Study of som physical properties of thermally evaporated sns thin films for photovoltaic applications

Walaa Abd El Rahman Abd El Ghany Abd El gwaad

Tin sulfide (SnS) bulk ingot material was prepared by direct fusionof the stoichiometric proportions of the constituent elements in vacuumsealed silica tube, following controlled heating and cooling stages. TheX-ray powder diffraction pattern indicated that the prepared powdersample belongs to SnS orthorhombic structure. The corresponding latticeparameters are a =0.43196, b=1.11850, and c=0.39746 nm.SnS thin films with different thickness (155, 225, 283, 470 and 585nm) were prepared by conventional thermal evaporation technique invacuum pressure of 10-3 Pa, onto glass substrates held at roomtemperature.The X-ray and electron diffraction study indicates that the asdepositedSnS films of thickness greater than 283 nm are partiallycrystalline with very small scattering volume. The crystalline nature ofthe as-deposited thinner SnS films (of thickness ~100 nm) was alsoconfirmed using transmission electron microscope and the -correspondingelectron diffraction patterns. It was also observed from the X raydiffraction that when the deposited SnS films being air annealed up to423 K the observed peaks intensity increases (i.e. increase thecrystalinity); however with further increasing in the annealingtemperature to 473 K the intensity of the observed peaks begins todecreases. The crystal size increases with increasing the film thicknessand also with the increase of the annealing temperature. The EDXanalysis of the deposited SnS films reveals that, the as-deposited thinnerSnS films as well as thicker films annealed at annealing temperature ≥473 K are deviated from stoichiometry.The optical transmission and reflection spectra were recorded fordifferent film thickness in the wavelength range 350-2500 nm, and theAbstractVIIdata was used to calculate the refractive index, absorption coefficient andoptical band gap. It was found that the refractive index of the depositedSnS films increases as the film thickness increase. The dispersion of therefractive index data was described according to the Wemple-DiDomenico single oscillator model whereby, the single-oscillator energy`gap' (Eo), dispersion energy (Ed), static refractive index (n (0)), staticdielectric constant, εs as well as the other related optical parameters forthe investigated SnS film thicknesses were determined. The refractiveindex data was further analyzed for different film thickness using theknown Sellmeier-dispersion relation from which the average oscillatorposition oλ , average oscillator strength o S , and dispersion parameter( ) s o E S have been calculated. The analysis of the optical absorptioncoefficient for the investigated

thickness of SnS films reveals thepresence of a direct allowed optical transition. The determined opticalband gap was found to be decreases with increasing the film thickness.The current-voltage characteristic of SnS indicates ohmic behaviorin the measured voltage range 0-9 V. The film resistance measured atroom temperature shows considerable decrease with the increase in thefilm thickness, reach almost constant value for higher film thickness (585nm which is the best thickness for photovoltaic application). It was alsoobserved that for all of the investigated film thicknesses, the conductivitydependence of temperatures showing normal semiconducting behaviorwith single linear part within the measured temperature range (300-460K); indicates one type of conduction mechanisms through thermallyactivated process. The determined activation energies values were foundto be decreased with the increase of the film thickness.The thickness dependence of the film resistivity is analyzed usingthe effective mean free path model on the basis of classical size effect.