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Characterization of Cds/Glass Substrate and Pani/Cds/Glass Substrate Thin Films

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Abstract:
In the present paper, the films of Cadmium Sulphide and Polyaniline have been prepared by Vacuum Evaporation Technique. The growth and characterization of single layer and multilayer films have been done. In this paper, we shall study the reflection spectra and energy band gap of Cds/Glass Substrate and Pani/CdS/Glass Substrate thin films.

Keywords: *Cadmium Sulphide and Polyaniline, Vacuum Evaporation Technique, reflection spectra, energy band gap*

1. Introduction

The sulphide semiconductors are one of the most extensively investigated semiconductor in thin film form and a large variety of deposition techniques have been utilized to obtain solar cells.The Cadmium sulphide films grown by vacuum evaporation technique has been used as gas sensors for detection of oxygen and with a direct band gap it serves as a window material for heterojunction solar cells. Sharma, R.P. et al, [1] showed that CdS / polyaniline composite thin films can form tunable band gap heterostructure with vacuum evaporation CdS thin film on to glass substrate. Jayachandran, M. et al,[2] prepared Polyaniline layers onto porous structure by in-situ electrode position and showed photoluminescence at room temperature with a maximum current density 20 mA/Cm^2, a possibility of polyaniline as ohmic contact. Schlamp, M.C. et al, [3] demonstrated improved efficiency in LED's made with CdS and CdSe core / shell type nanocrystal incorporated in semiconducting polymers. Ad vincula, R.C et al, [4] reported improvement in performance of LED's which incorporated polyaniline coated on to ITO glass polyelectrolyte layer for heterostructure. N.F. Foster et al, [5] prepared the polycrystalline CdS films and found that the structural, electrical and optical properties of vacuum coated thin films of Cadmium Sulphide are very sensitive to the deposition conditions e.g. the degree of vacuum, the rate of deposition, the substrate temperature and the subsequent heat treatment. He also found that the CdS films have excess of Cadmium owing to the dissociation of CdS during evaporation, and concluded that the stoichiometry can be restored by codepositing Sulphur together with CdS. The Porous structure was prepared on P-Si single crystal wafers by anodizing route at low current densities. They also gave the X-R-D studies which indicate that an optimum pore size is found at this anodizing condition and the crystal structure is cubic. They observed porous structure using SEM Hitachi 530011. The (I-V) study also gives both porous silicon surface and porous silicon surface coated with Polyaniline. The result shows the polyaniline incorporation into the pores which is capable of making good electrical contact for device applications.

2. Sample Preparation of CdS

Thin films of CdS have been prepared by vacuum deposition technique. For sample preparation Cadmium Sulphide powder of 99.99%. Purity was evaporated at about 115°C from a deep narrow mouthed molybdenum boat. Deposition was made on to highly cleaned glass substrate held at 200°C in a vacuum of 10^{-5} torr. The substrate was cleaned in aquaregia washed in distilled water and isopropyl alcohol (IPA). We have used glass substrate for the preparation of Cadmium Sulphide.

3. Sample Preparation of Poly aniline

Thin film of polyaniline have been prepared by vacuum evaporation technique, polyaniline is usually prepared by redox polymerization of aniline using ammonium perdisulphate, $(NH4)_2$ S_2O_2 as on oxidant. Distilled aniline (0.02 M) is dissolved in 300 ml of pre-cooled HC1 (l.0M) solution, maintained at 0-50°C. A calculated amount of ammonium perdisulphate, (0.05M) dissolved in 200 ml of HCl (1M), pre-coated to 0-50° C, is added to the above solution. The dark green precipitate (ppt) resulting from this reaction is washed with HC1 (l.OM) until the green colour disappears. This ppt is further extracted with terta-hydofuran and NMP (N-Methyl Pyrolidinone) solution by soxhelf extraction and dried to yield the emeraldine salt. Emeraldine base can be obtained by heating the emeraldine salt with ammonia solution. Simultaneously, separate salt solution is prepared by dissolving the MX (M=Metal and X=Halide) in distilled water. The solution is then slowly added to the precooled polymer solution with constant stirring. The composite is then dried in an oven, at high temperature, to get the conducting polymer in the powder form. This powder is vacuum evaporated on to highly cleaned glass substrate as well as metallic substrate.

4. Optical Characterization

The fundamental and basic optical properties which can be investigated are reflectance, transmittance and absorption of light at various wavelengths. The different samples have been characterized using Varian Cary 5000 U-3400 and on basis of these studies the energy and band gaps for different samples have been calculated.

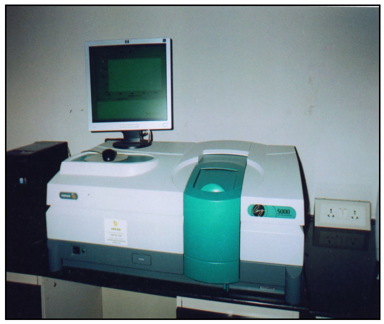
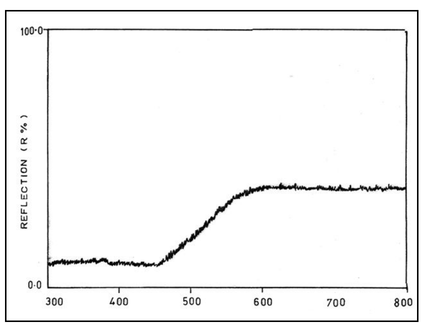


Figure 1: Photograph of Spectrophotometer (Varion Cary 5000)

A Varian Cary 5000 spectrophotometer was employed to record the reflection spectra of these films in the wavelength range of 300-800nm, at room temperature. The energy band gap of films was determined by reflection spectra. To measure the energy bandgap of CdS, we use the Tauc relation in which a graph between $(\alpha h\nu)^2$ Vs (hν) is to be plotted, where a is the absorption coefficient and hν is photon energy. The absorption coefficient a is proportional to $Ln[(R_{max}-R_{min})/(R-R_{min})]$,

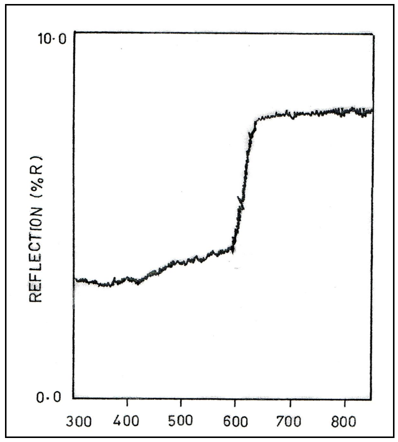
Where reflectance falls from R_{max} to R_{min} due to absorption of photons by the material, R is the reflectance for any intermediate energy photons. Hence we have a in terms of reflectance as $Ln[(R_{max}-R_{min})/(R-R_{min})]$. When we plot a graph between $(\alpha h\nu)^2$ Vs (hν), a straight line is obtained. The extrapolation of this straight line to $(\alpha h\nu)^2 = 0$ axis, gives the value of bandgap of the films material. The band gap measurement of such type of sample in which CdS is vacuum evaporated on to highly cleaned glass substrate in a vacuum of 10^{-6} torr, the reflection spectra is shown in fig, (2).

Fig. (4) Shows the band gap determination of vacuum evaporated CdS thin film of approximately thickness on to highly clean glass substrate. When the thin film of Polyaniline is deposited onto the above discussed sample, the different type of reflection spectra is obtained as shown in fig. 3 the band gap determination of such type of sample is illustrated in fig. 5 indicating the reduction of the band gap energy.



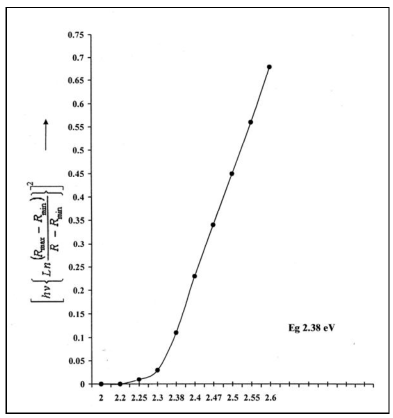
WAVELENGTH IN NM

Figure 2: Reflection spectra of CdS film on Glass Substrate



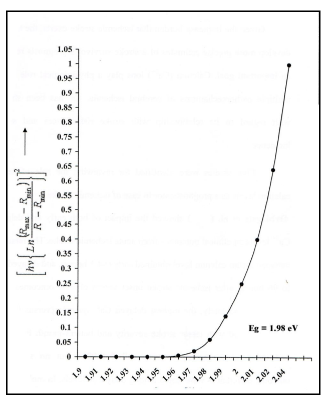
WAVELENGTH IN NM

Figure 3: Reflection spectra of Polyaniline CdS heterostructure on Glass Substrate



ENERGY (eV)

Figure 4: Energy band gap of CdS thin film on to Glass substrate



ENERGY (eV)

Figure 5: Energy band gap of Pani/CdS multilayer thin film on to Glass substrate

5. Conclusion

The reflection spectra were analyzed within the range of 300 to 1000 nm region at room temperature to determine the energy band gaps for single layer and multilayer thin films. It is observed that among these the reflection spectra give the fast and accurate information. A large variation in band gap energy of thin films has been observed. So the band gap technology can be used with modifying the structure of the Polyaniline thin film by introducing the addition of new material like CdS .The band gap in case of CdS on glass is 2.38 eV while it is 1.98 eV when pani is deposited onto it hence it also reduces in the similar manner. Band gap mechanism indicates that CdS can modify the band structure.

6. References

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