PHOTOELECTROCHEMICAL CHARACTERISTICS OF NANOCRYSTALLINE CdSe FILMS

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Nanocrystals and nanocrystalline films are being actively investigated owing to their interesting properties. Several established techniques are available for the preparation of nanaocrystalline materials and thin nano films. CdSe nano films have been earlier prepared by chemical bath deposition technique, molecular beam evaporation, electrodeposition etc. In this technique, the pulse plating method, which is a modified electrodeposition technique resulting in fine grained and hard deposits has been adopted for the first time to deposit CdSe nano films. Structural, optical, morphological and photoelectrochemical (PEC) properties have been studied.

Nano films of CdSe were prepared by pulse plating technique using cadmium sulphate and selenium di oxide (both AR grade chemicals) as precursors on gold coated glass substrates at 200 mA cm^{-2} with different duty cycles varying in the range 6 to 50 %. The gold film was vacuum evaporated on clean glass slides. The thickness of the gold film was 0.5 μm. The as deposited films were characterized by x-ray diffraction studies using Phillips x-ray generator, optical absorption studies were carried out by using U- 3400 UV-VIS-NIR spectrophotometer, TEM studies were carried out on JEOL Transmission electron microscope. The Gold film containing the coated CdSe film was peeled off from the glass substrate and mounted inside the TEM. The thickness of the CdSe film was 1.5 μm (measured by gravimetry). PEC cells were fabricated by using the films as photoelectrodes and graphite sheet as counter electrode. A 250 W tungsten halogen lamp was used as source of illumination. The intensity of light falling on the electrode was measured by using a suryamapi (light intensity meter, calibrated in mW cm^{-2}). Capacitance – voltage measurements were made by using BAS impedance analyzer. Spectral response measurements were made with the help of Photophysics monochromator. The wavelength was varied in the range 400 – 800 nm using white light illumination.

X-ray diffraction studies indicated the formation of single phase hexagonal CdSe. Additional peaks due to Cd or Se were absent, one or two peaks due to gold substrate were observed. As the duty cycle was varied, the peak height also increased. The grain size was found to decrease as the duty cycle decreased. Lower duty cycles possess lower ON times, hence the application of a high current density for a shorter period helps in the deposition of fine grained films. The grain size was calculated using Scherrer's equation. TEM studies indicated grain size of the order of 20 nm for the films deposited at 6 % duty cycle. Optical absorption studies indicated the bandgap for the films to be 2.1 eV. The increase in the bandgap value indicates quantum size effects.

PEC studies indicated that both the open circuit voltage and short circuit current increases with increase of intensity of illumination. An open circuit voltage of 0.55 V and short circuit current density of 5.0 mA cm^{-2} were observed under an illumination of 60 mW cm^{-2}. Mott Schottky plots indicated n- type behaviour for the films. The flat band potential was found from extrapolation of the Mott Schottky plot to the voltage axis and it was found to be –1.15V(SCE). Spectral response studies indicated maximum photocurrent at 2.1 eV, which agrees well with the bandgap calculated from optical absorption measurements.

All the results of the investigation point to the possibility of preparing device quality films.

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