CHAPTER VI

THERMALLY STIMULATED CONDUCTIVITY

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6.1 Introduction

Conductivity of material is a measure of number 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 semiconductors there are some electrons at room temperature. Hence it shows some conductivity. However in case of insulators, band gap is large, hence there are no electrons in conduction band. But by increasing the temperature it is possible to transfer the electrons from valence band or traps to conduction band and the resultant conductivity is called as thermally stimulated conductivity (TSC). The temperature required to transfer the electrons from valence band to conduction band depends on the band gap 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

The resistivity of the material at different temperature is measured by four probe method. The experimental set up is described in Chapter II. A sample in the form of sintered pellet is placed in sample holder, and probes are placed so as to make good contacts. The sample was then placed in a Oven and temperature was increased. The current and corresponding voltage are measured at different temperatures. The resistivity of the material is calculated by using the formula,

$$\rho = \frac{2\pi S}{G_7(w/s)} \frac{V}{I} \quad \text{.. (6.1)}$$

where I is the current through the phosphor V is the voltage between two voltage probes, S is the distance between two probes and $G_7(w/s)$ is the function of thickness of sample and distance between two probes.

The value of $G_7(w/s)$ is used from the data given by the manufacturer.

The band gap energy is given by the formula,

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

The value of $\frac{\log_e \rho}{(1/T)}$ is obtained from the slope of the $\log_{10} \rho$ versus $1/T\,^{\circ}k$ graph.

6.3 Results and discussion

a) Conductivity of phosphors

It is observed that phosphor behaves as an insulator at room temperature. This shows that it has large band gap as compared to semiconductors. As temperature is increased then above a particular temperature about 165°c the phosphor shows some conductivity. This conductivyty is due to the thermally generated electrons and holes. Thus the electrons from traps or from valence band are transferred to the conduction band. The values of resistivity and conductivity for a typical sample SD 12 are shown in table 6.1. The conductivity intially decrease and then increases wi[illegible] increase in temperature,

b) Band gap energy

In case of CaS phosphor, the reported value of band gap energy is expected around 4.5eV.(1,2,3). In the present study the band gap energy is calculated by plotting the graph between $\log_{10} \rho$ and 1/T (fig. 6.1). The band gap energy thus calculated is 1.68eV.

Author would like to make clear that band gap energy estimated by four probe method does not agree with the reported value of band gap energy for CaS. Follwoing may be probable reason for this large variation in the value of band gap energy.

To transfer sufficiently large number of electrons from valence band to conduction band, still higher temperature is required. In the present experimental set up the range of temperature of oven is limited (room temp.-250^{o}c.) In the above said range of temperature, electrons from intermediate traps might be getting transferred to the conduction band instead of that from valence band. As such the calculated energy may not be a band gap energy of the material, but may be a trap depth from which electrons are transferred to the conduction band. Such an understanding requires confirmation with additional data and experimentation.

Simultaneous measurement of thermoluminescnece after suitable excitation and conductivity has been made for the sample CaS:Bi.(4) The paper reports correlation between them. Efforts in this direction may help in xxxxxxxxxx understanding mechanism involved in both the phenomenon.

Table 6.1 : showing the values of Conductivity and resistivity at different temperature.

Temperature °K	Conductivity $(\Omega\ cm)^{-1}$	Resistivity Ω cm.
438	5.942×10^{-8}	1.6829×10^{7}
443	2.426×10^{-8}	4.122×10^{7}
448	2.2867×10^{-8}	4.373×10^{7}
453	2.524×10^{-8}	3.9617×10^{7}
458	2.957×10^{-8}	3.381×10^{7}
463	3.4977×10^{-8}	2.859×10^{7}
468	4.2764×10^{-8}	2.3384×10^{7}
473	5.045×10^{-8}	1.9821×10^{7}
478	5.747×10^{-8}	1.7400×10^{7}
483	6.7713×10^{-8}	1.4768×10^{7}
488	8.2528×10^{-8}	1.2117×10^{7}
493	10.018×10^{-8}	0.9982×10^{7}
498	11.6238×10^{-8}	0.8603×10^{7}
503	14.084×10^{-8}	0.7100×10^{7}
508	17.015×10^{-8}	0.5877×10^{7}
513	20.525×10^{-8}	0.4872×10^{7}

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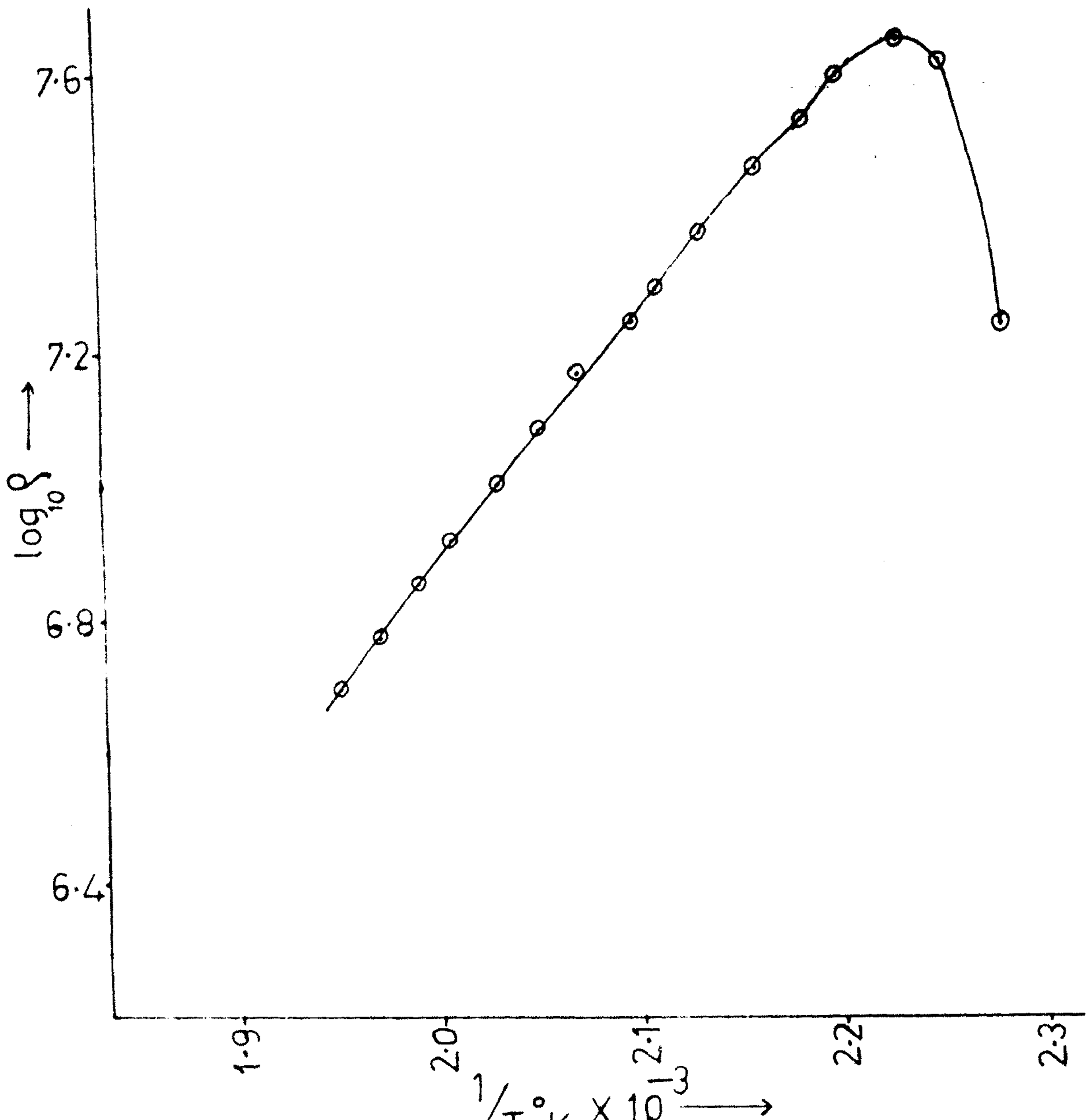

FIG. NO: 6·1.

Plot of $\log_{10}\rho$ Vs $1/T°K$.