Effect of Tl Concentration on the Thermoluminescence of Deformed NaCl : Tl Phosphors

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It is known that thermal and/or mechanical pretreatment influences the luminescent behaviour of phosphors. It has been reported that mechanically pretreated NaCl : Tl specimens, exposed to ultraviolet radiation, exhibit a pronounced glow peak at 420 K. The present work concerns the study of the intensity of this peak as a function of impurity concentration. There is a remarkable growth in the intensity of the 420 K glow peak with decreasing concentration. This can be explained on the basis of the interaction between impurity ions and moving dislocations.

It has been reported earlier [1–3] that the thermoluminescence of a phosphor depends in a significant way on it's pretreatment. It was found that the glow peaks at 340 and 390 K of ultraviolet irradiated NaCl : Tl phosphors markedly increase in intensity if the phosphors were subjected to thermal treatment. The present investigation was undertaken with the aim of studying the behaviour of the 420 K glow peak in deformed NaCl : Tl phosphors as a function of activator concentration.

The experimental arrangement and procedure used to record the glow curves was essentially the same as described previously [2]. The work has been carried out with polycrystalline specimens with varying Tl concentrations. The specimens were prepared by crystallization from aqueous solutions of sodium chloride to which various amounts of thallium chloride were added. The specimens were pressed to tablets in a stainless steel press with pressures of the order 1000 kg M^{-2}. Other specimens were pressed to tablets after they had been subjected to thermal treatment (quenching from 750 °C in air). The thermoluminescence measurements were made under identical experimental condition for all specimens. The rate of heating used was 10 K/min.

Curves A and B in Fig. 1 represent the intensity of the 420 K glow peaks displayed by the NaCl : Tl phosphors. It is seen that the intensity of the 420 K peak drops sharply as the Tl concentration is increased beyond 10^{-5} m.f. In this respect the behaviour of the 420 K glow peak is just opposite to that of the 340 K peak whose intensity increases with increasing Tl concentration.

According to the current understanding the dislocation debris, created in the form of vacancy clusters and dislocation dipoles by dislocation motion during the deformation process is a major factor in influencing the optical properties of deformed ionic crystals [5, 6]. Since deformation induces a growth of the 420 K peak, it has been suggested earlier [3] that the centre responsible for the 420 K peak may involve combination of Tl^+ ions and vacancies situated in the vicinity of dislocations. In view of the large size of the Tl^+ ion, occupying a Na^+ ion position in the lattice, there will be strong elastic interactions between Tl^+ ions and moving dislocations during the deformation process. It is therefore to be expected that in a specimen with sufficiently high concentration of Tl, the dislocation motion and multiplication will become nearly impossible. This in turn will suppress the production of vacancy clusters and dislocation dipoles. Such a situation will not favour the formation of 420 K centres. On the other hand, decrease in the Tl con-

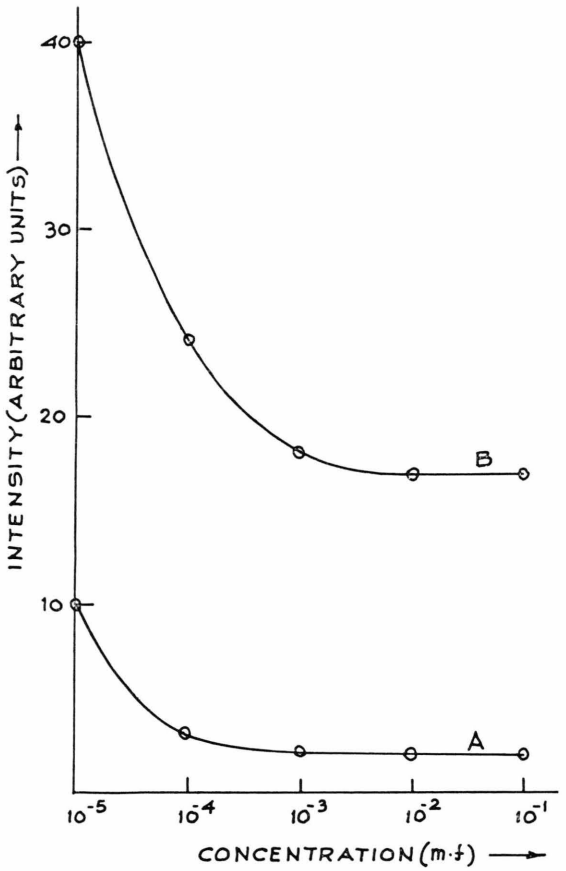

Fig. 1. Variation with impurity content of the intensity of the 420 K glow peak of NaCl : Tl phosphors after U.V. irradiation for four minutes. Curve A: As obtained from solution and pressed. Curve B: Annealed and quenched from 750 °C in open air and then pressed.

centration permits motion of the dislocations and multiplication which is conductive to the generation of the centres responsible for the 420 K glow peak. This explains the rapid fall in the intensity of the 420 K peak as the Tl concentration is increased.

[1] A. Halperin and M. Schlesinger, Phys. Rev. **113,** No. 3, 762 [1959].
[2] R. V. Joshi and T. R. Joshi, Japan J. Appl. Phys. **10,** 1291 [1971].
[3] R. V. Joshi and T. R. Joshi, Z. Naturforsch. **27 a,** Heft 12 [1972].
[4] R. V. Joshi and T. R. Joshi, Z. Phys. Chemie N.F. **83,** 325 [1973].
[5] R. Chang, Phys. Rev. **138,** A 839 [1965].
[6] F. Fröhlich and P. Grau, Phys. Stat. Sol. **8,** 917 [1965].