Supralinearity of UV Repopulated

TL From TLD-100

MASTER

by

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Supralinearity is one of the more puzzling and interesting features of the TL from LiF, and many models have been proposed to explain it (1, 2, 3). UV repopulation provides a method for selectively producing free electrons in previously irradiated material, hopefully in the absence of defect producing excitations (4). UV is a low LET excitation, producing at most one free electron for each photon absorbed. From the work of Suntharalingam (3), one would expect to see supralinearity in UV repopulated TL (REPTL) as large or larger than that seen with ^{137}Cs gamma rays (5).

A 30 mg sample of TLD-100 was prepared from powder irradiated with ^{137}Cs gamma rays for each of the following exposures: 100R, 300R, 10^3R , $3 \times 10^3\text{R}$, 10^4R , $3 \times 10^4\text{R}$, and 10^5R . Heating the samples to 300°C for 5 minutes removed the TL from glow peaks 1 through 6 (see Figure 1). Higher temperature TL peaks remained filled. The low temperature tails of these peaks lie under peaks 1 - 5 and limit the minimum measurable repopulation to the equivalent of 50mR of ^{137}Cs gamma rays. In fact, if much of peak 6 remains, repopulation of 1 - 5 will occur slowly in the dark. After

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the 300°C annealing the samples were exposed to 300mR of ^{137}Cs gamma rays. Figure 2 shows the TL produced by this exposure as measured by the height of peak 5. Supralinearity of a factor of 6 is seen.

A Hanovia 901-C Hg-Xe lamp and a Bausch and Lomb monochromator (grating 33-36-01) provided UV light having a bandwidth of about 3nm. The intensity of the UV was measured with a calibrated Epply thermopile. The wavelengths chosen were 232nm and 245 nm which are the peak absorptions of the $\text{K}^{4,6}$ and F absorption bands respectively. To keep the REPTL light output at approximately the same levels, different samples were exposed to different amounts of UV, as per the following schedule: 100R, 300R and 10^3R samples exposed to 2.5 mwatt-sec cm^{-2} , $3 \times 10^3\text{R}$ and 10^4R exposed to 0.84 mwatt-sec cm^{-2} , and the $3 \times 10^4\text{R}$ and 10^5R samples exposed to 0.34 mwatt-sec cm^{-2} . Since the repopulation of any sample is directly proportional to UV exposure up to at least 50 mwatt-sec cm^{-2} , the resulting TL signals could be easily normalized to an exposure of 2.5 mwatt-sec cm^{-2} . Figure 3 shows the normalized REPTL as measured by the height of peak 5. Each point is an average of three exposures.

The vertical displacement of the curves in Figure 3 for the different wavelengths reflects the wavelength dependence of the REPTL seen before (4). Since the optical absorption increases directly with gamma exposure, one would expect a straight line relationship between REPTL and gamma exposure due simply to increased UV absorption. The

use of powder samples complicates this absorption due to scattering and overlapping crystallites, but Figure 3 shows a region of supralinear behavior between $10^3 R$ and $3 \times 10^4 R$ just where the supralinearity for gamma induced TL occurs. The maximum increase in REPTL efficiency is about a factor of 7 at about $3 \times 10^4 R$, in good agreement with the model of Suntharalingam's (3).

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Figure 1

Typical glow curve from TLD-100.

Figure 2

TL from 300mR gamma rays as a function of initial exposure.

Figure 3

REPTL from an exposure of $2.5 \text{ mwatt-sec cm}^{-2}$ at wavelengths of 232nm and 245nm as a function of the initial gamma exposure.