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Manganese Sulphide (MnS) thin film by Spray Pyrolysis technique

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Abstract:

This paper report the study of MnS thin film prepared by spray Pyrolysis technique at 380^0. To prepared aqueous solution manganese chloride (0.1N) and thiourea (0.1N) is dissolved in double distilled water. Optical energy band gap of MnS thin film report at 2.2 -2.3 ev. The XRD pattern show the prepared MnS thin film is polycrystalline in nature. Electrical properties confirm current dependence with variation of temperature. The strong absorption edge of the spectrum confirm direct optical band gap. Increase in conductivity with temperature in MnS thin film material is semiconducting material with single charge carriers.

Keywords*: MnS thin film, XRD, optical analysis, spray pyrolysis.*

Introduction:

Based on II VI compounds have long been known to be suitable materials for thin film photovoltaic (PV) device applications because of their high absorption coefficients. This group of compounds can form ternary and quaternary alloys with a direct fundamental band gap over the entire alloy composition range [1]. Varieties of methods are used for thin films deposition such as chemical bath deposition, electro deposition, spray Pyrolysis, screen printing, spin coating, sol gel coating etc. Wide ranges of metal and non metal semiconductor compound are been studied for the deposition of thin film on substrate.[1-5]. In paper report spray Pyrolysis method used for deposition of MnS thin film. Spray pyrolysis method is simple, low cost and convenient for large layers of deposition on the glass substrate.[6-9]. In solar cell systems, where MnS films have been demonstrated

to be effective, with the higher band gap material has led to a decrease in window absorption loss and an increase in the short circuit current [8-10]. Particularly, MnS crystalline layers can be used as n-type wide gap windows in Hetero junctions for photovoltaic energy conversion [2].Optical absorbance direct and indirect band gap of MnS film having a potential application in photodiode, gas sensors, solar cell, transparent electrodes, solar cell, photo transistor. Manganese sulphide (MnS) thin films deposition was done by chemical bath deposition (technique. Various Chemicals combinations were tried for the deposition of good quality MnS thin films [3].Manganese sulphide belongs to VII VI compound semiconducting material. The MnS thin films are having potential use in solar cell application in the form of a window buffer material. [3-6] Homogenous thickness measurement is carried out with gravimetric method is used[8].

Experimental work:

Biological glass plates which are used for disposition are content of impurity. So before deposition the glass substrate was cleaned several times in conc. Nitrate acid, alcohol and distilled water to remove the impurities on the surface of substrate. The glass substrate is weigh on electron unipan microbalance of accuracy 10^{-4} gm. Manganese chloride (0.1N) and thiourea (0.1N) solution are prepared in 100ml double distilled water and stirrer for 10 hours on electronic stirrer. By mixing manganese chloride and thiourea in balance to from an aqueous solution for preparing MnS thin film by spray Pyrolysis method. Now the clean glass substrate was arranged on hot metal plate on heating coil with controlled variac with suitable temperature (380^0c). Solution combination of manganese sulfide sprayed on the glass substrate to form MnS thin film. After complete deposition done the glass substrate was allow to cool at room temperature. Once the deposition done the deposited glass plate is allow to weigh on unipan to measure the thickness of the thin film. Sample of prepared thin film are consider for study of different parameter. Electrical properties are carried out using four probe methods with same correction factor for thin layer (4.532) is allowing during calculation. The thickness of deposited MnS thin film is determined by gravimetric method.

Result and Discussion:

Structural characterization: - XRD pattern of MnS thin film deposited by spray Pyrolysis method (fig. 1). The film was characterized by using X-ray diffractometer. The XRD pattern is mixed phases of Cubic and hexagonal symmetry [3].The peak observe at 2θ = 27.457, 33.774, 49.752, 60.421 (JCPDS card no. 08 - 1518). The orientation are observed at (111), (200), (211),(222) The nature of deposited MnS thin film is polycrystalline.

Optical characterization: -Optical absorption and % transmission of the deposited MnS thin film in visible region (380 1000nm) on ELCO SL159 Spectrophotometer which shows high transmission in the visible wavelength. Absorption , % transmission, Optical Band gap (Fig.2,3,4) of MnS thin film is determine by the equation of stern [6-9].Absorption coefficient $(\alpha.hv)^2$ is linear

function of frequency which indicates direct transition in MnS material at strong absorption edge. As per the characterization and calculation for direct Optical energy band gap of MnS thin film report at 2.2 - 2.3 ev.

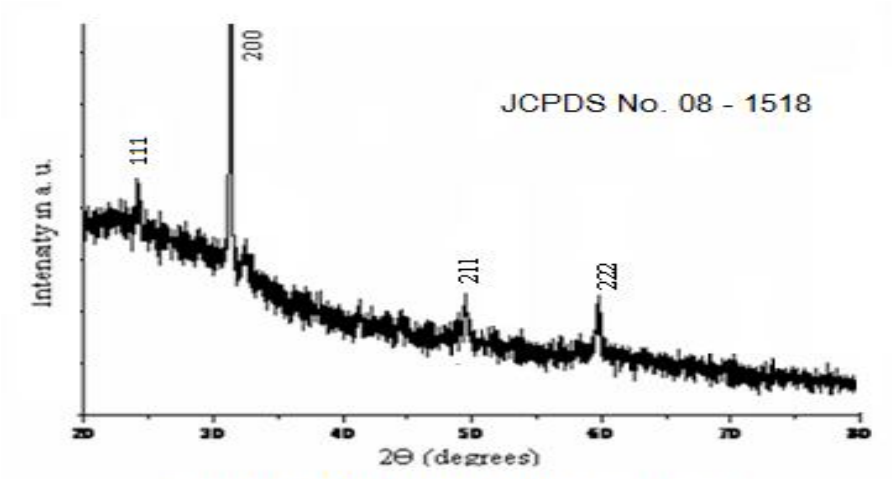

Fig. 1 XRD Pattern for MnS Thin film

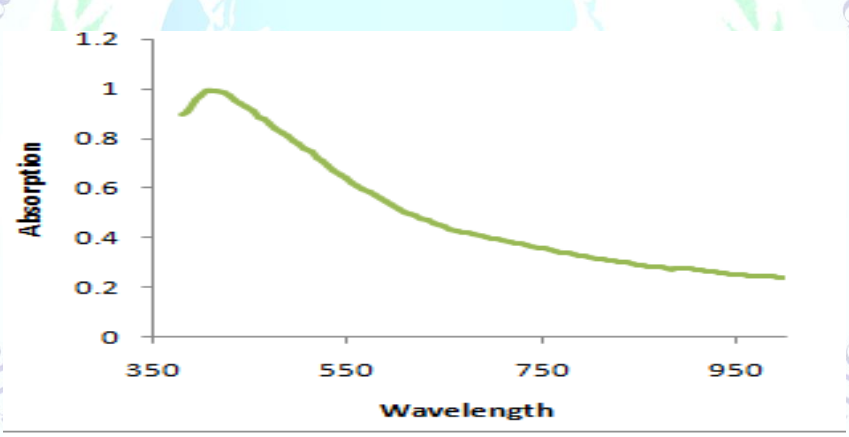

Fig. 2 absorbance of MnS thin film

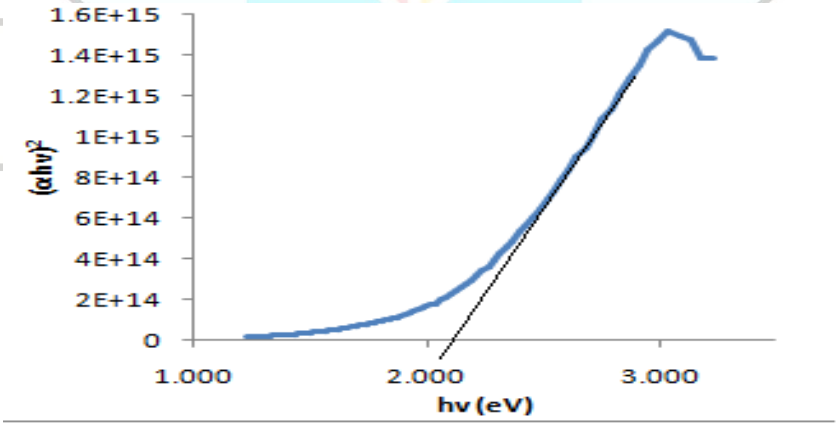

Fig. 4 optical band gap (Eg= 2.2 - 2.3 eV)

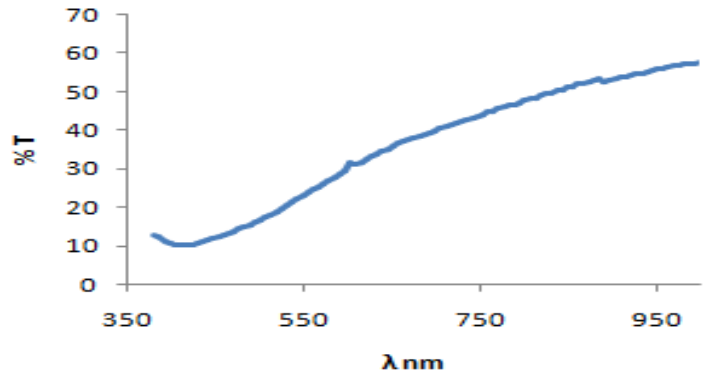

Fig. 3 plot of %T vs wavelength (nm) for MnS thin film

Electrical characterization: Prepared MnS thin Film is studied for thickness parameter to be used for determination of resistivity and conductivity by using weight difference density method (gravimetric method). MnS thin film thickness is calculated by weight difference equation. Electrical characterization of MnS thin film is studied by using four probe techniques which is most commonly method used to determine bulk resistivity and conductivity of the material [3,8]. Due to the combination of current and voltage probe correction factor is applied to determine resistivity of the thin film. Fig. 5 and Fig. 6 show the resistivity and conductivity as a function of temperature. Figure shows Resistivity of the MnS thin films decreased with the increases in temperature and conductivity is increased with increase in temperature.

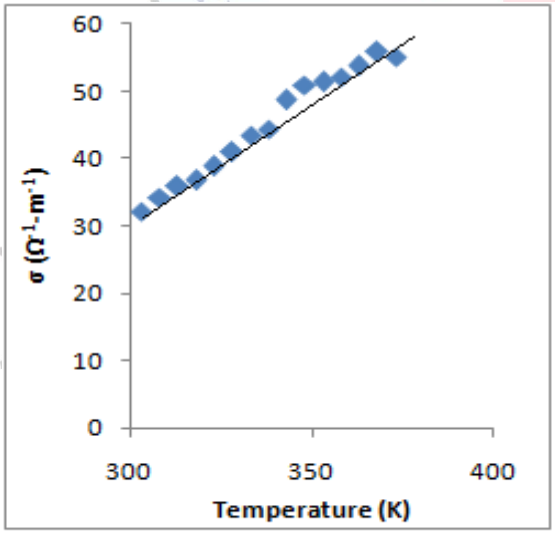

Fig. 6 Electrical Conductivity for MnS thin film

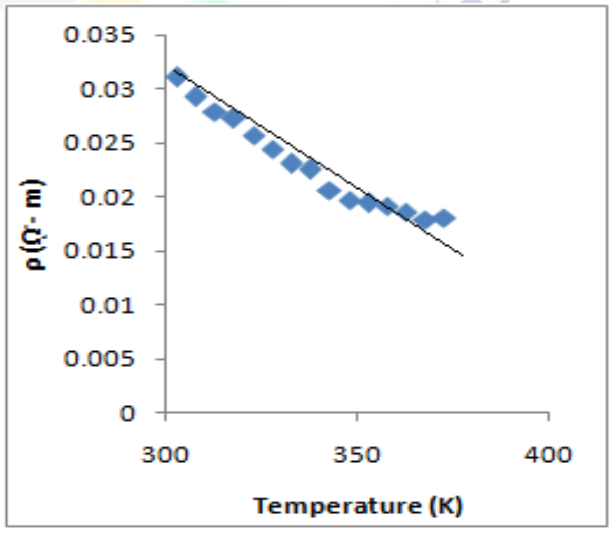

Fig. 5 electrical resistivity for MnS thin film

Conclusion:

This paper report that thin film of MnS deposited on glass substrate at 380^0c by spray Pyrolysis technique are suitable for photovoltaic devices and various application on optoelectronics. Optical characterizations are studied on MnS thin film show homogenous nature with strong absorbance edges with direct band gap between 2.2 2.3 ev.. XRD pattern of MnS thin film is mixed phases of Cubic and hexagonal symmetry with polycrystalline in nature. As the conductivity increases with increase in temperature concludes that MnS thin film material is of semiconducting nature with single charge carriers. Study of Variation characterizations analysis show that the spray pyrolysis technique can be used to prepared MnS thin film on glass substrate.

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