ABSTRACT OF THE THESIS

CHAPTER I

In this chapter the phenomenon of luminescence and mechanoluminescence (ML) are described. The review of work on the ML of crystals, activated and nonactivated ZnS phosphors and mixed phosphors is discussed and emphasis is given to the mechanism of ML excitation. The recent trends of research on the ML is described and finally the objectives of the present investigation are clarified. It is mentioned that the main interest of the present investigations are:

(i) To prepare intense mechanoluminescent Cu, Ag, Mn and Au doped \((Zn, Cd)S\) mixed phosphors and to understand the impact velocity dependence, activator concentration dependence, temperature dependence, time dependence of ML and variation of ML intensity with CdS content in this system of phosphors.

(ii) To understand the mechanism of ML excitation in impurity doped \((Zn, Cd)S\) mixed phosphors.

CHAPTER II

In this chapter definition of phosphor, composition of phosphor and general requirement for the preparation of phosphors is described. The description of preparation of Cu, Ag, Au and Mn doped mixed phosphors is given. The phosphors \((Zn, Cd)S: Mn; (Zn, Cd)S: Au; (Zn, Cd)S: Cu\) and \((Zn, Cd)S: Ag\) with varying CdS content were prepared in nitrogen atmosphere by firing one hour at 900°C for cubic and at 1100°C for hexagonal structure, having activator concentration \(1 \times 10^{-1}\)
Sodium chloride was used as a flux. The ML devices used in our laboratory is described in detail.

CHAPTER III

In this chapter the Impulsive Excitation of ML by impact of load on the phosphor is described. The ML intensity increases with time, attains a maximum value and then decreases in (Zn,Cd)S:Au and (Zn,Cd)S:Mn phosphor. In (Zn,Cd)S:Ag and (Zn,Cd)S:Cu phosphors a different type of kinetics is observed, the reason of different nature is discussed. In the ML intensity versus time curve, the peak increases and shifts towards shorter time values with increasing impact velocities, and the rising portion of the curve follows the relation \( I = I_1 \exp(\lambda_1 t) \) and the decaying portion follows the relation \( I = I_2 \exp(-\lambda_2 t) \), where \( I_1 \), \( I_2 \), \( \lambda_1 \) and \( \lambda_2 \) are constants. The total ML intensity \( I_T \) is defined as the area below the ML intensity versus time curve.

Initially \( I_T \) increases with impact velocity \( V_0 \) and then it attains a saturation value for higher impact velocities, which follows the relation \( I_T = I_T^0 \exp \left( \frac{-V}{V_c} \right) \), where \( I_T^0 \) and \( V_c \) are constants. Total ML intensity increases linearly with the mass of the phosphors for higher impact velocities.

The ML intensity \( I_m \), corresponding to the peak of ML intensity versus time curve, increases linearly with the impact velocities. The time \( t_m \) is found to be linearly related to \( 1000/V_0 \). The ML intensity attains an optimum value for a particular activator concentration \( 4 \times 10^{-3} \) gm/gm.
of host (Zn,Cd)S matrix for different activated (Zn,Cd)S mixed phosphors. For given activator concentration ML intensity is maximum for particular CdS content (10% CdS) in the present system of phosphor. (Zn,Cd)S:Mn mixed phosphors (10% CdS) are found to be intense mechanoluminescent phosphors. While the ML intensity of (Zn,Cd)S:Au is very weak compared to (Zn,Cd)S:Mn, (Zn,Cd)S:Ag and (Zn,Cd)S:Cu.

CHAPTER IV

This chapter deals with the mechanoluminescence and photoluminescence spectra of (Zn,Cd)S:Mn, (Zn,Cd)S:Cu, (Zn,Cd)S:Ag and (Zn,Cd)S:Au mixed phosphors. It is found that PL spectra is similar to ML spectra of the phosphors within the limit of experimental error. It is found that ML spectra shift towards lower wavelength side as compared to PL spectra in (Zn,Cd)S:Cu, (Zn,Cd)S:Au and (Zn,Cd)S:Ag phosphors, while in Mn doped (Zn,Cd)S phosphor ML spectra shift towards higher wavelength side as compared to PL spectra. It is found that ML and PL spectra shift towards longer wavelength side with the increasing content of CdS in doped (Zn,Cd)S mixed phosphors.

CHAPTER V

In this chapter the effect of temperature on the mechanoluminescence of doped phosphors of (Zn,Cd)S is described. It is found that the ML disappears beyond a particular temperature. The temperature dependence of ML intensity follows the relation $I = I_0 T^\frac{1}{n}$.
Where $I^0_T$ is a constant, $n$ is the slope of log $I_T$ versus log $(1-T/T_c)$ plot which lies between 0.90 and 1.10. $T_c$ is the temperature at which ML disappears. It is found that the ML intensity in (Zn,Cd)S:Mn, (Zn,Cd)S:Ag, (Zn,Cd)S:Au and (Zn,Cd)S:Cu disappears at $(578, 570, 600, 615)K$ respectively.

CHAPTER VI

In this chapter the phenomenon of electroluminescence (EL) in intense mechanoluminescent (Zn,Cd)S:Mn and (Zn,Cd)S:Ag is described. The EL brightness of the phosphor increases with the frequency and applied electric field. The voltage dependence of EL brightness follows the relation $B = B_0 \exp (- \frac{b}{\sqrt{V}})$, where $B_0$ and $b$ are constants. Above relation suggest the Mott-Schottky barrier in the present system of phosphors and indicates that the mechanism of the EL excitation should be an acceleration collision type. The EL brightness is optimum for a particular activator concentration. It is observed that (Zn,Cd)S:Ag phosphors are intense electroluminescent, and EL intensity decreases with increasing CdS content in doped (Zn,Cd)S mixed phosphors. The EL spectra of doped (Zn,Cd)S mixed phosphor are found to be similar to the ML spectra.

CHAPTER VII

This is the last chapter of the thesis in which an attempt is made to correlate different results obtained in the present investigation from the ML, PL and EL studies of doped (Zn,Cd)S mixed phosphors. For explaining the ML excitation of doped (Zn,Cd)S mixed phosphors, different
models are discussed with regard to their suitability. It is concluded that the piezoelectrification during fracture of phosphors may give rise to ML. The correlation among ML, PL and EL of doped (Zn, Cd)S mixed phosphors are also described. Why the ML intensity is maximum for a particular percentage of CdS in contrast to PL and EL intensity, is discussed.

At the end of the chapter, the various conclusions drawn from the studies on the mechano, Photo and Electroluminescence of doped (Zn, Cd)S mixed phosphors are summarized. It is found that the ML emission is comparable to other well understood luminescence phenomenon. The difference is in the process of excitation of electrons, while relaxation with photon emission involves the same transition centres as in other types of luminescence.