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Thermoluminescence Intensity as a Function of Radiation Dose

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Thermoluminescence Intensity as a Function of Radiation Dose

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Abstract—The thermoluminescence of organic crystalline materials is found in several instances to show an initially-linear increase with radiation dose; after a certain irradiation time no further increase in intensity is observed and the form of the glow is independent of dose.

In the course of examining the X-ray stimulated thermoluminescence of a number of organic crystalline materials, the emission intensities of a number of glow peaks were studied as a function of radiation dose. It was found that in several compounds the intensities of glow peaks were in linear proportion to the radiation dose given to the crystals, until a "saturation" dose was reached. Larger radiation doses than this did not produce any further increases in emission intensity.

This variation of the thermoluminescence intensity as a function of the radiation dose has not been studied in detail although it is often mentioned in the literature. Townsend[1] observed that the total light emission of individual glow peaks rose almost linearly with increasing radiation dose, while Brocklehurst, Russel and Savadatti,[2] Bettinali and Ferraresso,[3] Ehrlich[4] and Bousted[5,6] have reported saturation. Charlesby and Partridge[7] and Bousted[5,6] have found glow peaks whose intensity rose with increasing radiation dose until a maximum luminosity was reached, after which the brightness of the glow peak diminished with longer irradiation. Such increase, followed by saturation of point defects caused by radiation damage as a function of dose has been reported by Agler, Anderson and Webb[8] in electron spin resonance studies and by Rabin and Klick[9] in observations of F band absorption.

In the experiments described below the samples were irradiated at liquid air temperature on the copper tip of a cold finger in an evacuated chamber. A molybdenum target X-ray tube run at 35 kV gave the samples doses of approximately 120 krad per hour for

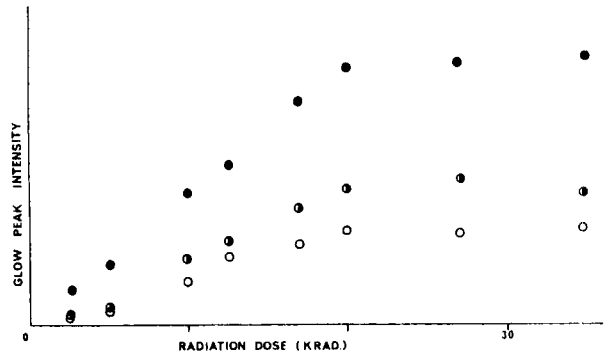

Figure 1. The variation in thermoluminescence intensity as a function of radiation dose found for three glow peaks in urea.

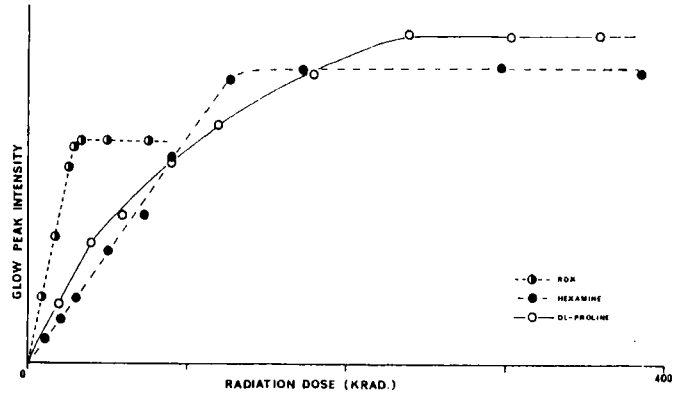

Figure 2. The variation in the thermoluminescence intensity of RDX, hexamine and DL-proline as a function of radiation dose.

varying exposure times. As the samples were warmed at 20 °K per minute to room temperature the thermoluminescence was observed using a liquid air cooled 1P28 photomultiplier. The shorter radiation times for each sample were interspersed among longer ones and one

reading was repeated frequently throughout the experiment to ensure that there were no spurious effects introduced because of the increase in the total cumulative dose received by the sample, and to verify that the sensitivity of the apparatus did not change during the experiment. The total number of recombination events giving rise to a specific glow peak is proportional to both the maximum brightness of the peak and the area under the experimental curve of emission intensity versus temperature.

The intensity versus irradiation time plots of hexamine (hexamethylenetetramine), urea (pre-irradiated with a large dose of x-rays eliminate the phenomenon described by Butterfield and Ericson[10]), and RDX (cyclotrimethylene trinitramine) were found to exhibit an initial linear rise in intensity until a certain fixed dose had been received, after which the thermoluminescence emission remained constant (figs. 1 and 2). DL-proline (fig. 2) and anthracene (both "Analytical Reagent" grade and tetracene-free samples) also exhibited saturation, but in these cases the initial rise was nonlinear. In all instances the shapes and relative intensities of the glow peaks appeared to be unchanged with increasing radiation dose, and only the overall brightnesses varied.

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