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ZnS and Graphene Quantum Dots Nanocomposite as Potential Electron Acceptor for Photovoltaics

Authors : S. M. Giripunje, Shikha Jindal

Abstract : Zinc sulphide (ZnS) quantum dots (QDs) were synthesized successfully via simple sonochemical method. X-ray diffraction (XRD), scanning electron microscopy (SEM) and high resolution transmission electron microscopy (HRTEM) analysis revealed the average size of QDs of the order of 3.7 nm. The band gap of the QDs was tuned to 5.2 eV by optimizing the synthesis parameters. UV-Vis absorption spectra of ZnS QD confirm the quantum confinement effect. Fourier transform infrared (FTIR) analysis confirmed the formation of single phase ZnS QDs. To fabricate the diode, blend of ZnS QDs and P3HT was prepared and the heterojunction of PEDOT:PSS and the blend was formed by spin coating on indium tin oxide (ITO) coated glass substrate. The diode behaviour of the heterojunction was analysed, wherein the ideality factor was found to be 2.53 with turn on voltage 0.75 V and the barrier height was found to be 1.429 eV. ZnS-Graphene QDs nanocomposite was characterised for the surface morphological study. It was found that the synthesized ZnS QDs appear as quasi spherical particles on the graphene sheets. The average particle size of ZnS-graphene nanocomposite QDs was found to be 8.4 nm. From voltage-current characteristics of ZnS-graphene nanocomposites, it is observed that the conductivity of the composite increases by 10⁴ times the conductivity of ZnS QDs. Thus the addition of graphene QDs in ZnS QDs enhances the mobility of the charge carriers in the composite material. Thus, the graphene QDs, with high specific area for a large interface, high mobility and tunable band gap, show a great potential as an electron-acceptors in photovoltaic devices.

Keywords : graphene, heterojunction, quantum confinement effect, quantum dots(QDs), zinc sulphide(ZnS)
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