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UV Repopulation of TL Traps in LiF

by

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The nature of the TL process in LiF is still not well understood. Questions still exist concerning the identification of TL traps with hole or electron color centers.[1,2,3,4] The inability to color LiF additively[5] has prevented unambiguous identification of many absorption bands as being due to either electron or hole centers.

Using the F center as a source of electrons for filling TL traps provides a tool for clearing up some of these ambiguities.[6,7,8,9,10] The technique is as follows: A sample is irradiated with X-rays to produce the usual mixture of hole and electron centers. The sample is then heated to record the usual TL glow curve. After cooling the sample back down to a temperature below that of the glow of interest, the F band is then bleached optically. Some of the electrons released by this bleaching will be trapped by those emptied TL traps which are electron traps. When the sample is again heated, only those TL glow peaks which are caused by the thermal emptying of electron traps should appear. Since this effect has a low efficiency, the initial X-ray exposure must provide a reasonably large concentration of F centers. We could see an effect for concentrations as low as 10^{16} F centers per cm^3.

DISCLAIMER

This technique was applied to the TL peaks in LiF TLD-100 which are used for dosimetry. Some preliminary results are shown in Figure 1. The initial X-ray exposure was about 10^5 R. Exposing the F band to about 2×10^{15} photons per cm^2 is seen to be equivalent to a 1 R X-ray exposure. We conclude that these TL traps are electron traps.

We have reported the observance of simultaneous electrical "glow" and TL glow peaks in crystals of a pure LiF.[11] In this material, which we call H64UV, TL glow peaks at about 80°C and about 120°C are accompanied by peaks in the electrical conductivity of the crystal. Bleaching in the F band of a crystal of this LiF, which was initially exposed to 3 MegR and annealed at 150°C for five minutes, reproduces both the TL and electrical glow peaks. Figure 2 shows the TL glow peaks for X-ray exposure and F band bleaching. Figures 3, 4 and 5 show the electrical glow curves for similar conditions. The traps responsible for these effects would seem to be electron traps.

References

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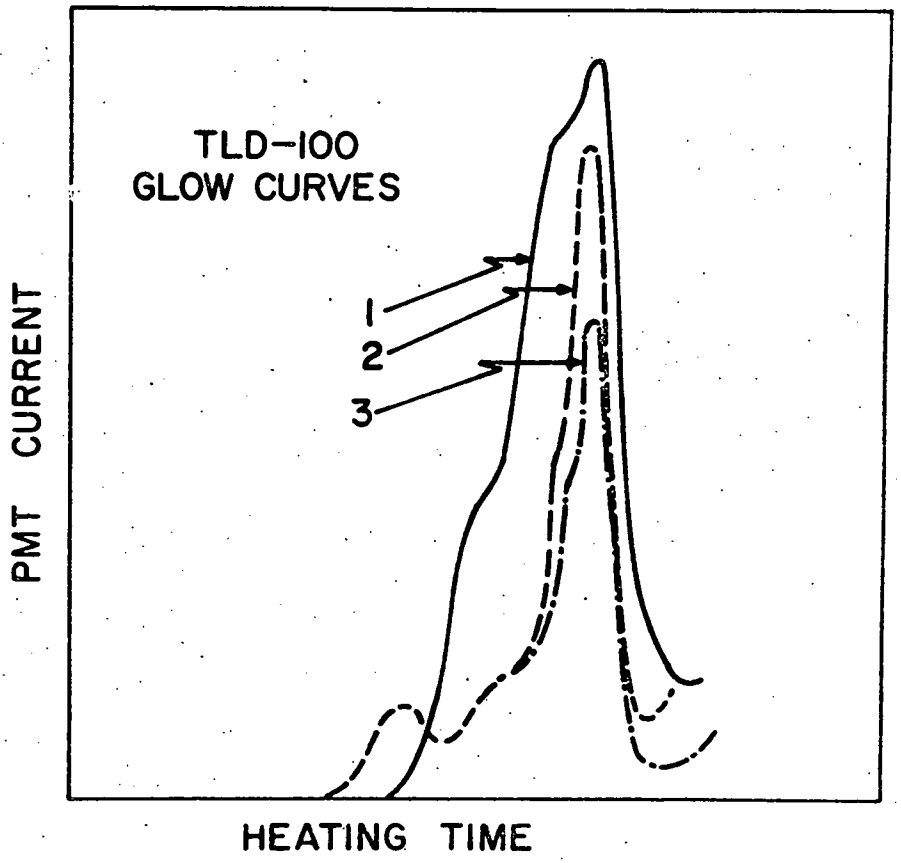

Figure 1 TLD-100 Glow Curves
Curve 1 shows the response to 10^5 R of X-rays. Curve 2 shows the effect of exposure to approximately 2×10^{15} photons per cm^2 of F band light. This curve is expanded a factor of 10^4 relative to curve 1. Curve 3 shows the response of this crystal to an exposure of 100 R of X-rays expanded a factor of 100 relative to curve 1.

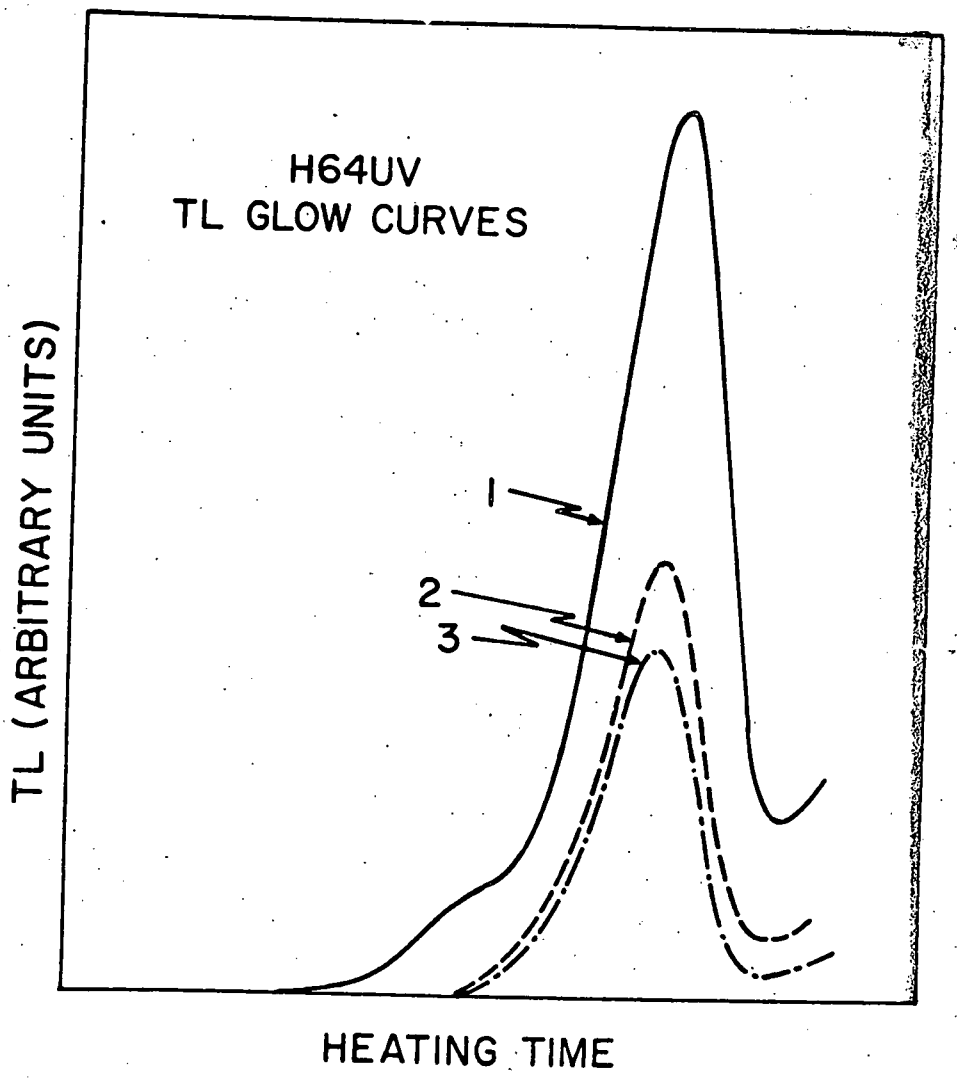

Figure 2 H64UV TL Glow Curves

This crystal had been exposed to 3 MegR of γ-rays and annealed five minutes at 150°C. Curve 1 shows the TL response to a 25 kR X-ray exposure. Curves 2 and 3 show the effect of successive exposures to 2×10^{17} F band photons per cm^2. These curves are all on the same scale.

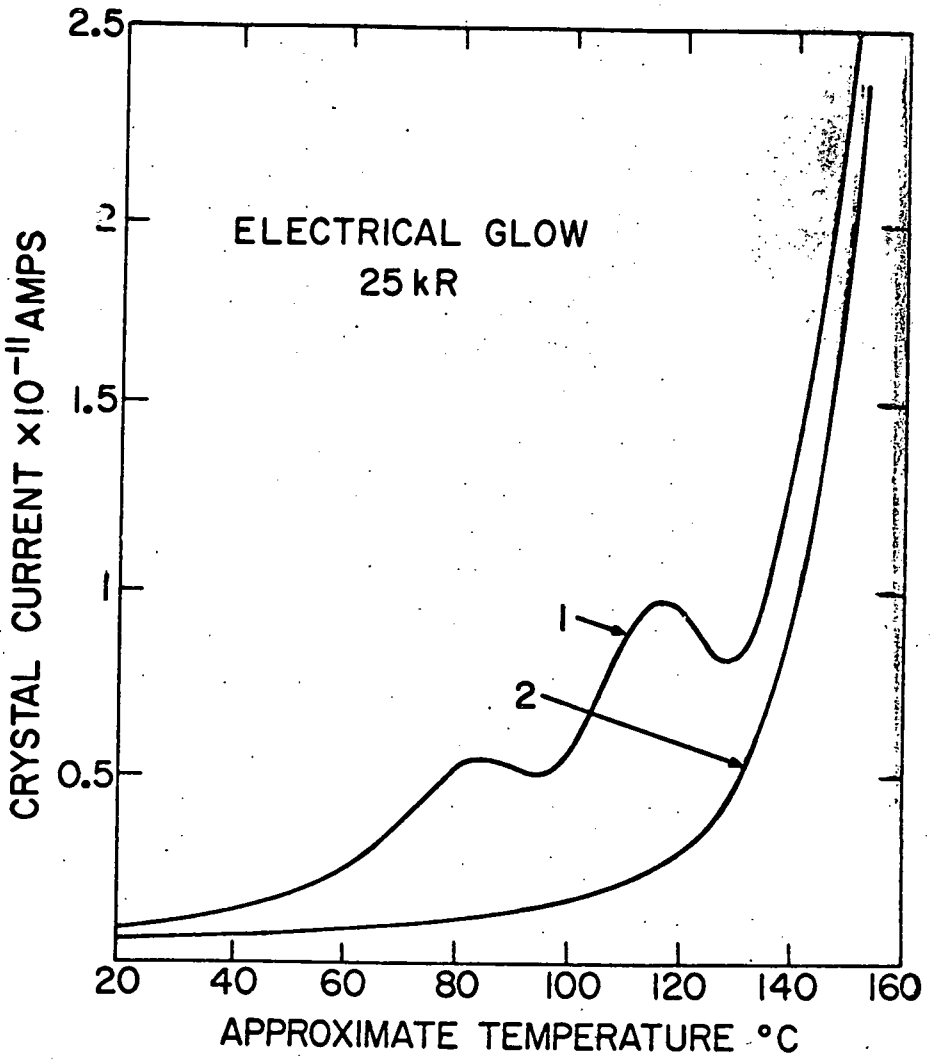

Figure 3 H64UV Electrical Glow Curve
This crystal had been exposed to 3 MegR of γ-rays and annealed five minutes at 150°C. Curve 1 shows the electrical conductivity after an exposure to 25 kR of X-rays. Curve 2 is the background ionic conductivity measured by cooling the crystal down and reheating it without moving it. The crystal is 8 x 9 x 0.8 mm.

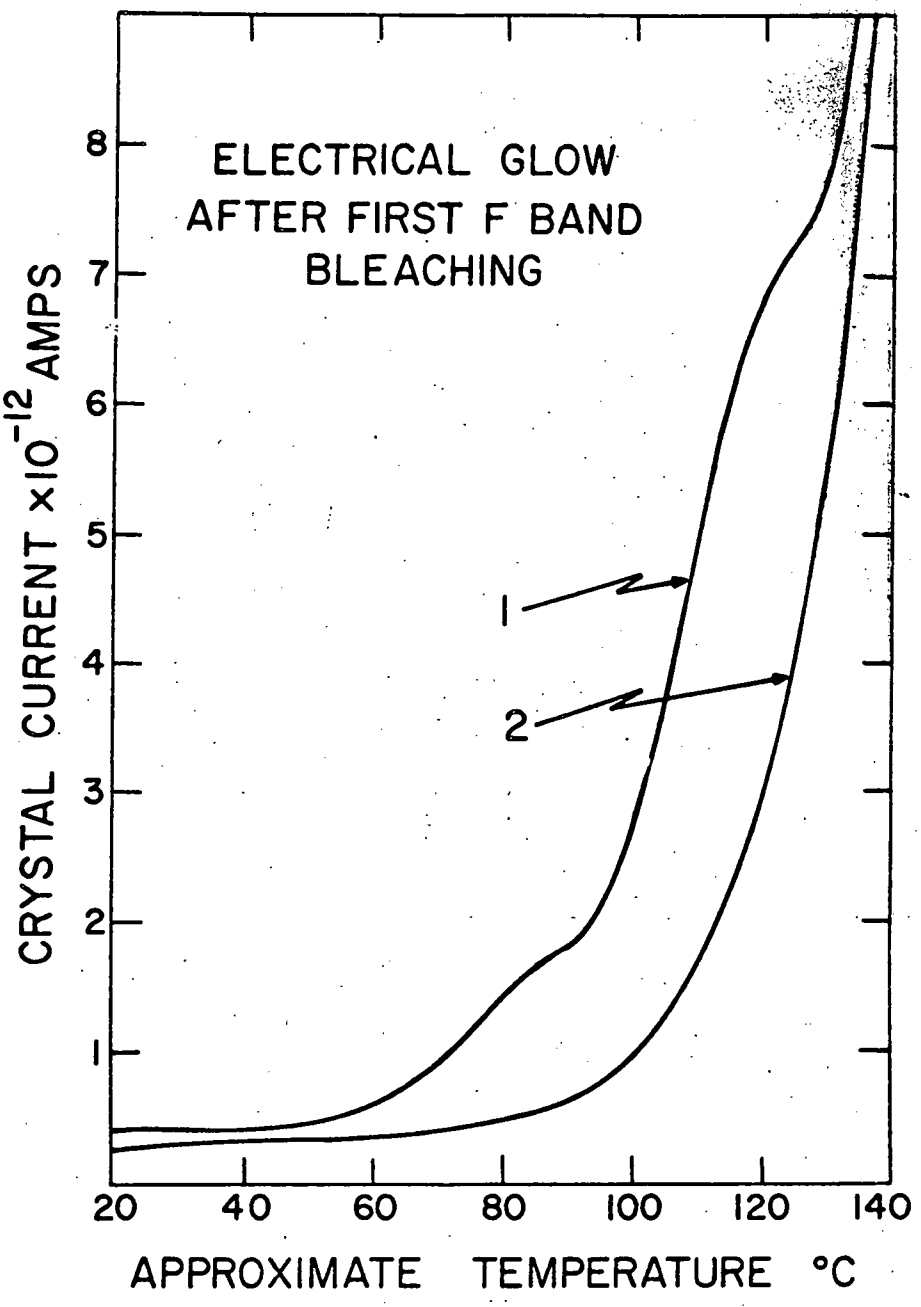

Figure 4 H64UV Electrical Glow Curve
Curve 1 shows the electrical conductivity of the same crystal after exposure to 2 x 10^{17} F band photons per cm^2. Curve 2 is the ionic background.

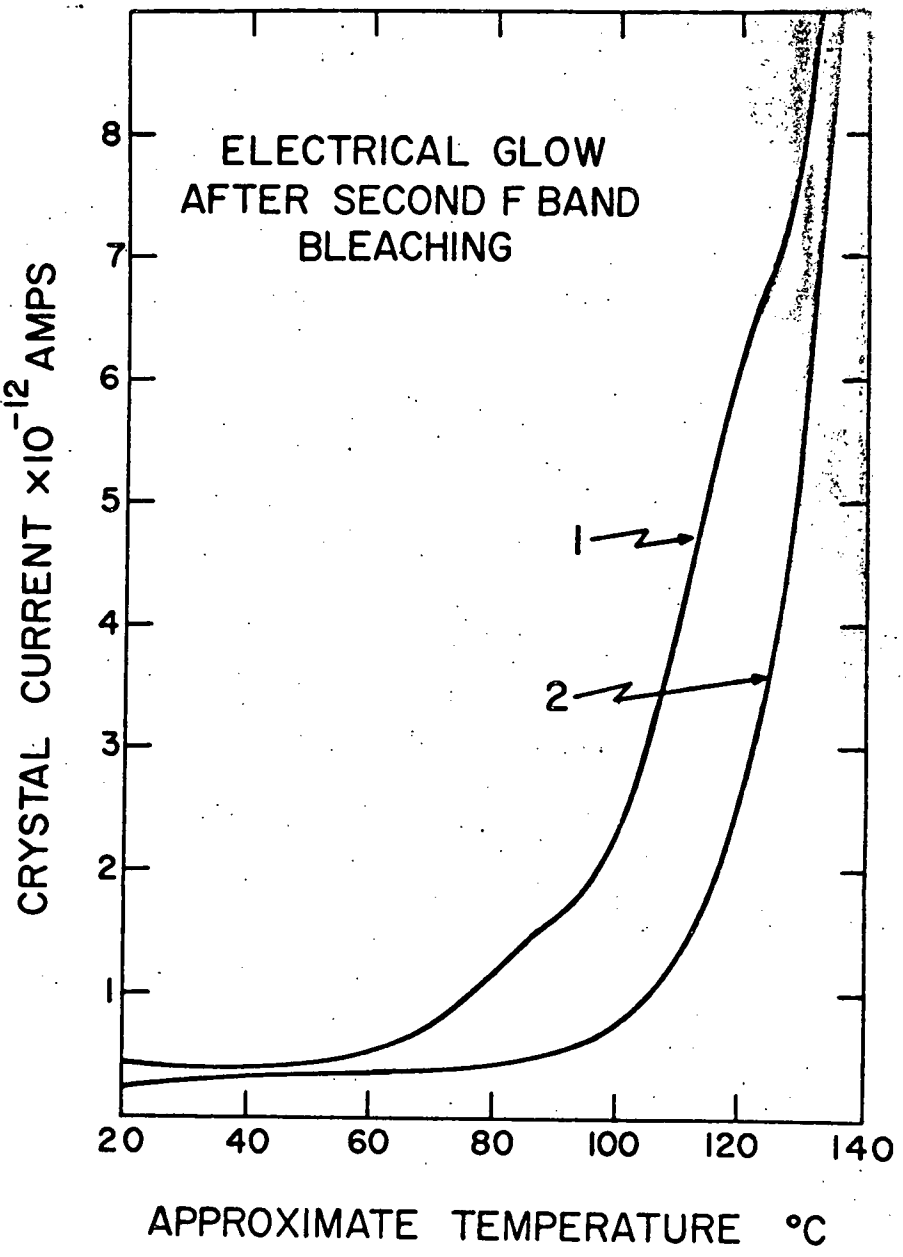

Figure 5 H64UV Electrical Glow Curve
Curve 1 shows the electrical conductivity of the same crystal after a second exposure to 2 x 10^{17} F band photons per cm^2. Curve 2 is the ionic background for this reading.