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Structural, Optical, Electrical and Hall effect studies of Spray pyrolysised $MgSnO_3$ Thin films

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Abstract: The aim of the present work was to find out the suitable substitute material for ITO. Because the production of ITO (Indium tin oxide) is low and the cost is very high. So $MgSnO_3$ can be considered as suitable alternative. In this work, $MgSnO_3$ is prepared by spray pyrolysis method using suitable molar concentration of magnesium acetate and stannic chloride (0.1:0.05, 0.1: 0.1, and 0.1:0.15) and isopropanal as the solvent at constant temperature (T_s) of 350°C.The structural analysis were taken. The prepared film at 0.1:0.05 molar concentrations shows the peak corresponding to MgO, SnO_2 and $MgSnO_3$ and film prepared at 0.1:0.15 molar concentration shows MgO, SnO_2. The peak position corresponding to SnO_2, $MgSnO_3$ and $MgSnO_4$ were observed for the films prepared with the concentration 0.1:0.15. From the results it is concluded that by varying the Ts and the concentration, peak corresponding to $MgSnO_3$ alone can be obtained, so that it can be used as a perfect TCO. The transmission studies carried out in the UV-Vis range shows that it has 60-84% transmittance and it has the optical bandgap varies from 3.65 -3.8eV. Hall effect measurements shows that $MgSnO_3$ shows n-type conductivity. The hall co-efficient, carrier concentration and the hall mobility were also observed.
Keywords: Hall effect studies, Spray pyrolysised $MgSnO_3$ Thin films.

Introduction

Magnesium meta stannate ($MgSnO_3$), a TCO used in solar cell applications shows high transparency in the visible and near infrared region spectrum and have a significant electrical conductivity [1]. In the present study Magnesium acetate ($Mg(CH_3COO)_2.4H_2O$) and stannic chloride ($SnCl_4.2H_2O$) was prepared at three different molarity ratios such as 0.1:0.05, 0.1: 0.1, and 0.1:0.15by spray pyrolysis method onto a well cleaned glass substrate at constant temperature (350 °C) and constant pressure (0.4 kg/cm^2)

Experimental Setup:

The spray technique involves spraying a solution, usually aqueous, containing soluble salts of the constituent atoms of the desired compound onto a substrate at elevated temperatures. The sprayed droplet reaching the hot substrate surface undergoes pyrolytic (endothermic) decomposition and forms a single crystallite or a cluster of crystalline of the product.

Results and Discussion:

Structural Analysis:

XRD spectra reveal the structural details and the crystalline nature of the thin film [2]. Fig 1.a shows the XRD spectrum of $MgSnO_3$ thin film in the composition of Mg:Sn= 0.1:0.05 molar ratio. All the diffraction peaks are indexed with the JCPDS standards (no:30-0794 of MgO,50-1429 of SnO_2,30-0798 of $MgSnO_3$). The 2Θ peaks observed at 28.65˚, 31.73˚, 39.75˚ corresponds to MgO, SnO2 and $MgSnO_3$ (meta stannate phase). The $MgSnO_3$ film prepared at (Mg:Sn=0.1:0.1) molar ratio, and XRD pattern reveals that the peak corresponding to magnesium oxide at 2Θ = 25.92˚, 37.43˚, dominates over the SnO_2 peak at 2Θ = 51.18˚. The absence of the $MgSnO_3$ peak may be due to the insufficient temperature of the reaction of the compound. XRD pattern of $MgSnO_3$ film prepared at molar ratio of (Mg: Sn= 0.1:0.15) is shown in the figure 1(b). The 2Θ peaks at 21.76° 26.64°, 31.62° corresponds to SnO_2 phase and it is obvious to say that the precursor concentration of stannic chloride is higher than the magnesium acetate. The peak corresponding to 2Θ = 28.64˚agrees with magnesium ortho stannate phase and the two peaks at 2Θ=38.25˚, 66.24 corresponds to magnesium meta stannate phase.

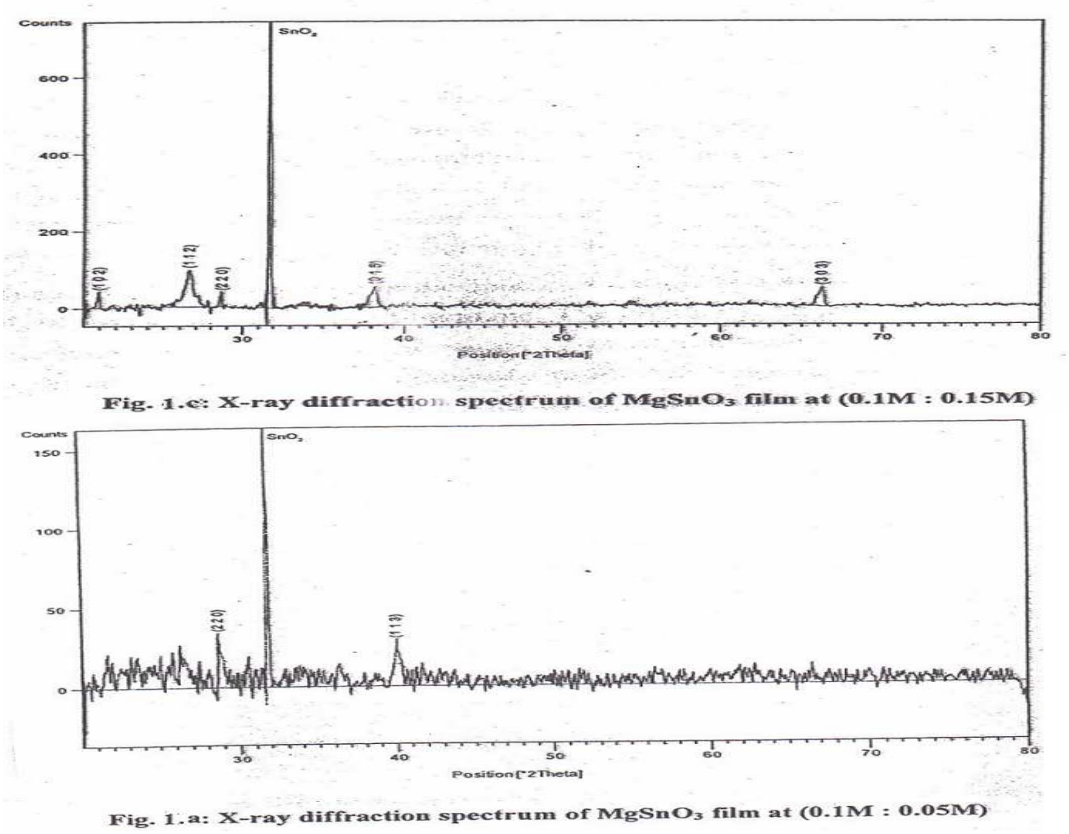

Fig 1. XRD diffraction peaks of $MgSnO_3$ thin films prepared at molar concentration of magnesium acetate and stannic chloride in the ratio (0.1:0.05, 0.1:0.15)

Optical Analysis:

From the transmittance spectrum it is observed that the $MgSnO_3$ films have optical transmittance of 60 to 84% in the visible range and the absorption edge occurs in the UV range. This reveals that it is suitable for applications such as transparent conductive devices and solar windows. Fig. 2 depicts the plot of $(\alpha h\vartheta)^2$ vs $h\vartheta$ of $MgSnO_3$ films. The calculated energy gap values are tabulated in the Table1. It is noted that the as the metallic conduction behavior is observed even for the material with optical bandgap greater than 3eV, it is concluded that $MgSnO_3$ can be used as a TCO instead of ITO.

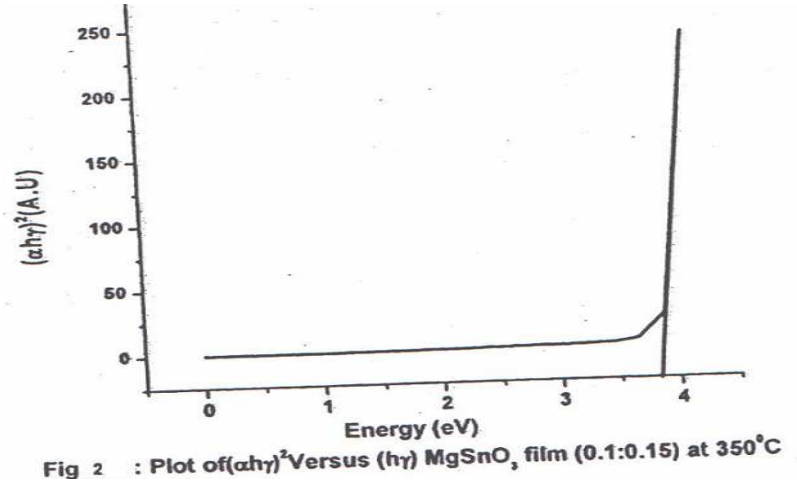

Fig 2 : Plot of$(\alpha h\gamma)^2$Versus $(h\gamma)$ $MgSnO_3$ film (0.1:0.15) at 350°C

Table-1 Estimated Energy gap values of $MgSnO_3$ films with magnesium acetate and stannic chloride in the ratio of (0.1:0.05, 0.1: 0.1, and 0.1:0.15)

``molar ratio of magnesium acetate and stannic choloride	Optical band gap values (eV)
0.1:0.05M	**3.65**
0.1:0.1M	**3.7**
0.1:0.1M	**3.8**

Hall Effect Measurements:

The type of conductivity is noted using Hall effect measurements and it is found that the film is of n-type conductivity [3]. Carrier concentration, mobility of the prepared films are also calculated and listed in the table 2.

Table-2 Hall coefficient, Carrier concentration, Hall mobility of $MgSnO_3$ thin films prepared at different concentrations of magnesium acetate and stannic choloride.

Different Molarity ratios of prepared $MgSnO_3$ film	Hall coefficient $R_H=(tV_H/VB)x10^8$ $cm^3/Cx10^2$	Carrier concentration(n) $n = 1/R_He$ cm^{-3}	Hall Mobility $\mu_H=R_H/\sigma$ cm^2/Vs
0.1:0.05M	4.79305	$2.0383x10^{16}$	90.76
0.1:0.1M	2.87447	$3.3987x10^{16}$	103.73
0.1:0.15M	0.8428	$1.180109x10^{17}$	72.04

It is concluded that by increasing the temperature the carrier mobility will increase.

Conclusion

In the future work the molarity concentration will be changed and the temperature will be raised to obtain the more effective film for the solar cell application.

References

1. Mayer .H Structures and properties of Thin Films (ed.Neugebaur, C.A.) Newkirk, J.B and Veronilyea, D.A. Wiley, New York (1959)225.
2. C.Sanjeeviraja, K.Srinivasan, "Applications of X-ray powder Diffraction" Eds C.Sanjeeviraja, M.Jayachandran, K.R. Murali, Proceedings on National Workshop of "TFPCT" Department of Physics, Alagappa University, (2004).
3. Charles Kittel "Introduction to SolidState Physics'',7th edition,(1996), john Wiley & sons inc., Singapore, New York.

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