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CHALLENGES IN PERSONAL AND CLINICAL DOSIMETRY USING Li_2B4O_7 AND MgB_4O_7 AS TLD AND OSLD

OLIVEIRA, L.S.S.[1], SOUZA, L.F.[2], DONALD, G.G.[1], EMIDIO, M.F.S.[1], and SOUZA, D.N.[1]

[1]Departamento de Física, Universidade Federal de Sergipe (UFS), 49100-00 São Cristóvão, SE, Brazil, gabigdonald@gmail.com
[2]Centro de Desenvolvimento da Tecnologia Nuclear, CDTN, 31270-901 Belo Horizonte, MG, Brazil

Introduction: Thermoluminescent (TLD) and optically stimulated luminescent dosimeter dosimeters (OSLD) are essential in radiation dosimetry, especially in clinical and personal areas. Such dosimeters can be easily transported due to their small size and can be used in *in vivo* dosimetry and anthropomorphic simulations. $Li_2B_4O_7$ and MgB_4O_7 compounds have stood out in dosimetry for their applicability in thermal neutron dosimetry. In general, magnesium tetraborate shows high sensitivity in TL dosimetry and lithium tetraborate has high UV transmittance for certain wavelengths.

In this work, the properties of candidate $Li_2B_4O_7$ and MgB_4O_7 compounds for dosimetry are evaluated based on their response to the applied stimulus, whether thermal or optical. The characteristics that must be considered to determine whether a material is appropriate depend on the application it is intended for. The linear dose response range of the luminescent signal, its fading, and reproducibility are important parameters in determining a good dosimeter; and the smaller the lowest detectable dose (LDD), the more likely the dosimeter will be suitable for clinical and personal dosimetry. Therefore, the objective of this work was, based on studies performed by other authors on dosimetric characterizations of doped an codoped Li_2B4O_7 and MgB_4O_7, to point out those compounds with the greatest potential for applications in personal and clinical dosimetry with TL and OSL techniques.

Material and method: The literature search was performed using keywords such as: magnesium tetraborate in radiation dosimetry, MgB_4O_7 dosimetry, lithium tetraborate in radiation dosimetry, $Li_2B_4O_7$ dosimetry, borates in radiation dosimetry. Indexed papers dated from 2000 to 2020 were included. Documents such as patents, theses, dissertations, and conference abstracts were not considered. Information related to the type of radiation beam employed, its energy, minimum detectable dose (LDD), fading, signal reproducibility, and energy dependence were considered.

Results: Among the studies on MgB_4O_7 that fit our selection criteria, in most them this compound was doped with Dy, Li or Na; in some doping with Ce, Mn was used. For $Li_2B_4O_7$, doping with Cu was most frequent.

In the studies, the dose response evaluation was done using photon beams or beta radiation. Analyzing the materials that were exposed to beta radiation ($^{90}Sr+^{90}Y$), the one that stands out most for clinical and personal dosimetry is $Li_2B_4O_7$, which showed linear dose range between 10^{-3} Gy and 10^{3} Gy, LDD of 20μGy, dosimetric peak around 178°C and fading around 10% in 90 days. On the other hand, the material that stood out among those irradiated with gamma radiation (^{60}Co, ^{137}Ce) was MgB_4O_7:Dy,Na that can monitor doses from $9x10^{-5}$ up to 100 Gy, with LDD of only 2μGy, luminescent signal decay of 8% over a storage period of 90 days and dosimetric peak around 220°C.

Conclusions: Considering the results described in other works, it is not yet possible to state which dopants are ideal for using MgB4O7 and $Li_2B_4O_7$ for TL or OSL dosimetry. Especially for the use of these materials as OSLD, of the twenty papers reviewed, only four described results. The materials that stood out for use in personal and clinical dosimetry were $Li_2B_4O_7$:Cu and MgB_4O_7:Dy,Na. In several of the reported studies, no data related to LDD, fading and reproducibility of the luminescent signal of the investigated compounds were found. Therefore, there are many possibilities for investigations into these two types of compounds for the purpose of their use in personal and clinical dosimetry. Further studies will provide a broader scientific basis for choosing appropriate dosimetric materials for these applications.