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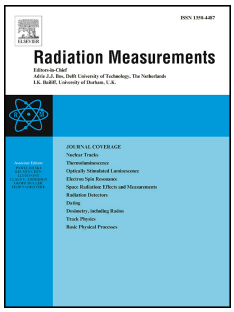

Photoluminescence dose dependences of F and F^+-centers in TLD-500 detectors

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Photoluminescence dose dependences of F and F^+-centers in TLD-500 detectors

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Abstract

The photoluminescence spectra of TLD-500 detectors were measured before and after γ-irradiation in the 1-50 Gy range. After irradiation, the PL spectrum at the excitation with E_{exc} = 4.8 eV features an additional wide band with the maximum at 550 nm associated with the formation of aggregate F_2^{2+}-centers. The intensity of the emission of this band increases with a growing dose. Dependences of the intensities of emission of F and F^+-centers on the dose was studied. A big difference in radiation-induced transformation of these centers is caused by competition of the processes of creation of aggregate centers and interconversion ($F \leftrightarrow F^+$).

Keywords: oxygen vacancies, photoluminescence, dose dependence

1. Introduction

To measure low doses of ionizing radiations, mainly for dosimetry of the personnel working with radiation sources, different kinds of commercial thermoluminescence (TL) detectors on the base of impurity-doped alkaline-haloid and alkaline-earth crystals, sulfates and sulfides are used today (McKeever et al., 1995; Kortov, 2007; Yazici et al., 2007; Salah et al., 2008, 2011). Unlike these TL detectors, in TLD-500 detectors made of anion-defective single alumina crystals, luminescence centers are created by their own defects rather than by dopants (Akselrod et al., 1990). Such defects include oxygen vacancies which emerge when single crystals in highly reducing conditions (with the presence of carbon) are grown and form F- and F^+- centers. Spectral parameters of these centers were found in previously measurements (Summers, 1984; Evans et al., 1994; Kotomin et al., 1994; Bos, 2001). TLD-500 detectors have a number of advantages. High initial concentration of F-type centers provides a necessary sensitivity of the detectors to radiations. Deep energy depth of luminescence centers that were created with the involvement of oxygen vacancies causes low fading of the detectors. Less distortions of the crystalline lattice in the detector material due to the absence of dopants is one of the main reasons for appearance of an isolated TL peak which is easily registered.