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INVESTIGATION OF MAGNESIUM TETRABORATE PRODUCTION FOR THERMOLUMINESCENCE MEASUREMENTS

NASCIMENTO, D.S.[1], CIOLINI, R.[1], SOUZA, S.O[1,2] and d'ERRICO, F.[1,3]

[1]Dipartimento di ingegneria civile e industriale, Università di Pisa, Pisa, Italy,
debora.siqueiranascimento@phd.unipit.it

[2]Departamento de física, Universidade Federal de Sergipe, São Cristovão, Sergipe, Brazil

[3]School of Medicine, Yale University, New Haven, CT, USA

Introduction: MgB_4O_7 doped with rare eath ions (RE) has been studied as a candidate for personnel as well as clinical dosimetry applications, mainly, because its effective atomic number Zeff ~8.4 is closer to the soft tissue ~7.4 [1-2]. Such properties allow personal dosimetric assessments without requiring correction factors. Furthermore, the material is sensitive to different types of ionizing radiation such as electrons, photons and beta. It also can be enriched with B-10 and B-11 for thermal neutron detection, making it a strong candidate for universal dosimetry.

Initially, MgB4O7 compounds were explored as thermolumincence dosimeters. Some groups used different RE doping yielding an optically luminescent property in recent years. The most efficient dopants used to achieve OSL behavior in MgB_4O_7 host are cerium (Ce) and lithium (Li) ions. They present TL and OSL response and interesting dosimetry characteristics such as large linearity range, fading < 5% per month [3]. However, there are some aspects in the production of MgB_4O_7:Ce, Li which could be optimized and enhance the efficiency of dosimeter.

In this work, we examined some features such as grain size, sintherization temperature and valence of doping Ce ions in order to improve thermoluminecent properties. Such advance in production can enable MgB_4O_7 as a future universal dosimeter.

Material and method: Samples of MgB_4O_7: Ce0.5%wt Li0.5%wt were produced by solid state synthesis. The starting chemicals used were MgO (sigma-aldrich), H_3BO_3 (sigma-aldrich) for main phase and cerium carbonate ($Ce_2(CO_3).xH_2O$), cerium oxide (Ce_2O) and lithium carbonate (Li_2CO_3), as doping reagents. Initially, two kinds of sample were produced to study the valence ion effect: one with cerium oxide (Ce_2O) as dopant reagent and another with $Ce_2(CO_3).xH_2O$. The powders were mixed until homogeneity and heat in the oven at 900°C for 7 h. A part of these samples were separated to perform x-ray diffraction (XRD) analyses to confirm the major MgB_4O_7 phase. The grain size was chosen using sieves of 149, 74 and 45 µm before making pallets under compression at 10 bar. Two different temperature treatment, 825°C and 850°C, were used keeping these temperatures for 1h.

The pellets were irradiated with 100 mGy using a 2.2 GBq Co-60 source. The TL signal was acquired at a rate of 2°C/s from 50°C up to 300°C using a Harshaw 4500 TL reader.

Results: XRD measurements confirmed that the material produced by solid-state synthesis is in majority MgB_4O_7. TL measurements showed more stability and high sensitivity from the sample produced with ^{+4}Ce with grain size between 149 and 75 µm and a temperature treatment of 825°C for 1 h.

Conclusions: We studied the influence of sintherization and grain size for MgB4O7:Ce,Li in TL measurements and selected the specific parameters to yield the highest sensitivity material for dosimetry.

References:

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