Low-temperature solution-liquid-solid growth of arrayed CdS nanowires

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CdS axial nanowires were synthesized employing a solution-liquid-solid (SLS) mechanism with the assistance of bismuth catalysts on fluorine-doped tin oxide (FTO) substrates. High-density and single-crystallinity CdS nanowires with a diameter of ~40-80 nm were successfully grown at a remarkably low temperature of 220 ^{o}C. Thin CdS layers were deposited on the FTO substrates to promote the growth of the nanowire. The growth procedure consists of two steps. Firstly, bismuth films were coated on the FTO substrates by DC sputtering with different time period, and then the substrates were annealed in order to form the bismuth catalyst seeded substrates. Secondly, vertical CdS nanowire arrays were grown by SLS mechanism from the bismuth catalysts. Cadmium oxide (CdO, 99.99%) and sulfur (S, 99.99%) were used as a precursors, and tri-*n*-octylphosphine oxide (TOPO, 99%), trioctylphosphine (TOP, 90%) and oleic acid (90%) were used as capping agents.

CdS nanowires were investigated using scanning electron microscopy (SEM) and x-ray diffraction (XRD) measurements and formation of a highly crystalline wurtzite (hexagonal) crystal, with preferred growth along the [002] direction, was identified. The SEM images illustrate that dense arrays of nanowires were grown normal to the substrate surface because the pre-deposited CdS films could supply epitaxial growth of the nanowires. Control of wire diameters and lengths was achieved by varying the reaction temperature and the bismuth catalyst size. The morphological feature of the nanowires were investigated by high-resolution transmission electron microscopy (HRTEM), which revealed the length varies from a few hundred nanometers to 5 μm and diameter ranges from 40 to 80 nm. The nanowires were almost defect free and they showed [002] direction growth. The crystal structure of the nanowires was confirmed as wurtzite by selected area electron diffraction (SAED) analysis.