CHAPTER - V

SUMMARY AND CONCLUSIONS

Growth of single crystal have been created much interest among the scientists due to their wide spread applications. In this dissertation the growth and characterization of $SrSO_4$: Dy single crystal and their electroluminescence (EL) studies have been reported.

The dissertation consists of five chapters. Chapter-I opens with brief introduction, survey of the crystal growth and electroluminescence. In light of this the problem has been selected and stated therein. Chapter-II gives brief outline of different types of solution growth techniques. At the end of this chapter, the detailed procedure of crystal growth of $SrSO_4$:Dy is described. Structural, electrical and optical properties of $SrSO_4$: Dy single crystals are studied and reported in Chapter-III. The phenomenon of EL in $SrSO_4$: Dy single crystal, voltage and frequency dependence EL brightness is explained in Chapter-IV. The results are summarised in brief and some conclusions are drawn in Chapter-V.

Since $SrSO_4$ decomposes at high temperature, crystal cannot be grown from the melt or by chemical transport. The only alternative is the solution growth. For this the concentrated sulphuric acid proved to be a suitable solvent.

Single crystals of $SrSO_4$ activated with Dysprosium as an impurity were prepared from Indian mineral celestine. Purified celestine powder was taken in a corning glass beaker and hot concentrated solution of sulphuric acid (A R grade) was added to dissolve the powder and saturated solution of celestine was prepared. Solution of Dy_2O_3 and sodium sulphate were prepared in various mol % in double distilled water and required quantity of activator (Dy_2O_3) and flux (Na_2SO_4) solutions were added to the celestine solution.

The beakers containing the solution were kept in the oven. The oven temperature was maintained at 200^oC for the first four days. The temperature of oven was then reduced to 175^oC and kept constant for another two days when crystal nuclei were formed. The temperature of oven was then reduced to at the rate of 25^oC/day for the subsequent four days until the solution completely evaporated and only transparent crystals are remained. The typical size of the crystals grown was of the order of 11 x 5 x 2 mm.

The structural, electrical and optical properties of single crystals are studied. For these studies, following techniques were employed : (i) Microscopic and X-ray diffraction (ii) Electrical conductivity and thermoelectric power, and (iii) Optical absorption.

Microphotograph shows pits on the plane surface of crystals. These pits confirm the morphology and orientation of growth hillocks. The specification of crystal structure photograph shows that crystal with charge compensator are bigger than without it. Studies of electrical conductivity performed at room temperature and it was noted that the I-V plots obey the Mott's relation. The variation of conductivity of $SrSO_4$ single crystals with diverse concentration of Dy shows that the conductivity decreases by increasing wt % of Dy. The graphs of log σ vs 1/T are ploted to yield the values of activation energies. There are two activation energies corresponding to two different temperature regions.These lies at about 0.06920 eV and 0.00123 eV.

Thermoelectric power was measured and the type of conductivity of all single crystals was determined. The polarity of thermally generated voltage at hot end was positive indicating that the crystals are of n-type. Thermoelectric power observed is of the order of few microvolts/^{o}C. Optical absorption measurements were carried out to estimate the values of band gap. Intercepts of the plots of $(kh\nu)^2$ versdus $(h\nu)$ were used for this purpose The values of band gap for $SrSO_4$ lies at about 5.5 eV and found to alter slightly **with** dopings.

Chapter-IV explains the mechanism of electroluminescence with five stages. In electroluminesdcent study it is observed that the increase in activator concentration decreases the threshold voltage for EL emission. This is attributed to the fact that the increase in the activator concentration (Dy^{3+}) enhance the population of donor levels and increase the probability of generation of free carriers with applied field. This helps to generate free carriers at lower applied voltages, which may accelerate and combine with luminescence centre to yield higher brightness.

The plots of brightness versus log Dy concentration were recorded for without and with Na_2SO_4 as charge compensator. It is found that brightness increases with increase in Dy concentration attains the maximum value at about 0.08 wet % Dy concentration, and then decreases. The monovalent sodium ions from the flux are incorporated during the growth of the crystal and plays an eminent role in intensity of electroluminescence.

The incorporation of Na^+ ions in $SrSO_4$ single crystals however, does not give its characteristics emission, as it has a close shell structure and does not have any energy levels.

Voltage dependence of EL brightness was studied. It is seen that the light output is a increasing function of the applied voltage and this brightness is more rapid at higher frequencies. Close observation of plots shows that there required some minimum voltage above which EL starts, called threshold voltage V_{Th}. Log B Vs log V curves suggest the excitation of charge carriers by field ionization of impurity ion electrons. The linear relation between log B Vs log V follows the power law relation.