Original Research Paper

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Study of variation of Electrical properties and thickness with temperature of S_n0_2 thin films by spray pyrolysis.

Physics

KEYWORDS: Spray pyrolysis, Sn02 thin films.

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ABSTRACT

transparent thin films of Sn02have been prepared by spray pyrolysis . The type of conducting tested by Hot-Probe method. Resistivity of the thin films measured by four probe method. It was observed that activation energy decreases and thickness of the increases if temperature increases

Introduction:-$S_n0_2$is a high transparent n-type semiconductor in the visible region. They have high electrical conductivity. It is most important in the field of research as well as in technology due to their variety of application such as uptoelectronic andindustrial devices such as solar cells, LED's , and laser damage resistant coating, S_n0_2 thin films can be prepared by various method. Such as r.f. sputtering, flash evaporation, reactively couple evaporation, chemical vapour deposition and spray pyrolysis.

We are chosen spray pyrolysis due to cheap and inexpensive and easy to change the proportion of the constituents. Moreover, it does not cause radiation damage to the substrate.

In this paper,we reported the study of effect of temperature on thickness and electrical properties of $S_n0_2$thin films. Thickness of the films was measured by precalibrated copper constantan thermocouple. The type of conductivity was tested by hot probe method. Resistivity of the films was measured by Four probe technique(1).

Experimental Details:-

The tin oxide thin films were prepared by spray pyrolysis method using 0.2M of s_ncl_4 in pure methanol. Biological glass slide used as a substrate. The temperature of the substrate vary from 350^{0}C to 425^{0}C in the interval of 25^{0}C. The sprayer move mechanically to and fro to avoid the formation of the droplets on the substrate.

Electrical properties:- Electrical Resistivity was measured by Four-Probe method. The type of conductivity was measured by Hot-probe was of n-type semiconductor. The sheet resistance of the thin films prepared from the temperature 350^{0}C,375^{0}C 400^{0}C and 425^{0}C were measured using standard Four-Probe method. It was observed that sheet Resistance decreases from 60 KΩ to 8 KΩ as temperature increases from 350^{0}C to 425^{0}C in the step of 25^{0}C.

Fig.1 shows the Arrhenius plot of conductivity versus inverse temperature of as deposited S_n0_2 thin films at different substrate temperature.

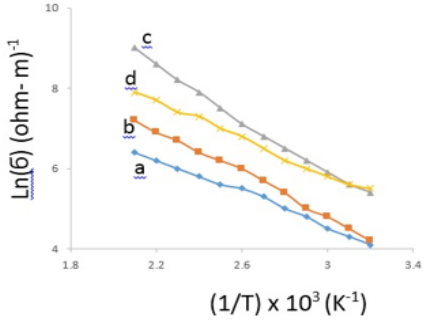

Figure 1 Shows Arrhenius plot of conductivity of SnO_2 thin films of as deposited (a) 350^0 C, b) 375^0 C, c) 400^0 C d) 425^0 C

The activation energy was calculated using the relation.

$\sigma = \sigma_0 e^{-E_a/kT}$ (1)

Where $_0$– Pre-expential conductivity, E_a– is the activation energy, K-Boltzmann constant, T is the absolute temperature. From the above conductivity plot it was observed that each plot is a straight line of all films which was prepared at four different temperature. Activation energy calculated by using above equation (1) foreach graph. It was observed that the activation energy decreases from 0.450 eV, 0.312 eV, 0.281 eV when temperature increases from 350^{0}C,375^{0}C& 400^{0}C respectively. But when the temperature increase further at 425^{0}Ccthen activation energy decreases again as 0.275 eV. This shows that from the Fermi level analysis of conductivity in material with donor levels located at a distance E below the bottom of conduction band. The straight line nature with slope of the plot indicating on activation energy. The conductivity of S_n0_2 thin films exhibits an expontial behavior with activation energy of 0.281 eV for the films deposited at 400^{0}C.This indicates that preparation of films at 400^{0}C is the optimum temperature.

Measurement of thickness:-

The thickness of the S_n0_2 films have been determined by Michelson Interferometer. Fig.2 shows the variation of thickness with substrate temperature. It was also observed that 9f the temperature increase from 350-400^{0}C, thickness of the films increases. Further increase of temperature of the films i.e. at 425^{0}C the thickness will decrease. This is due to higher evaporate the initial ingredient (2-5).This results are also well agree with the other workers (2,7)

Table 1. shows the variation of temperature, thickness and activation energy.

Temperature(0C)	Thickness (μm)	Activation energy (eV)
350	0153	0.450
375	0.180	0.312
400	0.199	0.281
425	0.0.191	0.275

Conclusion:- In highly transparent Sn02thin films, thickness of the films increases and activation energy decreases if temperature increases upto a certain extent and further increases of temperature reverse happens. This can be associated with the grain size of the films increases due to the higher substrate temperature.

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