$CaSiO_3$ polycrystal for neutron, proton and carbon detection

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Many natural or laboratory produced silicate crystals are sensitive TL materials [1]. In this work, synthetic polycrystals of undoped and doped $CaSiO_3$ have been produced by the devitrification method [2], for investigation as neutron and accelerated ions detector. They were then irradiated with thermal neutron with various fluences at the research reactor IEA-R1 of the Institute for Energy and Nuclear Researchers, São Paulo. In addition, they were irradiated 160 MeV proton beam and 290 MeV/n carbon ion beam from an upper synchrotron of HIMAC (Heavy Ion Medical Accelerator in Chiba, Japan) at NIRS (National Institute of Radiological Sciences) [3]. For application with neutron detection grains of 80-180 μm of undoped and B, Cd, Dy doped $CaSiO_3$ were used. For detection of radiation doses involved in a nuclear reaction involving accelerated proton and carbon beam, chips of $CaSiO_3$ have been produced compressing powder with a pressure of 11 ton/cm^2 and then sintering at 1200 °C for one hour. The calibration of chips was carried out irradiating them with Co(60) γ rays. Each chip has 6mm diameter and 1mm thickness. Undoped and B, Cd, Dy doped $CaSiO_3$ when irradiated with neutron presented TL peaks at 110-130 and 240-250, the second peak is the prominent one. In addition, these chips of calcium silicate presented a prominent peak at 120 °C, and at 270 °C when irradiated with accelerated heavy ions. The dose read out in Harshaw TL reader presented a good agreement with doses found using ion chamber in the case of proton beams and slightly less in the case of carbon beam due to the LET dependency. Mechanism of the neutrons and accelerated ions interact with the detectors will be discussed at the meeting.

Keywords: Thermoluminescence, $CaSiO_3$, Protons, Carbon, Ion accelerator.

[1] S. Watanabe, N. Cano, Lucas S. Carmo, R. Barbosa, J. Chubaci, High- and very-high-dose dosimetry using silicate minerals, Radiation Measurements, Volume 72, 2015, Pages 66-69, ISSN 1350-4487.

[2] C. Gonzales-Lorenzo, S. Watanabe, N. Cano, J. Ayala-Arenas, C. Bueno, Synthetic polycrystals of $CaSiO_3$ un-doped and Cd, B, Dy, Eu-doped for gamma and neutron detection, Journal of Luminescence, Volume 201, September 2018, Pages 5-10, ISSN 0022-2313.

[3] L.F. Nascimento, F. Vanhavere, S. Kodaira, H. Kitamura, D. Verellen, Y. De Deene, Application of Al2O3:C+fibre dosimeters for 290MeV/n carbon therapeutic beam dosimetry, Radiation Physics and Chemistry, Volume 115, 2015, Pages 75-80, ISSN 0969-806X.

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