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Electrical properties of S_n0_2 thin films by spray pyrolysis

Physics

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ABSTRACT

Transparent conducting thin films of tin oxide have been prepared by spray pyrolysis at 4000C as a substrate temperature Conducting of the films was tested by hot –probe method was of n-type. The Resistivity of the films were measured by four probe method. From the Arrhenius plot activation energy calculated as 0.273 eV and 0.281 eV fro the thickness of the films was 0.215 µm and 0.199 µm. indicating the grain size of the films was increases at higher temperature.

Introduction:- Tin oxide is an n-type semiconductor and it has high transparency in the visible region and high electrical conductivity. Transparent of tin oxide have importance in the field of research as well as technology due to their variety application. Transparent conductors are widely used in electronic, opto-elctronic and industrial devices such as solar cells, LEDs, heat mirror and laser damage resistant coating. Thin films of tin oxide can be prepared by a variety of method, such as reactive sputtering, vacuum evaporation, flash evaporation, r.f. sputtering chemical vapour deposition. These all above method are quite expensive. But spray pyrolysis is a simple and inexpensive method to preparethin films of the substance which are completely soluble in water. There are varies uses as thin films resistor, gas sensor, antireflection coating and transparent liquid crystal display, opto- electronic devices and heterojunction solar cells.We are chosen spray pyrolysis method.This is very simple and cheap in cost and it is easy to controlled proportion of the substance. It is also to control stoichiometry of the deposits.

In this paper we have studies the electrical properties and calculated activation energy from the Arrhenius plot. Temperature of the substrate was measured by copper constantan thermocouple. The electrical conductivity of the films was measured by Four probe method (1)

Experimental Details:-Tin oxide films have been prepared spray pyrolysis method using 0.2 m s_ncl_4 in pure ethanol. Biological glass plate used as a substrate. Temperature of the substrate measured by pre-calibrated copper constantan thermocouple was maintained at 400^0C .This temperature was most suitable for the production Tin oxide thin films. The glass sprayer was mechanically move to and fro the avoid the formation of droplets on the substrates. The distance between the sprayer and substrate was kept 30 cm.

Electrical properties:-The types of conductivity was tested by hot-probe method was of n-type semiconductor. Electrical resistivity was measured by four probe technique. The sheet resistance of the films of thickness 0.215 µm deposited at 400^0C in the air atmosphere was of 150.2 K . It was also observed similar resistance deposited between the temperatures 375^0C to 425^0C.

Fig.1 shows the Arrhenius plot of conductivity verses inverse temperature for two different thickness of the films.

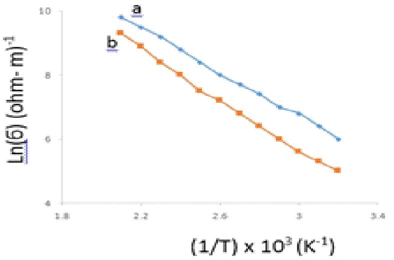


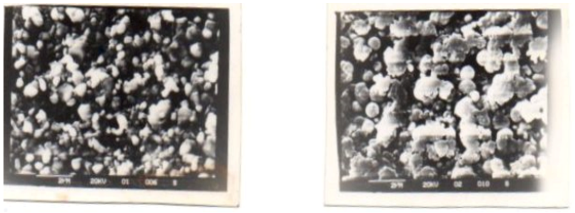
Figure 1 Shows Arrhenius plot of conductivity of SnO_2 thin films of as deposited (a) t = 0.215 µm b) t = 0.199 µm

The temperature decreases from 503^0K to 273^0K in the conductivity cell. It was observed that plot is a straight–line region, indicating the activation energy. From the plot activation energy was calculated using the relation,

$$\sigma = \sigma_0 e - E_a / kT \qquad (1)$$

Where $\sigma_0$is the pre-expontial conductivity, E_a– is the activation energy, K- Boltzmann constant, T- is the absolute temperature.The activation energy calculated using above equation (1) was of 0.273 eV and 0.281 eV for the thickness of the films 0.215 m and 0.199 m respectively. Our calculated value of activation energy between 0.273 eV and 0.281 eV are well agree Raghupatiet all (2). They have reported that the activation energy between 0.268 eV to 0.569 eV for the reactively evaporated tin oxide thin films between the temperature 275^0Cto 500^0C respectively.This indicates that activation energy increases when the evaporation temperature decreases from higher temperature to lower temperature. Our calculated activation energy also comparable to the values reported by other workers (3,4). They also states that the reduction in the activation energy of the tin films is obtained with increase in substrate. This indicates that there is increase of grain size of the films due to the higher substrate temperature.

Study of SEM= SEM photograph of tin oxide thin films of two different thickness. The grain size of the film increases if the thickness of the film increases.This are also matches with the other worker(2). Raghupati et.al. have also reported reactively evaporated tin oxide thin films have grain size of was 19.5 nm for the temperature 275^0c. This shows that the spray pyrolytically deposited thin films of good quality and stoichiometry (5,6).



a b

SEM Photograph of SnO_2 thin films of as deposited (a) t=0.199µm (b) t=0.215 µm

Results and conclusion :-Spray pyrolysis is best and ruff tuff method gave good result and it is matched with result obtained by single crystals. From the Arrhenius plot the activation energy value increases if the thickness of the films increases while SEM study reveals that grain size of the films are nearly same.

References :-

1) L.B. ValdeProceeding of the I.R.E. 420 (1954) "Measurement of Resistivity ofgermanium crystal by Four Probe method".
2) M P.S. Raghupati, George Joseph and C.S. Menon "Effect of substrate temperature on the electrical and optical properties of reactively evaporated thin oxide thin fims" Indi J. of Pure and Appl. Phys.43 (2005) 620-623.
3) S. Tolansky – An introduction to interferometry Longmans (Green,London)1955.

4) R.Sanjines, V.Demarne andF.Levy. Thin Solid Films 935(1990)193-194.

5) 1) J. P.Hirde and Y.D. Tembhurkar Optical and structural properties of II-VI solid-solution thin films of CdxZn1-xS deposited by spray pyrolysis Indi. J. Pure and Appl. Phys 28 oct (1990) pp 583-585.

6) 2) Y.D. Tembhurkar and J.P.Hirde Structural, optical and electrical properties of spray pyrolytically deposited films of copper indium diselenide .Thin Solid Films 215(1992) 65-70.