Abstract

The synthesis of semiconductor nanostructures has paramount importance due to their fascinating optical and electrical properties and potential applications in quantum devices. Cadmium Sulfide (CdS) nanostructures have been found to be attractive for applications in semiconductor lasers, light emitting diodes, photovoltaic cells, display devices and biological sensing. The present research study is concerned with the growth and characteristics of CdS nanostructures and nanocomposites for their possible applications in charge storage, nano-capacitor, photovoltaic and photosensing devices. The fabrication of hexagonal, well-arranged porous alumina templates and the growth of CdS nanowires in alumina templates have been investigated in details. Needle- and wire-like CdS nanocomposites have been synthesized in a polymer (polyvinyl alcohol) matrix. The optical band gap of nanocomposites is found to decrease from 3.28 eV to 2.71 eV with the increase in growth temperature from 70 ^{o}C to 90 ^{o}C. A huge enhancement of dielectric permittivity is observed due to the polarization effect and high interfacial area of the nano-needles/nanowires. The nanocomposite/conducting polymer device structures exhibit negative resistance and charge storage characteristics with a large flatband voltage shift due to injected charges into CdS nanoneedles. Quantum confined CdS nanoparticles have been grown on multi-walled carbon nanotube (MWCNT) surfaces by a chemical process. Superior photocurrent behavior of MWCNT-CdS films over CdS has been demonstrated. MWCNT-CdS nanostructures embedded in a conducting polymer shows a broad spectral response (400 nm-1000 nm), which is attractive for hybrid photovoltaic devices. On the other hand, MWCNT-CdS nanostructures in an insulating polymer matrix exhibits a significant enhancement of dielectric constant over MWCNT. Core-shell Ge/CdS radial nanowire heterostructures have been fabricated by a combination of vapor-liquid-solid growth (VLS) and chemical bath process. UV-visible absorption, Raman and XRD spectrum demonstrate the formation of nanocrystalline CdS shell on Ge surface. The photodiode behavior of Ge/CdS heterojunction has been studied in details. An improved photocurrent with a broadband response from visible to near-IR region is observed due to the formation radial heterojunctions.

Keywords: CdS nanostructures, Porous alumina, CdS nanocomposites, Core-shell nanowire, Photoluminescence