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THERMOLUMINESCENCE STUDY OF SEVERAL SYNTHETIC MATERIALS BASED ON SILICATES PRODUCED BY DIFFERENT METHODS

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Introduction: This project aims to produce and characterize magnesium, calcium, lithium, and strontium silicate ($MgSiO_3$, Li_2SiO_3, $CaSiO_3$, and Sr_2SiO_4), with applications in gamma dosimetry. Synthetic polycrystalline of these materials were produced by the Sol gel-Combustion method, solid-state method, and devitrification methods.

Material and method: The magnesium silicate was obtained from dissolving the magnesium hexahydrate with distilled water plus tetraethyl orthosilicate TEOS ($C_8H_{20}O_4Si$), later also Ethanol (C_2H_5OH) and citric acid monohydrate ($C_6H_8O_7$ * H_2O) at 80 °C for 350 RPM. After 24 hours, the UREA (CH_4N_2O) was added until obtaining a Sol-Gel. Finally, it was put in the microwave for 5 min, then it was dried in the oven at a temperature of 800 °C for 1 hour and the material was obtained. After that, the obtained material was exposed to 1350 °C for 3 hours using a high-temperature furnace. To obtain a lithium silicate, stoichiometric quantities of $LiCO_3$ and SiO_2 were mixed, then submitted to 900 °C for 24 hours using the solid-state method. For the production of strontium silicate, stoichiometric quantities of $SrCO_3$ and SiO2 were mixed and carried out to a furnace at 1400 °C for 3 hours. For the production of calcium silicate polycrystalline, $CaSiO_3$, the devitrification method was used (Magallanes-Perdomo et al., 2009). The synthesis process starts with weighing quantities of reagent grade CaO (Anadrol-PA ACS, 99.9%) and SiO2 in a stoichiometric way (Gonzales-Lorenzo et al. 2020).

Results: Samples of $MgSiO_3$ were heat-treated at temperatures from 1000 to 1600 °C and its X-ray diffraction patterns and its luminescent response were studied. Pellets of $MgSiO_3$, Li_2SiO_3, $CaSiO_3$, and Sr_2SiO_4 were produce using a mechanic press for 3 minutes. Pellets of about 6 mm diameter and 1 mm thickness were obtained. Dosimetric properties were evaluated using the Thermoluminescence method. The materials will be exposed to different times to gamma radiation and the TL intensity will be evaluated as a function of the irradiated dose. Fading and reproducibility properties will be analyzed and presented at this congress.

Conclusions: Fig. 1 shows the comparative TL response of the produced material irradiated to 2 Gy gamma dose from a Co-60 source. Most sensitive materials correspond to Li_2SiO_3 and $CaSiO_3$ as their thermoluminescence response is concerned.

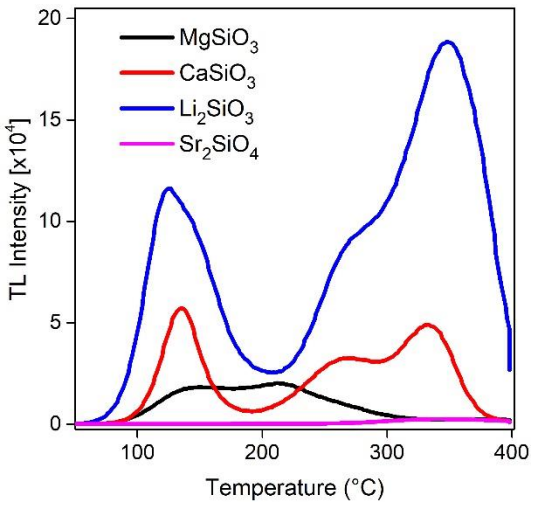

Figure 1: TL response of $MgSiO_3$, Li_2SiO_3, $CaSiO_3$, and Sr_2SiO_4 irradiated to 2Gy gamma dose.

References:

1. Magallanes-Perdomo, M., Pena, et. al., 2009. Devitrification studies of wollastonitetricalcium phosphate eutectic glass. Acta Biomater. 5, 3057–3066.
2. Gonzales-Lorenzo, C.D., Watanabe, et al., 2018. Synthetic polycrystals of $CaSiO_3$ un-doped and Cd, B, Dy, Eu-doped for gamma and neutron detection. J. Lumin. 201, 5–10.