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Absorption Spectra and Energy Band Gapof Multilayer ZnS Films

Vishal Kumar Sharma, Mahendra Kumar, Kapil Sirohi

Dept.of Physics, University of Lucknow,Lucknow (U.P.), INDIA

Abstract—*In the present investigation, the films of Zinc Sulphide and Polyaniline have been prepared by vacuum evaporation methods.The growth and characterization of single layer and multilayer films have been done. Results are reported in terms of absorption spectra and energy band gap of Pani and Pani/ZnS thin films.*

Keywords:-ZnS thin films,vaccum evaporation technique.

I. INTRODUCTION

The present era of microminiaturization of electronic and photonic devices to be used in civil and commercial applications is the center of attention of present day research. Fast and efficient electronic devices and photovoltaic devices has been fabricated using elements alloys compound, in various forms. These forms consists of single crystal, poly crystal, amorphous bulk, the other forms are there films prepared by various methods. In this paper we shall study the multilayer ZnS thin films with the help of vacuum evaporation technique.

ZnS is the II–VI family semiconductor, has wide band gap (3.65 eV) at room temperature and large excitation binding energy 60 meV, ZnS is an attractive semiconductor material especially in electronic and optoelectronic application. The dielectric constant of ZnS (wurtzite structure) is 8.75 at lower frequencies and 3.8 at higher frequencies. The molecular mass is 81.389 and the melting temperature is 1450 K.

ZnS was used by Ernest Rutherford and others in the early years of nuclear physics as a scintillation detector, because it emits light on excitation by x-rays or electron beam, making it useful for x-ray screens and cathode ray tubes.It also exhibits phosphorescence due to impurities on illumination with blue or ultraviolet light.

Zinc sulfide, with addition of few ppm of suitable activator, is used as phosphor in many applications, from cathode ray tubes through x-ray screens to glow in the dark products.When silver is used as activator, the resulting color is bright blue, with maximum at 450 nm. Manganese yields an orange-red color at around 590 nm. Copper provides long glow time and the familiar glow-in-the-dark greenish color. Copper doped zinc sulfide (ZnS+Cu) is also used in electroluminescent panels .

Zinc sulfide is also used as an infrared optical material, transmitting from visible wavelengths to over 12 micrometres. It can be used planar as an optical window or shaped into a lens. It is made as microcrystalline sheets by the synthesis from H_2S gas and zinc vapor and sold as FLIR (Forward Looking IR) grade ZnS in a pale milky yellow visibly opaque form.This material when hot isostatically pressed (HIPed) can be converted to a water-clear form known as Cleartran (trademark). Early commercial forms were marketed as Irtran-2 but this designation is now obsolete.

II. SAMPLE PREPARATION OF ZnS

Thin films of ZnS have been prepared by vacuum deposition technique. For sample preparation Zinc 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 Zinc Sulphide.

III. 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) uptil 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.

IV. ABSORPTION SPECTRA AND ENERGY BAND GAP OF ZNS AND PANI ON ZNS FILMS

The absorption spectra of these films have been recorded in the wavelength range of 400 to 1000 nm, at room temperature. The energy band gap of films was determined by absorption spectra. To measure the energy band gap of ZnS we use the Tauc relation for direct band gap semiconductors, in which a graph between $(\alpha h\nu)^2$ vs. $h\nu$ is plotted, where α is the absorption coefficient and $h\nu$ is the photon energy. The absorption coefficient α is also proportional to Ln $[(R_{max}-R_{min}) / (R-R_{min})]$, where reflectance falls from R_{max} to R_{min} due to absorption of photons. Hence we have α in terms of reflectance as Ln $[(R_{max}-R_{min}) / (R-R_{min})]$.When we plot a graph between $(\alpha h\nu)^2$ vs. $h\nu$, a straight line is obtained. The extrapolation of this straight line to $(\alpha h\nu)^2 = 0$, gives the value of band gapof the film material. The band gap measurement of ZnS on glass substrate comes out to be 3.65 eV which is shown in fig.4.

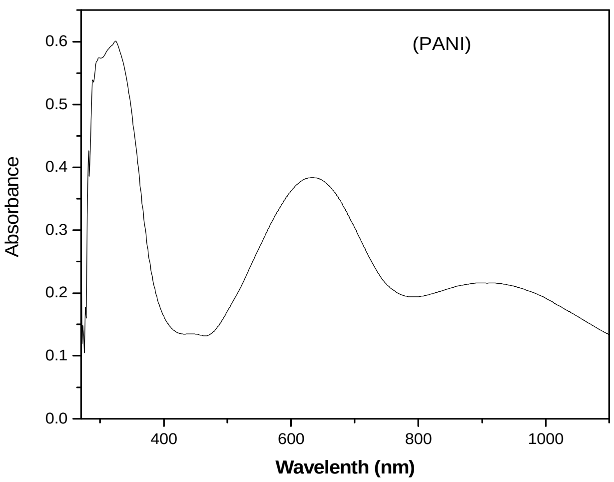

Fig.1: UV-VIS-NIR Absorbance spectra of Polyaniline

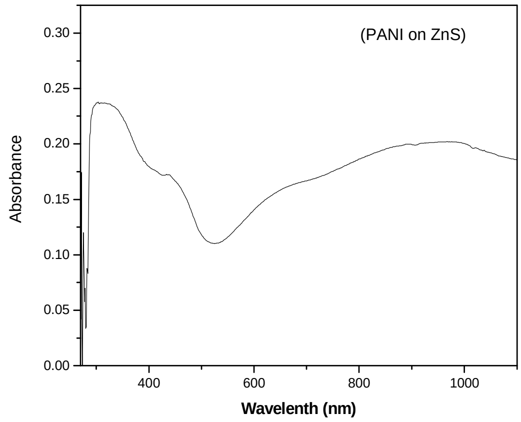

Fig.2: UV-VIS-NIR Absorbance spectra of PANI on ZnS

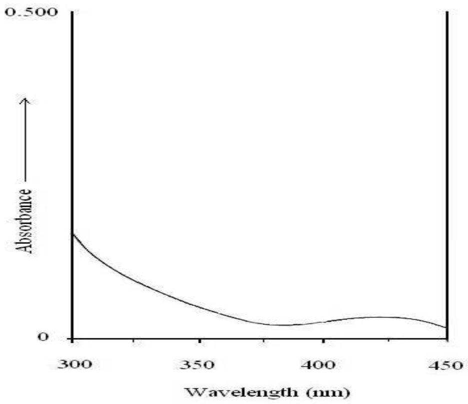

Fig. 3: Absorbance spectra of ZnS

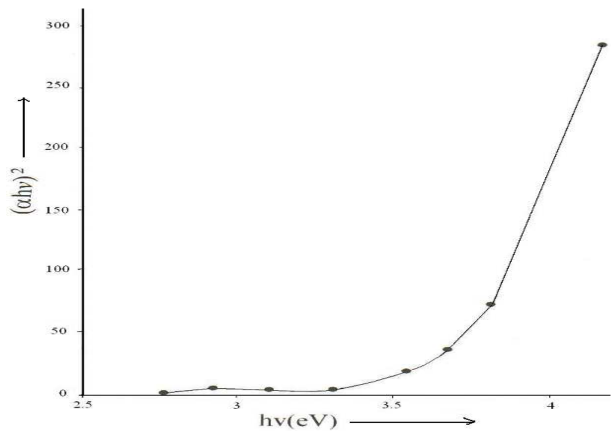

Fig.4: Band gap measurement of ZnS thin film

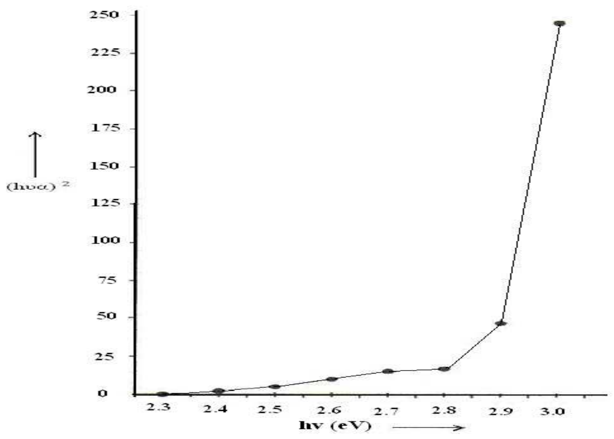

Fig.5: Band gap measurement of PANI on ZnS

The band gap energy of PANI on ZnS as observed is 2.86 eV which is shown in fig.5. The absorption spectrum of this sample is given by fig.2. It is observed that band gap decreases when PANI is deposited on to it. Fig.1. & 3, shows UV-VIS-NIR absorption spectra for both samples. For Polyaniline on ZnS, the peak at 304 nm due to the π - π* transition of benzene amine structure. The absorbance spectrum of pure polyaniline shows two peaks at 329 nm and 633 nm. The peak at 329 nm due to the π - π* transition of benzene amine structure. And additional peak at 633 nm due to a charge- transfer excitation-like transition from the highest occupied energy level to the lowest unoccupied energy level.

V. RESULTS AND DISCUSSIONS

The absorption spectra 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 absorption spectra gives the fast and accurate information. Large variations in band gap energy of thin films have 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 and ZnS to reduce the band gap and different substrate can also be a part in such phenomena. The band gap measurement of ZnS on glass substrate comes out to be 3.65 eV while it reduces to 2.86 eV when pani is deposited onto it.

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