LUMINESCENT CHARACTERISTICS OF MAGNESIUM ALUMINATE SPINEL OF DIFFERENT STOICHIOMETRY

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Magnesium aluminate spinel (Mg-Al) is a fascinating material with very high radiation tolerance and absence of swelling even after heavy fast-neutron irradiation [1]. Therefore, Mg-Al crystals and transparent ceramics are considered as attractive candidates for diagnostics/optical windows in future fusion devices (ITER, DEMO, PROTO). In a "normal" $MgAl_2O_4$, there is no cation disorder, while exchanging the cations between tetrahedral and octahedral sites results in the formation of antisite defects (ADs) – $Mg|_{Al}$ or $Al|_{Mg}$. These main as-grown structural defects are charged and serve as efficient electron and hole traps. In nonstoichiometric spinel (Al-rich), Al^{3+} replace Mg^{2+} creating large concentration of ADs in form of $Al|_{Mg}$, while some cation vacancies (mainly V_{Al}) are additionally formed for charge compensation [2].

The present study deals with a comparative study of the cathodoluminescence spectra for virgin and neutron-irradiated samples in stoichiometric [3] and Al-rich spinel samples compared with the photoluminescence spectra at 6-300 K. In addition, the spectra of optical absorption, the excitation spectra of phosphorescence and thermally stimulated luminescence have been measured for Mg-Al crystals. Experimental manifestations of as-grown ADs have been revealed in crystals with different stoichiometry by means of the above-mentioned optical methods. ADs serve as "stickers" for exciton-like electron excitations (bound excitons) in the spectral region of ~7–7.5 eV. This suggestion is also confirmed by previous data on radiation-induced defects (including ADs) in fast-neutron irradiated Mg-Al spinel crystals [3]. According to excitation/creation spectrum of phosphorescence, the beginning of interband transitions lies above 7.5 eV in $MgAl_2O_4$ at 270 K.

References

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