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Studies on thermoluminescence of La^{3+} doped microcrystalline Al_2O_3

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Introduction: Thermoluminescence (TL) is the thermally stimulated emission of light following the previous absorption of energy from radiation. TL is a convenient technique to understand the charge trapping and detrapping mechanisms that result from the interaction of radiation with the existing defects in material and that may interfere in scintillator response [1].The dosimetric properties of aluminium oxide (Al_2O_3) were first described by Rieke and Daniels [2] with further investigation of its TLD behaviour by McDougall and Rudin [3]. The material used by McDougall and Rudin was nominally pure Al_2O_3, but it probably contained a few ppm of Cr^{3+}. Buckman [4] points out that the emission from Cr^{3+}-free Al_2O_3 is predominantly at ~ 410 nm which is much more desirable wavelength for TLD. Mehta and Sengupta [5-7] describe the preparation of an Al_2O_3 phosphor for TLD which emits at 420 nm. The glow in this material is believed by these authors to be related to the presence of Si and Ti. Osvay and Biro [8] discussed a Mg- and Y-doped Al_2O_3 phosphor, but no emission wavelengths are quoted. The material studied by Mehta & Sengupta is described as being a sensitive γ-detector, but is insensitive to α-particles. The same authors showed that the sensitivity to thermal neutrons may be increased by mixing the material with Dy_2O_3 or by covering it with cadmium foil [9]. In the present paper, thermoluminescence of γ-irradiated lanthanum doped microcrystalline aluminum oxide synthesized by combustion technique are presented

Experimental: Microcrystalline aluminum oxide was synthesized by combustion technique. The detailed procedure for synthesis was discussed elsewhere [10]. For gamma irradiation, ^{60}Co gamma chamber-900 (supplied by Board of Radiation and Isotope Technology, Mumbai) with a dose rate of ~2.5 kGy per hour installed at ISRO, ISAC, Bangalore was used. TL measurements were made using PC based TL analyzer.

Results and discussions:

Thermoluminescence glow curves of Lanthanum doped microcrystalline aluminum oxide irradiated with 2.5 kGy gamma rays are studied. It is found that the TL intensity decreases with increase in La concentration. The TL emission of 1 mol % La doped samples (closed samples) shows maximum intensity. However, the intensity of 1 and 2 mol % doped samples is up to certain value only. La doped Al_2O_3 showed good TL response and further studies on La doped microcrystalline samples are done at lower doses only. Figure 1 shows the TL glow curves of 1 mol % lanthanum doped micro-crystalline aluminum oxide γ-irradiated for doses in the range 0.041 – 0.415 kGy. Above 0.415 kGy the intensity is maximum so that it was not detected by the PMT.

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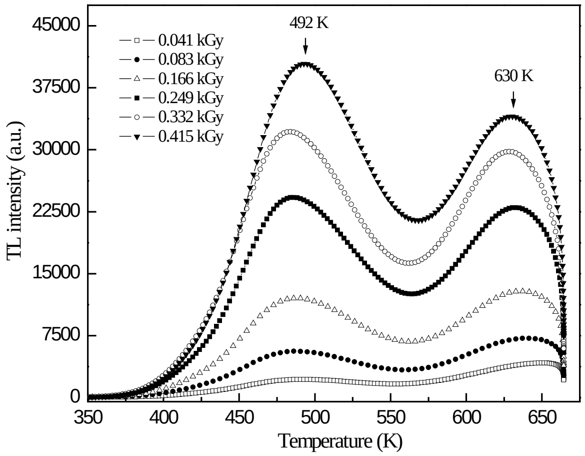

Figure1. TL glow cures of γ-irradiated micro -crystalline Al_2O_3: La^{3+} (1 mol%).

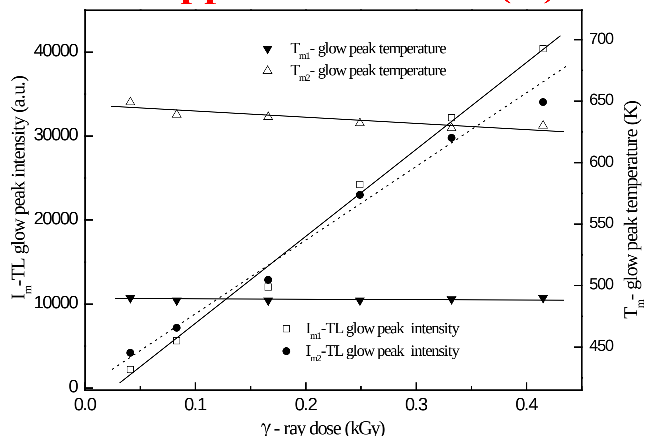

Figure 2. Variation of TL glow peak intensity and glow peak temperature v/s temperature in γ-irradiated Al_2O_3: La^{3+} (1 mol%).

Two TL glows a prominent one with peak at 492 K and another glow with at 630 K are observed. The TL intensity of doped samples is found to be enhanced by ≈10 times more than undoped samples.

The variation of TL glow peak intensity (I_m) and TL glow peak temperature (T_m) with γ-ray dose in Al_2O_3:La (1 mol %) is shown in Figure 2. It is found the TL glow peak intensity (I_{m1} and I_{m2}) in alumina increases linearly with increase in dose. The glow peak temperatures (T_{m1} and T_{m2}) are observed to be steady for the entire range of γ-ray dose. That is no peak shift was observed. Further, the T_{m1} is showing maximum intensity when compare to T_{m2}. Further, detailed investigations using other techniques such as thermostimulated conductivity, thermoluminescence emission, electron spin resonance, photoacoustic studies/optical absorption etc is required in order to understand the TL mechanism leading to generation and trapping of defect centers due to ionizing radiation and light emission in aluminum oxide during thermal stimulation.

Conclusions: The TL intensity of La^{3+} doped samples is enhanced when compare to undoped samples. TL intensity decreases with increase in La concentration. Two TL glows a prominent one with peak at 492 K and another glow with at 630 K are observed. It is found that, TL glow peak intensity (I_{m1} and I_{m2}) increases with increase in γ-dose.

References:

1. R.S. daSilva, Z.S. Macedo, A.L. Martenez, et. al., Nucl. Instr. and Meth. **B 250** (2006) 390.
2. J.R. Rieke and F. Daniels, J. Phys. Chem. **61** (1957) 629.
3. R.S. McDougall and S. Rudin, Health Phys. **19** (1970) 281.
4. W.G. Buckman, Health Phys. **22** (1972) 402.
5. S.K. Mehta, and S. Sengupta, Health Phys. **31** (1976) 176.
6. S.K. Mehta, and S. Sengupta, Phys. Med. Biol. **21** (1976) 955.
7. S.K. Mehta, and S. Sengupta, Phys. Med. Biol. **22** (1977) 863.
8. M. Osvay and T. Biro, Nucl. Instr. and Meth. **175** (1980) 60.
9. S.K. Mehta, and S. Sengupta, Nucl. Instr. and Meth. **157** (1981) 515.
10. K.R. Nagabhushana, Ph.D Thesis (2008),Bangalore Unviversity, Bangalore, India