ABSTRACT

In recent years, research on semiconductor nanostructures and nanocomposite has attracted much attention due to changes in the fundamental properties as a function of size and shape. These nanostructures have been applied in the field of solar cells, detectors, optoelectronic devices, sensors etc. In this work, synthesis, structural and optical properties of SnS, ZnO nanostructures and their nanocomposite were investigated. SnS, ZnO nanostructures and SnS/ZnO nanocomposite were synthesized through chemical route and its structural and optical properties were studied by using X-ray diffraction, transmission electron microscopy, UV-VIS-NIR optical absorption, Raman and photoluminescence spectroscopy.

SnS nanoparticles with size varying from 7 to 15 nm were synthesized at room temperature. The direct and indirect band gap transitions were observed at 1.78 eV and 1.2 eV respectively. Compared to bulk SnS, there is an increase in the band gap of SnS nanoparticles due to the quantum confinement effect. The direct band gap transition emission was observed at 1.57 eV from the photoluminescence spectrum of SnS nanoparticles. All the predicted Raman modes were observed and the modes were shifted towards lower wavenumber side. This is due to the phonon confinement effect. SnS nanosheets were formed by the agglomeration of small size
SnS nanoparticles (13 nm). The direct band gap transition was observed at 1.88 eV. The band gap emission and defect level emission were observed at 1.75 and 1.57 eV respectively from the photoluminescence spectrum of SnS nanosheets. SnS nanostructures (nanoparticles, nanosheets and nanorods) were synthesized at 180 °C. Shape evolution, from nanoparticle to nanorods was achieved by varying the reaction time. The formation mechanism SnS nanostructures were discussed with respect to reaction time. The UV-VIS-NIR spectrum of SnS nanostructures shows direct and indirect band gap transitions at 1.26 eV and 1.12 eV respectively.

The effect of annealing temperature on the photoluminescence spectra of ZnO nanoparticles was studied. On annealing, the yellow and green luminescences were quenched and blue luminescence was persistent. In the MicroRaman spectra of ZnO nanoparticles, B$_1$ silent modes were observed as a result of disorder-activated Raman scattering. In order to enhance the optical properties in the visible region, SnS/ZnO composite was synthesized. From the MicroRaman spectrum of SnS/ZnO nanocomposite, the intensity of B$_{2g}$ mode of SnS nanorods was dramatically decreased due to surface coating of SnS nanorods with small sized ZnO nanoparticles. The optical absorption spectrum of SnS/ZnO nanocomposite indicated an absorption in the visible region.