Characterization of GdAlO3 as beta radiation detector

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ABSTRACT

One of the most widely exploited methods for radiation detection and dosimetry is those based on luminescence phenomena. Among them, the most important for practical applications of ionizing radiation monitoring is the thermoluminescence technique. For this sense, various materials have been submitted under investigation as radiation detectors. High quality inorganic halide perovskite brings an opportunity for ideal electronic radiation detection due to its large carrier mobility, lifetime, and heavy atoms. Here, we report on the GdAlO3 perovskite powders synthesized using the coprecipitation method. The surface morphology of undoped GdAlO3 NPs have been analyzed using SEM images. SEM images were obtained for different calcination temperature. These images manifested that clusters are formed on the surface in large number by spherical particles but the most are formed by irregular forms. It is observed that the particles are highly agglomerated due to the high surface interaction between the nanoparticles. The X-ray diffraction (XRD) studies show that the synthesized powders can be indexed to nearly single-phase orthorhombic GdAlO3. The TL characteristics following 90Sr/90Y beta irradiation were studied. The TL intensity response of the synthesized samples are recorded for an irradiation at 13.2 Gy dose using beta radiation with heating rate 15°C/s. TL intensity is found to depend on the calcination temperature. The highest TL response was observed for powders submitted at 1500°C. TL glow curve beta irradiated showed three peaks centered at 142.2 °C, 230.4°C, 271.5 °C, respectively. The first lower temperature peaks lose information for 24 hours, remaining the rest of the two peaks to study dosimetry properties. TL dose responses of the phosphors to beta doses from 1.1 up to 44 Gy showed fairly linear behavior. The kinetic parameters of the GdAlO3 samples were estimated by the free glow curve deconvolution, the curve fitting, and the peak shape methods. The results indicate that these phosphors can be considered to be promising as good candidates as a beta radiation detector.

INTRODUCTION

One of the techniques to perform audits of X-ray generating equipment is thermoluminescence (TL), for which the characterization of a material using the phenomenon of thermoluminescence is proposed, various experiments were carried out to determine reproducibility, linearity and fading of the material.
The material used was gadolinium aluminate (GdAlO3), the samples were irradiated with betas of 90Sr/90Y.
The TL response of GdAlO3 irradiated with beta radiation the material showed a defined curve with 3 characteristic peaks which are at 142.2 ° C, 230.4 ° C and 271.5 ° C respectively, while the TL curve of the samples using high energy photons showed a weak signal was difficult to determine some characteristic peaks.
The response of dusts as a function of radiation dose is an exponential process in the range of 0-44Gy.
The repeatability property of the information contained in the material presents a standard deviation of 3% when evaluating the characteristic for 10 consecutive times.
One of the main characteristics in the study of the information contained in post-irradiated materials is fading. This characteristic was determined by evaluating the material for a period of 30 days.

RESULTS

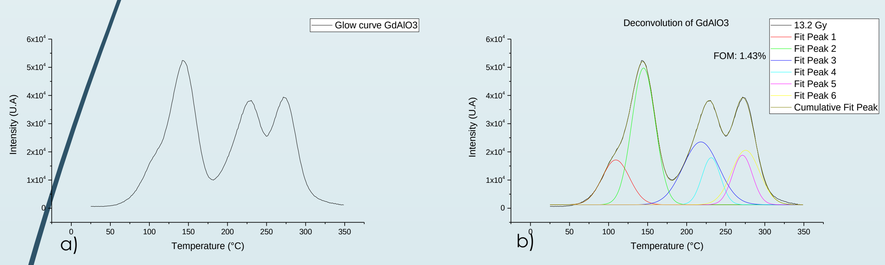

Figure 1.- a) Glow curve of GdAlO3. b) Deconvolution analysis of GdAlO3 with a fom of 1.43%

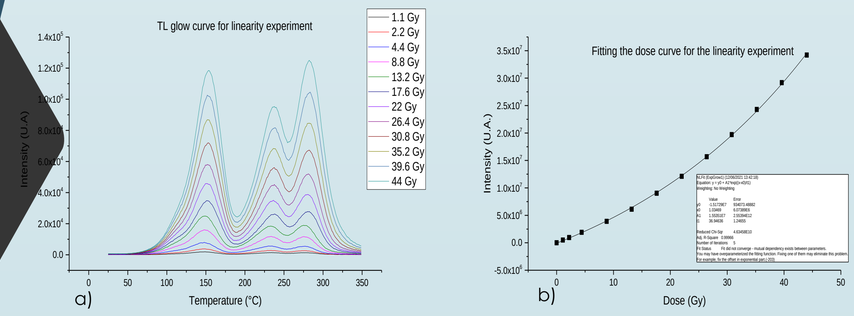

Figure 2.- a) Glow curve of GdAlO3 for linearity experiment. b) Fitting the dose curve of GdAlO3 for the linearity experiment.

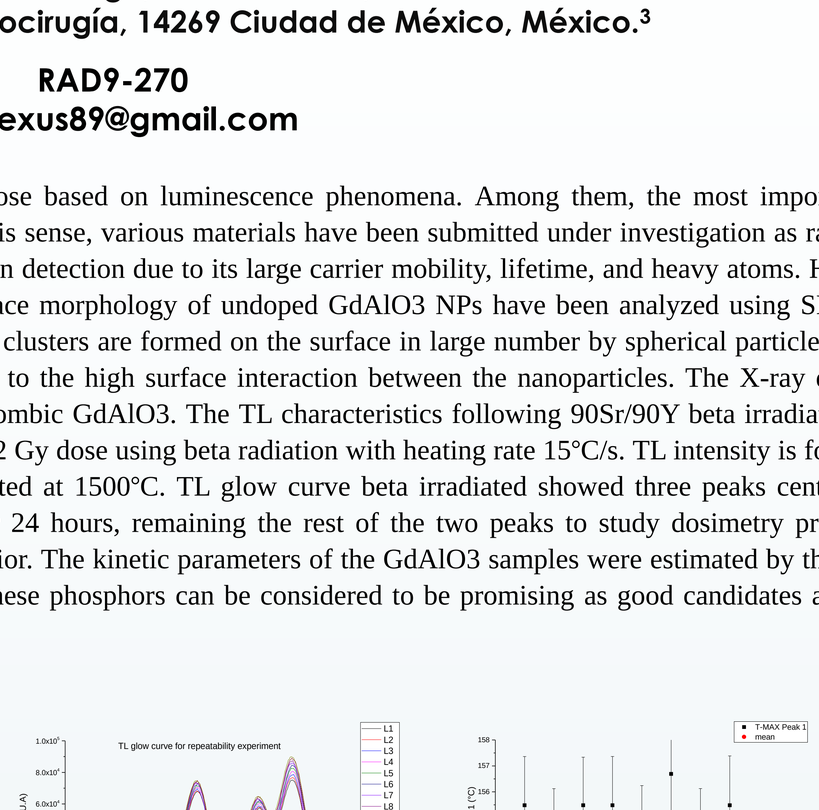

Figure 3.- a) Glow curve of GdAlO3 for repeatability experiment. b) analysis of peak 1 of the repeatability experiment. c) analysis of peak 2of the repeatability experiment. d) analysis of peak 3of the repeatability experiment.

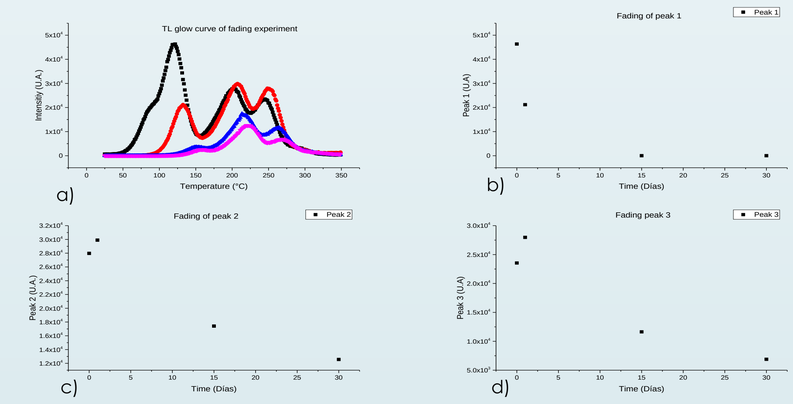

Figure 3.- a) Glow curve of GdAlO3 for fading experiment. b) analysis of peak 1 of the fading experiment. c) analysis of peak 2 of the fading experiment. d) analysis of peak 3 of the fading experiment.

CONCLUSIONS

For the experiment of linearity, the response as a function of radiation showed an increase in the luminescent signal by increasing the radiation dose in a range from 0 to 44 Gy, the material has an exponential adjustment as observed in the linearity process.
For the repeatability process, the material shows an error of less than 3% with respect to the T-MAX, proving to be a material with its very defined traps.
For the fading process, the material showed a fading of 50% for the first peak in a period of 24 hrs, while for the second and third peaks an increase was observed in the first reading at 24 hours post-irradiation, this means that there is a competition between peak two and three, the electrons that are released from peak two become trapped in peak three, this is because the first peak has surface traps and the second and third are from deeper traps, for the 15-day post-irradiation process. the first peak faded by 92%, while for peak two it showed a fade of 37% and peak three a fade of 50%. For the last reading at 30 days post irradiation, peak one shows a fading of 94% and peak two showed a fading of 55% and peak three a fading of 70%, this makes us think that the second peak is the dosimetric one.

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