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Investigation of optical framework of Chalcostibite nanocrystal thin films: an insight into refractive index dispersion, optical band gap and single-oscillator parameters

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Abstract

Herein, we report the synthesis of chalcostibite ($CuSbS_2$) nanocrystals based on hot injection method and the characterization of $CuSbS_2$ thin films by spin coating technique. The deposited films were subjected to the UV-Vis spectrophotometer, XRD, TEM and SAED for optical, structural, morphological and elemental analysis. XRD pattern showed that $CuSbS_2$ nanocrystals have chalcostibite structures and SAED diffraction spots supported the XRD results. Different optical parameters like extinction coefficient, refractive index, real and imaginary parts of dielectric constant and surface and volume energy loss functions have been calculated applying single term Sellmeier dispersion relation and Wemple–DiDomenico single oscillator model. The obtained results are discussed in detail. The optical dispersion and dielectric properties of the $CuSbS_2$ have been determined by the transmittance and reflectance modes in the range of 300–1600 nm. Thus, the $CuSbS_2$ is transparent up to 40–45% in the visible range. The optical bandgap determined by the optical absorbance spectrum analysis showed that thin films possess direct bandgap of 1.86 eV. The calculated refractive index of thin film varies between 1.76 and 2.11 throughout the spectral region considered. The results presented here permit a better understanding of the properties of the chalcostibite nanocrystals which in turn result in the design of more efficient solar cells.

Keywords: Chalcostibite, $CuSbS_2$, Copper (I) antimony sulfide, optical properties, dispersion study