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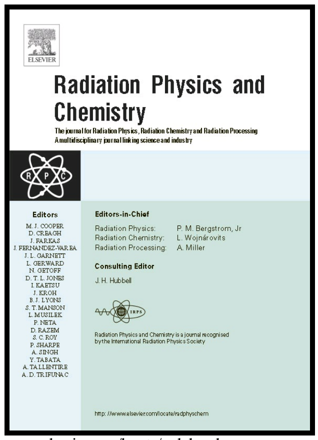

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Structural recovery and optical properties stabilization of CeO_2/TiO_2-doped boroaluminosilicate glass under gamma irradiation

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Abstract. The structure and optical properties of CeO_2/TiO_2-doped boroalumnosilicate glass with the composition $54SiO_2$-$10B_2O_3$-$13Al_2O_3$-$14Na_2O$-3ZnO-$2Li_2O$-$4CaF_2$ before and after gamma irradiation at varied dose were investigated by spectroscopy analysis. The results indicated that doping CeO_2 and/or TiO_2 can significantly improve structural stability against irradiation and that solely doping CeO_2 or appropriate co-doping of CeO_2/TiO_2 achieves a perfect stabilization on optical property. A model based on self-repairing that irradiation may recover the structural defect via microstructure reconfiguration amid network depolymerization is employed to explain gamma irradiation-induced structural stability and stabilization of optical properties in presence of CeO_2/TiO_2.

Key words: Boroaluminosilicate glass; Gamma irradiation; Structural recovery; CeO_2/TiO_2.

1. Introduction

Borosilicate glasses have been preferentially used as materials that have to be exposed to irradiative environment. Typical applications cover immobilization of nuclear waste forms [1, 2], light transparent materials of radioactive facility [3] and optical component of irradiative instruments. However, it raises the concern about the safety and stability of glasses under irradiation and makes irradiation resistance of glass the key premise for their proper use. Various modifier oxides, particularly transition metal oxides, are conventionally introduced into borosilicate composition to improve the glasses' irradiation resistance [4–6]. Typically, CeO_2 is the most popularly used for this purpose that makes glass optical properties steady by virtue of the polyvalent state of Ce^{4+}/Ce^{3+} hindering the formation of color centers [7, 8]. Benefited from this advantage, cerium-containing borosilicate glasses [9, 10] achieved wide applications in aerospace & nuclear industries, photovoltaic technology as well as medical and martial fields associated with irradiation. The amount of CeO_2 introduced to glass has to be confined to a limited range because of the severe coloration on glass at higher dosage