Synthesis and characterization of hybrid materials with MgB4O7:Ce,Li for dosimetry applications

N. A. Araujo[1,2], M. G. Martins[2], S. S. Lalic[3], R. C. Nunes[1], F. J. O. Ferreira[1], H. J. Kroury[4], L. M. Lima[5], F. d'Errico[6], J. C. Pinto[2], L. Carvalheira[1], S. Tatumi[7]
E-mail: nicolis@peq.coppe.ufrj.br, mmartins@peq.coppe.ufrj.br, susanasouzalalic@gmail.com, chaffin@ien.gov.br, fferreira@ien.gov.br, hjkhoury@gmail.com, lmlima@firjan.com.br, francesco.derrico@unipi.it, pinto@peq.coppe.ufrj.br, luciana@ien.gov.br, sonia.tatumi@gmail.com,

[1] SEREA, IEN, [2]COPPE, UFRJ, [3]DEF, UFS,[4]DEN, UFPE, [5]FIRJAN [6]LMN,UNIPI, [7] UNIFESP

Keywords: polymer PMMA, polymeric nanoparticles, Polymeric films, radiologic techniques.

This study deals with the development of MgB_4O_7:Ce,Li crystals produced by the sol-gel synthesis as an emitter for the optically stimulated luminescence technique and the verification of structural and luminescent properties of the crystals to be inserted in a polymeric film for dosimetry applications. Magnesium borate exhibits interesting thermoluminescent (TL) properties for TL dosimetry with good performance for X-ray, gamma, beta and neutrons types of ionizing radiation [1]. The presence of boron-10 in its chemical composition makes the material presents a high cross-section for slow neutrons, allowing the detection of thermal neutrons. Moreover, magnesium tetraborate (MgB_4O_7) doped with rare earth elements has been used in the scope of personal and environmental dosimetry [2]. For the production of these materials, the sol-gel method was selected as it is versatile for preparing organic-inorganic hybrid materials. The sol-gel method employs low temperatures and allows the incorporation of active species during the hydrolysis and polycondensation processes [3]. Consequently, the physical properties of these materials can be modified according to changes in the experimental conditions [4]. The term sol is used for the suspension of colloidal particles formed by the hydrolysis of precursors and in the initial phase of the condensation reaction. With the particles undergoing polymerization, the viscosity of the solution increases in a process called gelatinization. Figure 1 illustrates the initial solution after the reaction (left side) and overtime in the gelatinization process (right side).

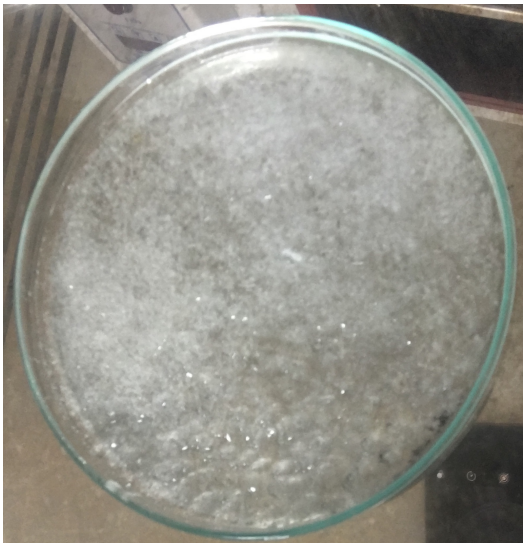

Figure 1. Sol-gel synthesis of MgB_4O_7:Ce,Li

Further, polymeric films of PMMA (poly(methyl methacrylate)) loaded with nanocrystals of MgB_4O_7:Ce,Li will be synthesized to evaluate the material response to optically stimulated luminescence. We expect this hybrid material to allow neutron dosimetry for applications in Radiotherapy successfully.

References

[1] PROKIĆ, M. Magnesium borate in TL Dosimetry. Radiat. Prot. Dosim., v. 17, p. 393-396, 1986.

[2] PROKIĆ, M. Development of highly sensitive CaSO4:Dy/Tm and MgB4O7:Dy/Tm sintered thermoluminescent dosimeters. Nucl. Instrum. Meth. B, v. 175, p. 83-85, 1980.

[3] ZELAZOWSKA, E.; RYSIAKIEWICZ-PASEK, E.; BORCZUCH-LACZA, M.; CHOLEWA-KOWALSKA, K. Sol-gel derived hybrid materials doped with rare earth metal ions. Optical Materials. v. 33. p. 1931- 1937, 2011.

[4] SASSI, Z.; BUREAU, J.C.; BAKKALI, A. Structural characterization of theorganic/inorganic networks in the hybrid material (TMOS – TMSM – MMA). Vibrational Spectroscopy, v. 28, p. 251-261, 2002.