CHAPTER VI

THERMALLY STIMULATED CONDUCTIVITY

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6.1 INTRODUCTION

Conductivity of any material is a measure of the numbr of electrons in the conduction band. The number of electrons in conduction band can be increased by increasing temperature of the material. In case of semi conductors, there are some free electrons at room temperature. Hence it shows some conductivity [1,2].

However, in case of insulators, band gap is large, hence there are no electrons in conduction band. Therefore, insulator does not show any conductivity [1,2].

If the temperature of the insulator is increased, it is possible to transfer the electrons from valance band or traps to conduction band and the resultant conductivity is called thermally stimulated conductivity (TSC).

The temperature required to transfer the electrons from valence band to conduction band depends upon the bandgap energy of the material. Thus from the change in resistivity with temperature it is possible to estimate the band gap energy of the material.

6.2 EXPERIMENTAL PROCEDURE

An attempt is made to measure resistivity of a typical phosphor $CaSO_4:Mn_{0.1}:Eu_{0.05}$ using four probe experimental set up. The phosphor which is found promising with optimum concentration has been used in the investigations.

The experimental set up is described in chapter II. A sample in the form of pellet is placed in a sample holder, and probes are placed so as to make good contacts. The sample is then placed in

on oven and temperature is increased. For different temperature corresponding voltage is measured at constant current. The resistivity of the material is calculated by using the formula

$$\rho = \frac{2\pi S V}{I} \qquad .. \qquad (6.1)$$

where I is the current through the phosphor. 'V' is the voltage across the two probes. 'S' is the distance between the two probes and G_7 (W/S) is the function of thickness of sample and distance between two probes. The correction factor G_7 (W/S) is not applied, since the thickness of the pellet is greater than the distance between two probes of the four probes set up

The band gap energy is given by the formula,

$$E_g = 2K \frac{\ln \rho}{(1/T)} \qquad .. \qquad (6.2)$$

The value of $\frac{\ln \rho}{(1/T)}$ is obtained from the slope of the graph ρ Vs $\frac{1}{T}$

6.3 RESULTS AND DISCUSSION

6.3.1 CONDUCTIVITY OF PHOSPHORS

It is observed that phosphor behaves an insulator at room temperature. This shows that, it has large band gap as compared to semiconductor. As temperature is increased upto 225°c, still phosphor doesnot show any appreciable measurable conductivity.

When the same phosphor is excited by uv excitation for 30 minutes and the conductivity measurement is made, the samples shows some conductivity at about 210°c. This conductivity is due to the thermally generated electrons or holes. Due to uv excitation electrons from traps may be excited and they get transfered to conduction band showing very feeble conduction. The values of resistivity and conductivity for a typical sample $CaSO_4:Mn_{0.1}:Eu_{0.05}$ under uv excitation are shown

in the table 6.1

6.3.2 BAND GAP ENERGY

In the present study band gap energy is calculated by plotting the graph of $\ln \rho$ versus $\frac{1}{T}$ (fig.6.1) for $CaSO_4:Mn_{0.1}Eu_{0.05}$ phosphor on uv excitation for 30 minutes. The band gap energy thus calculated is 4.01 eV.

The band gap energy estimated by four probe method does not agree with the reported band gap values. The following may be the reason for it.

The transfer of electrons from valence band to conduction band requires high temperature. The four probe apparatus provides a temperature range upto 240°c. In this range of temperatures electrons may be transferred from intermediate traps to the conduction band instead of from valence band. This indicates that calculated energy may not be band gap energy but trap depth[4,5] from which electrons are transferred to conduction band. This explanation requires further investigation.

TABLE 6.1

Values of resistivity and conductivity of $CaSO_4:Mn_{0.1}:Eu_{0.05}$ phosphor at different temperatures.

Temperature		Resistivity (ρ)	Conductivity
^oC	^oK	Ω-cm	(Ω-cm^{-1})
210	483	1.25×10^7	8.00×10^{-8}
215	488	3.8×10^7	2.63×10^{-8}
220	493	6.3×10^7	1.58×10^{-8}
222	495	5.0×10^7	2.0×10^{-8}

REFERENCES

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PLOT OF ln ρ Vs $\frac{1}{T}$ FOR $CaSO_4:Mn_{0.1}:Eu_{0.05}$ PHOSPHOR AFTER 30 MINUUTES UV EXCITATION.

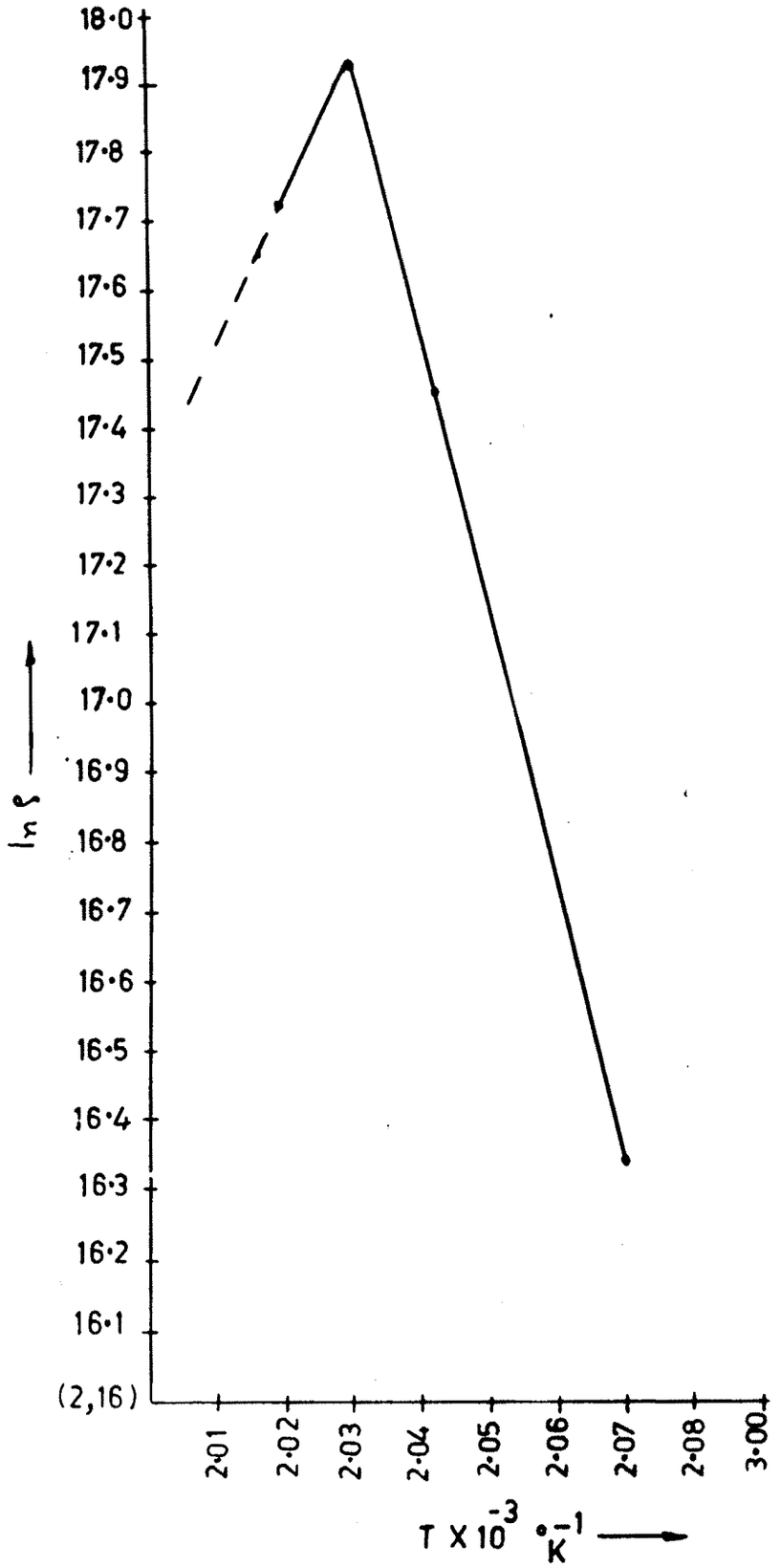

Fig. 6·1