron beam lithography. During the growth of InAs nanowires from Pd catalyst particles on InAs(111)A, two distinct classes of nanowires are observed with smooth or zigzagged sidewalls. We show that this is related to a bimodal distribution of the wire-tip diameter: above a critical diameter wires grow with smooth sidewalls, and below with zigzagged morphology. Transmission electron microscopy analysis shows that the catalyst particles at the tip of zigzagged wires are smooth and have a higher aspect ratio than those at the tip of smooth wires. Zigzagged wires grow from liquid particles in the vapor–liquid–solid (VLS) mode whereas the smooth ones grow from solid particles in the vapor–solid–solid (VSS) mode.