

Effect of the UV lighting for photo-transfer of the charges of radiation dosimeters: TL and PTTL responses

P. L. Antonio, A. M. B. Silva, I. S. Silveira, L. V. E. Caldas

Instituto de Pesquisas Energéticas e Nucleares, Comissão Nacional de Energia Nuclear, IPEN/CNEN-SP
Av. Prof. Lineu Prestes, 2242, 05508-000, São Paulo-SP, Brazil
patrilan@ipen.br

Some solid-state materials store energy in the form of trapped electronic charges, when they are exposed to ionizing radiation. This energy can be measured when the stimulation of those charges occurs and one way is the heating of the sample, in order to observe its luminescent signal by the thermoluminescence (TL) technique. Another way to study the luminescence of these materials is by means of the phototransferred thermoluminescence (PTTL) technique, that allows the observation of the light-induced transfer of charges from one kind of trap to another [1-2]. The main objective of this work was to study the TL and PTTL of radiation dosimeters in ^{60}Co and UV beams, in order to apply these dosimeters using an established photo-transfer procedure in high-dose dosimetry.

The luminescent responses of commercial LiF:Mg,Ti , $\text{CaF}_2\text{:Dy}$, $\text{CaF}_2\text{:Mn}$ and $\text{CaSO}_4\text{:Dy}$ dosimeters were studied according to this sequence: 1) TL after irradiation; 2) TL after irradiation and post-irradiation thermal treatment (PITT); and 3) PTTL after irradiation, PITT and illumination. The irradiations were performed using a ^{60}Co source, and all the measurements were taken using the Risø reader system, model TL/OSL-DA-20. The absorbed doses were: 0.7 Gy (LiF:Mg,Ti and $\text{CaSO}_4\text{:Dy}$), 20 Gy ($\text{CaF}_2\text{:Dy}$) and 50 Gy ($\text{CaF}_2\text{:Mn}$), for the first step, and 5 Gy (LiF:Mg,Ti), 100 Gy ($\text{CaF}_2\text{:Dy}$), 200 Gy ($\text{CaF}_2\text{:Mn}$) and 25 Gy ($\text{CaSO}_4\text{:Dy}$), for the second and third steps.

As results of the first step, TL emission maximum peaks were observed for all four materials at about 250°C (LiF:Mg,Ti), 300°C ($\text{CaF}_2\text{:Dy}$ and $\text{CaSO}_4\text{:Dy}$) and 385°C ($\text{CaF}_2\text{:Mn}$). After PITT, in the second step of the experiments, the TL peaks arised at about 365°C for LiF:Mg,Ti , and for the other materials no peaks were observed. In the final step, after exposure to UV light, PTTL signals appeared for LiF:Mg,Ti at 260°C and 370°C, for $\text{CaF}_2\text{:Mn}$ at 398°C and for $\text{CaSO}_4\text{:Dy}$ at 200°C; no PTTL was observed for $\text{CaF}_2\text{:Dy}$.

According to the results obtained, it was possible to study the occurrence of the phototransference signal of the materials, present for LiF:Mg,Ti , $\text{CaF}_2\text{:Mn}$ and $\text{CaSO}_4\text{:Dy}$. These data open the possibility of applying these materials and the PTTL technique in high-dose dosimetry of gamma irradiators, with applications in the industrial area.

Acknowledgements: *This work was supported by the Brazilian agencies FAPESP (Grants Nr. 2022/13430-2 and 2018/05982-0) and CNPq (Grants Nr. 165609/2020-6, 426513/2018-5, 305142/2021-6 and INCT/INAIS 406303/2022-3).*

References

- [1] W. L. McLaughlin, A. W. Boyd, K. H. Chadwick, J. C. McDonald, A. Miller. *Dosimetry for radiation processing*. Taylor & Francis, London (1989).
- [2] E. G. Yukihiro, S. W. S. McKeever, C. E. Andersen, A. J. J. Bos, I. K. Bailiff, E. M. Yoshimura, G. O. Sawakuchi, L. Bossin, J. B. Christensen, *Primer*, 2(26) (2022) 1-21. DOI: <https://doi.org/10.1038/s43586-022-00102-0>