NT-P026

Novel fabrication of wavelength-controlled photodetectors based on $Zn_xCd_{1-x}Se$alloyed nanowires

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One-dimensional nanostructures such as nanowires, nanotubes, and nanobelts have been synthesized using a wide range of semiconductors and used as building blocks for novel electronic and optoelectronic devices. Especially, multi-component 1-D nanostructures, including coaxial core-shell, axially-modulated, and alloyed nanowires, have attracted much attention because of their controlled morphologies and multi-functional optoelectronic properties. Nanowire-based optoelectronic devices are usually fabricated either by pick-and-place process of a single nanowire followed by making electrical contacts to the individual nanowire using expensive and time consuming fabrication techniques such as electron-beam lithography or by a series of processes involving synthesis, sonication, and dispersal of ensemble nanowires on another substrate with pre-fabricated electrodes. These fabrication techniques have been a major platform for fundamental research but rather complicated and irreproducible, which is unsuitable for large-scale manufacturing.

In this work, nanowire photo-sensors were fabricated by growing $Zn_xCd_{1-x}Se$ alloy nanowires bridging the gap between two pre-patterned Au catalysts and their optical properties were characterized by photo-current measurements. From transmission electron microscope, x-ray diffraction studies and photoluminescence spectra, we found that the $Zn_1Cd_{1-x}Se$ nanowires were perfectly alloyed in an entire range of Zn composition without any phase separation and the lattice constants of the a-axes and c-axes constants and near-band-edge peaks of the alloy nanowires were linearly changed with increasing Zn composition and the symmetry was changed from zinc blende to hexagonal wurtzite between 31% and 72% of Zn composition. These sensors displayed excellent photo-sensing properties. In on-off switching operations, we found that CdSe sensor has slower response and recovery behaviors than ZnSe and $Zn_{0.72}Cd_{0.28}Se$ ones, which is attributed to the adsorption and desorption of O_2 on the surface of CdSe nanowires.