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ENGINEERING $MgAl_2O_4$ SPINEL FOR OPTICALLY STIMULATED LUMINESCENCE (OSL) DOSIMETRY (LASSD-2021)

PAN, L.[1], SHOLOM, S.[2], McKEEVER, S.W.S.[2], and JACOBSOHN, L.G.[1]

[1]Department of Materials Science and Engineering, Clemson University, Clemson, SC, USA, luiz@clemson.edu
[2]Department of Physics, Oklahoma State University, Stillwater, OK, USA

Introduction: Presently, there are only two commercially available optically stimulated luminescence (OSL) dosimeters, BeO and Al_2O_3:C, fabricated by Dosimetrics and Landauer, respectively. New materials are sought towards better efficiency and performance [1-5]. $MgAl_2O_4$ is potentially attractive for OSL dosimetry [1] due to its relatively low effective atomic number Z_{eff} = 11.2. Recently, the investigation of $MgAl_2O_4$ as an OSL dosimeter received further impulse when the material was doped with a variety of elements, including rare earths. Within the context of OSL dosimetry, the Al_2O_3-MgO phase diagram was explored in this work. This work investigates the effects of calcination temperature and different Mg:Al ratios on the structure, luminescence and OSL properties of $MgAl_2O_4$ [6].

Material and method: Powders were prepared via the co-precipitation method with Mg:Al ratios 1:2 (stoichiometric), 1.5:2 (MgO-rich) and 1:3 (Al_2O_3-rich) and calcined from 800 °C to 1090 °C in air for 2h. The microstructure was investigated by X-ray diffraction (XRD) and Raman spectroscopy. Radioluminescence (RL) under X-ray excitation and thermoluminescnce (TL) were used to characterize the effects of the synthesis conditions and thermal processing on the luminescence response of the spinel. Optically stimulated luminescence (OSL) measurements were executed under continuous-wave blue (CW 470 nm) illumination of samples exposed to different doses in the 0.16-80 Gy range using a $^{90}Sr/^{90}Y$ beta source.

Results: An investigation of the effects of the Mg:Al ratio of magnesium aluminum spinel in the luminescence, and especially in the OSL response, was performed for the first time combined with microstructural characterization. A higher level of structural disorder was found in the powders than in the single crystal, while the same luminescence centers were present in all materials. The OSL dose-response characteristics of all powders were non-linear. The non-linearity is believed to be the result of fading of the OSL signal during irradiation. The OSL signal is believed to originate from thermally unstable centers when stimulated at 470 nm.

Conclusions: The nature of the band at 385 nm was identified as being related to anti-site defects. Among the different Mg:Al ratios, stoichiometric spinel presented superior OSL dose response, being linear within 0.16 Gy and 2 Gy, presenting 1% reproducibility of the dosimetric response after repeated exposure to the same dose, having the least fading, and with a minimum detectable absorbed dose (MDD) of 0.65 mGy.

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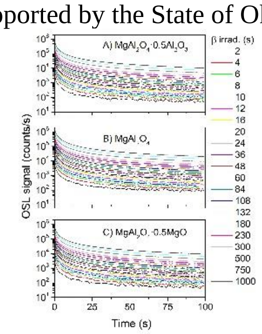

Figure 1: OSL curves of spinels with different Mg:Al ratios obtained after different irradiation times.

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