TEMPERATURE DEPENDENCE OF ELECTROLUMINESCENCE OF ZnO : Mn PHOSPHORS

LAXMI KANT SINGH* AND HARI MOHAN

Luminescence Research Laboratories, Physics Department, Allahabad University, Allahabad, India

ABSTRACT

The temperature dependence of the electroluminescence (around 5900 Å) of ZnO : Mn phosphor have been investigated. The brightness-temperature curves for Mn-emission exhibit peak shift with the rise of excitation frequency, but with rise in voltage only over all intensity is increased. The temperature dependence of threshold excitation frequency obeys the relationship $\log \nu\ (\mathrm{Hz}) = c_1 - c_2/T$.

INTRODUCTION

THE temperature dependence of electroluminescent brightness is an important characteristic of Destriau effect and is of much help for understanding the nature of trap levels which exert remarkable influence on the emission characteristics of electroluminophors. Destriau[1] studied the behaviour of ZnO, ZnS type phosphors and observed that the threshold voltage of excitation falls as the temperature is lowered. Later works due to Gobrecht[2], Roberts[3], Halsted[4], Neumark[5], Mattler[6], Thornton[7] and Haake[8] in this direction are also remarkable. Osiko[9] has observed that the emission characteristics are mainly concentrated in yellow-orange region.

EXPERIMENTAL

The zinc oxide is activated with trace quantities (10^{-4} g/g) of Mn and fired in nitrogen atmosphere around 1000° C. The phosphor thus obtained shows yellow-orange electroluminescence. For temperature studies, permanent type of electroluminescent cells were formed by dispersing the electroluminophor in Araldite between two conductive but transparent plane parallel mica sheets. The cell so formed was excited at different voltages and frequencies with the help of an audio oscillator *cum* wide band amplifier unit and the light output was recorded with photomultiplier and ultrasensitive microammeter assembly.

Such a cell was mounted over a copper sheet fitted at the end of a copper rod, about 10″ in length and 1″ in diameter. The desired temperature was achieved by cooling the rod with the liquid air or by heating it with the help of a cylindrical replaceable heater. The temperature was measured with a copper constantan thermocouple.

RESULTS AND DISCUSSION

As usual with the electromuminophors of the ZnS-family, the Mn activation in ZnO also gives the emission in yellow-orange region. The emission peak is observed around 5900 Å. We further notice that as the temperature rises, the intensity of yellow-orange emission of Mn increases fast with very little shift in peak position. As the temperature is further increased there is a fall in the intensity due to quenching effect.

FREQUENCY DEPENDENCE

The brightness *versus* temperature curves exhibit that as the excitation frequency is increased, the emission peak shifts to high temperature (Fig. 1).

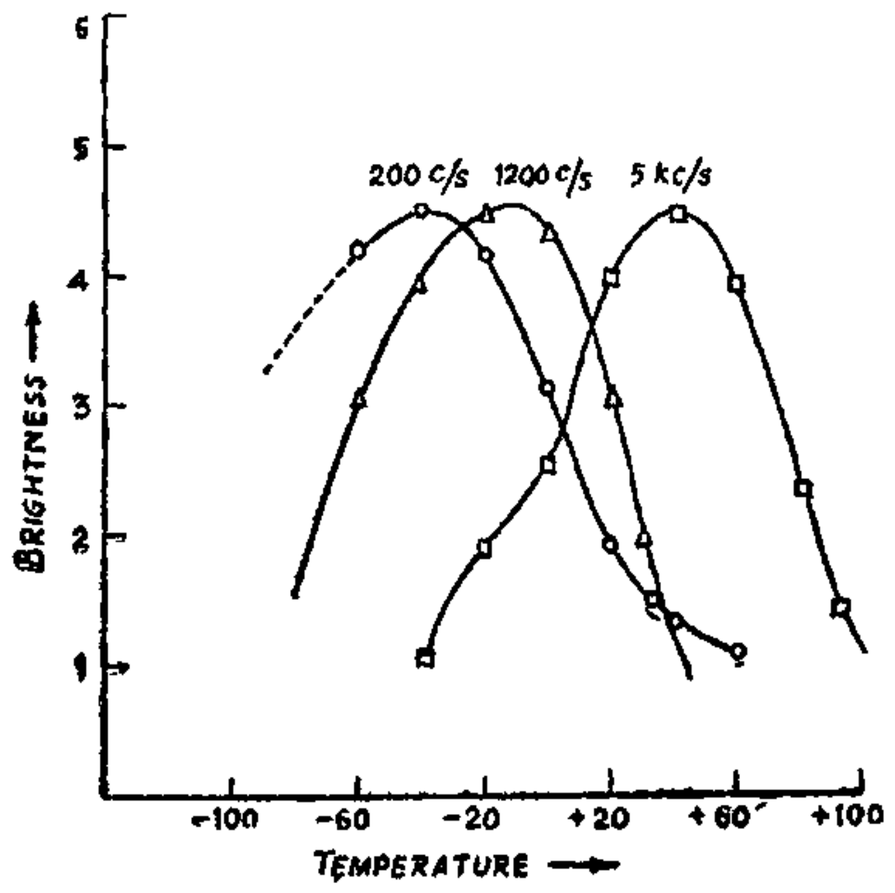

FIG. 1. Brightness *vs.* Temperature curves for the electro-luminophor/ZnO : Mn/excited by different exciting frequencies at fixed voltage near 600 V.

This is due to the fact that with increased frequency the available time for the exhaustion of the trapped electrons is decreased, requiring higher thermal energy to make the traps empty[8]. This shift is about 80° C when the excitation frequency changes from 200 c/s to 5 kc/s. These observations are found in accordance with the well-known facts[10-11]. No secondary peaks on temperature scale are observed probably due to absence of deeper traps.

The temperature effect at different voltages of excitations were tried. Plots of $\log \nu$ (Hz) *vs.*

---

* Present address : Dr. Laxmi Kant Singh, Lecturer in Physics, Kamla Nehru Institute of Science and Technology, Sultanpur (U.P.), India.

1/T (Fig. 2) gave straight lines obeying the relationship[12] $\log \nu\ (\mathrm{Hz}) = c_1 - c_2/T$. The slope of these straight lines decreased with the rise of

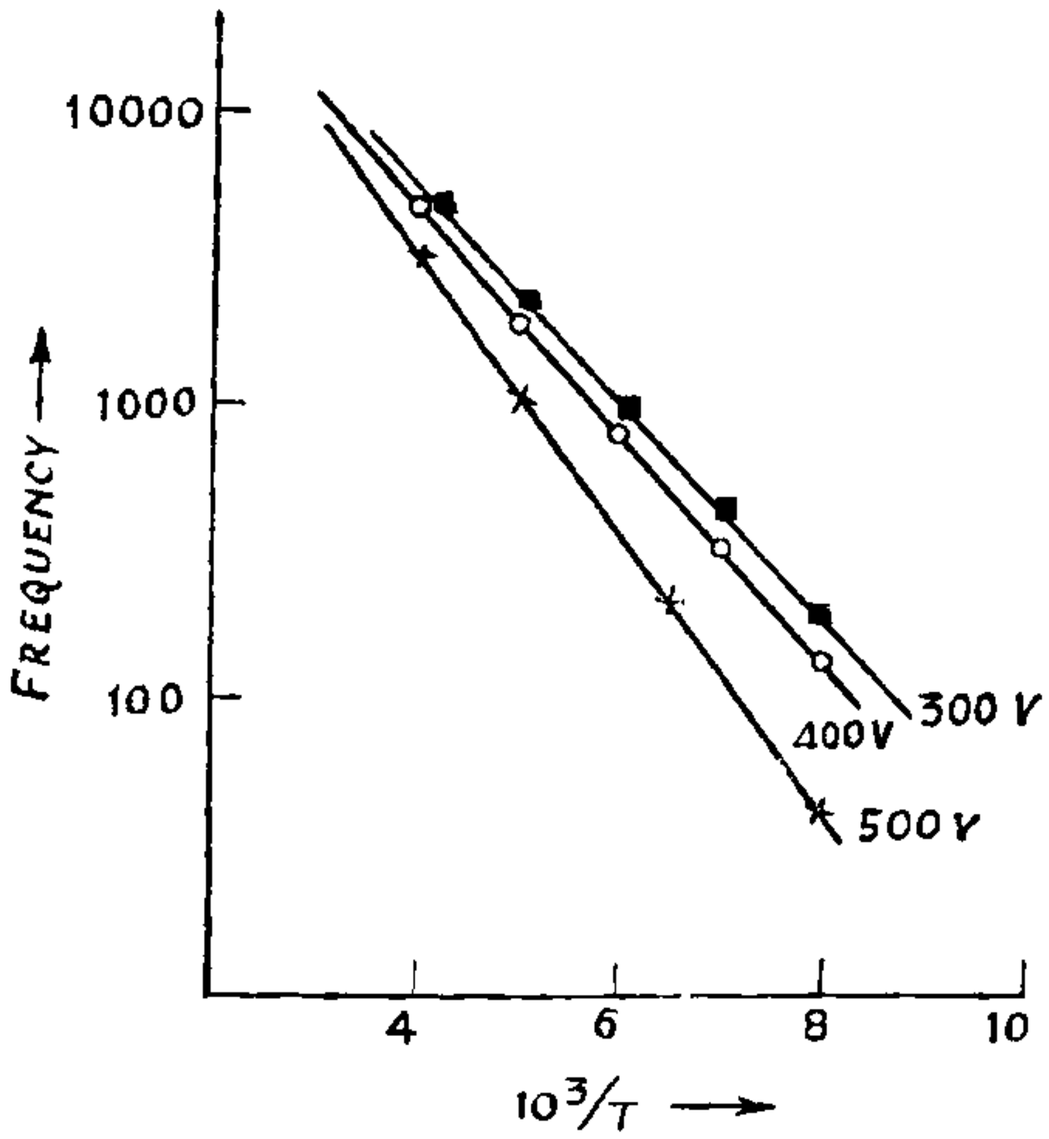

FIG. 2. Dependence of threshold frequencies of excitation with the temperature for/ZnO : Mn/.

exctation voltages, which means, higher threshold frequencies are required at the lower voltages for excitation.

Voltage Dependence.—Increase in voltage enhances the brightness (Fig. 3) at different temperatures but no peak shift is observed. This peak is found around 20° C when the excitation field frequency is kept at 1·5 kc/s. At 600 volts, the brightness is enhanced considerably at low temperatures. This type of behaviour at low temperature may be correlated with the decrease in trap depth.

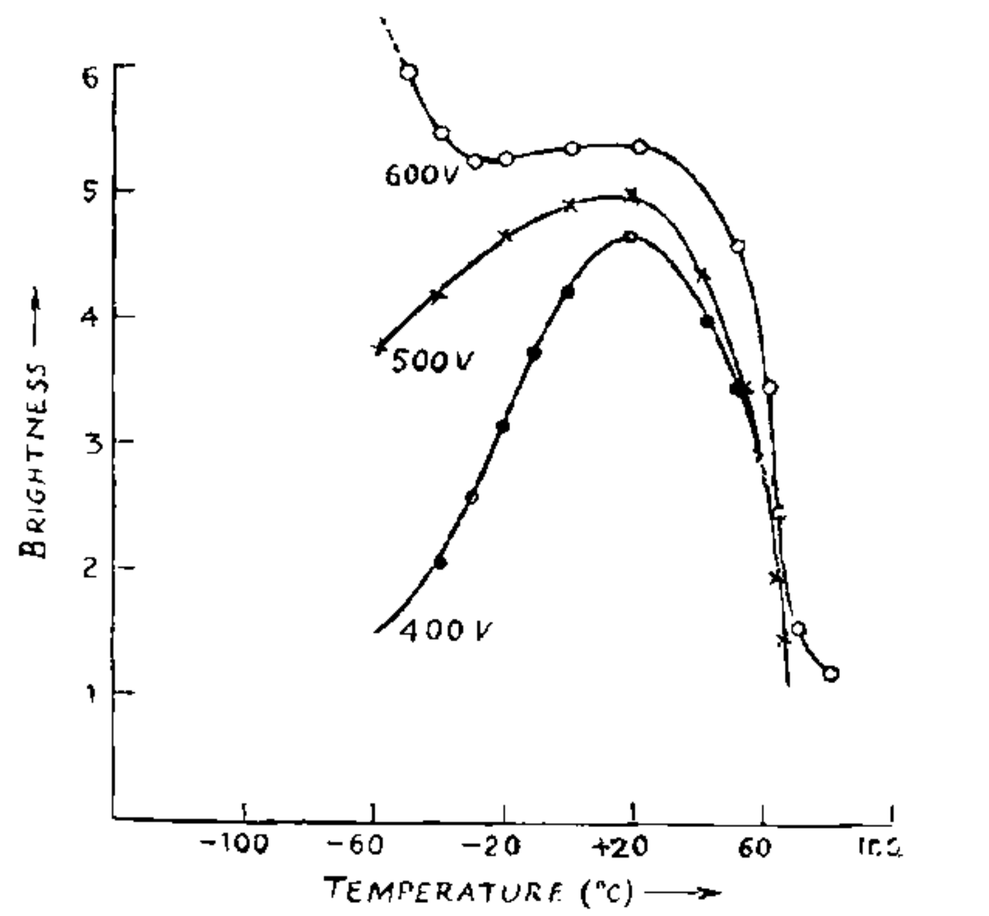

FIG. 3. Brightness *vs* Temperature curves for the electroluminophor/ZnO : Mn/ excited by different a.c. voltages with fixed frequencies (1500 c/s) of field.

1. Destriau, G., *Phil. Mag.*, 1947, **38**, 700.
2. Gobrecht. H. *et al., Z. Physik*, 1954, **136**, 623.
3. Roberts, S., *J. Opt. Soc. Am.*, 1952, **42**, 850.
4. Halsted. R. E., *Phys. Rev.*, 1954, **93**, 349.
5. Neumark, G. F., *Ibid.*, 1956, **103**, 41.
6. Mattler, J., *J. Physique Rad.*, 1956, **17**, 42.
7. Thornton, W. A., *Phys. Rev.*, 1955, **102**, 38.
8. Haake, C. H., *J. Opt. Soc. Am.*, 1957, **47**, 881.
9. Osiko, V. V., *Opt. and Spect.*, 1959, **7**, 459.
10. Nuvarejeva, V. V. *et al., Ibid.*, 1964, **17**, 42.
11. Georgobiani, A. N. *et al., Ibid.*, 1963, **15** (1), 48.
12. *Proc. (Trudy) of the P. N. Lebdev, Phys. Inst.*, Vol. 50, Edited by D. V. Skobeltsyn.

2-HYDROXY-3,5-DICHLOROACETOPHENONE OXIME AS AN ANALYTICAL REAGENT : GRAVIMETRIC DETERMINATION OF COPPER, NICKEL AND COBALT

KEEMTI LAL AND S. P. GUPTA

Chemical Laboratories, D.N. College, Meerut-2

ABSTRACT

2-Hydroxy-3,5-Dichloroacetophenone Oxime (HDCAO) has been found to be a good reagent for gravimetric estimation of copper, nickel and cobalt and for their separation from other ions. The composition of the complexes is 1 : 2 as determined by modified continuous variation method.

OXIMES have been used as analytical reagents for the gravimetric as well as spectrophotometric determination of a number of metal ions[1-3]. In an earlier communication[4], conductometric, potentiometric, micro-analysis and I.R. spectral studies were reported for these metal complexes. The reagent has now been successfully employed for the gravimetric determination of copper, nickel and cobalt and their separation from a number of other ions.