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PHOTOLUMINESCENCE OF HIGH ENERGY ION IRRADIATED MAGNESIUM ALUMINATE SPINEL SINGLE CRYSTALS*

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Magnesium Aluminate spinel ($MgAl_2O_4$) is one of the most promising material for optical applications at nuclear-power facilities, laser technology and dosimetry, due to its high resistance to radiation damage, thermal stability and transparency in a wide spectral range. There are some experimental studies devoted to the structural disorders in $MgAl_2O_4$ irradiated with fast fission neutrons, high-energy electrons and protons [1-3]. However, information about radiation defects caused by swift heavy ions in this material has been lacking, particularly in the range of high ionization energy losses. In the present work, a swift heavy ion irradiation-induced defects in $MgAl_2O_4$ single crystals have been studied using photoluminescence spectroscopy technique.

Samples were irradiated with high energy Ar (46 MeV), Kr (107 MeV), Xe (150 MeV) and Bi (710 MeV) ions in the fluence range of 10^{10}-10^{13} cm^{-2} at IC-100 and U-400 cyclotrons in Flerov Laboratory of Nuclear Reactions JINR (Dubna, Russia). The PL measurements were performed in two experimental geometries: standard ($\lambda_{exc.}$ = 355 nm) using Shamrock SR303i spectrometer and confocal ($\lambda_{exc.}$ = 355 nm, 445 nm, 473 nm and 532 nm) using confocal microscope Ntegra Spectra NT-MDT at room temperature.

It was found that the PL spectra from intact $MgAl_2O_4$ contain emission bands of Cr^{3+} (1.8 eV) and Mn^{2+} (2.4 and 1.6 eV) impurities. Irradiation of $MgAl_2O_4$ crystals by high-energy heavy ions causes the appearance a broad luminescence band at 2.48–3.1 eV (standard geometry) with a three-peak structure, which is similar to MgO crystals [4], and an intense non-elementary bands around 1.55-3.1 eV (confocal system) under 355 nm, 445 nm, 473 nm and 532 nm excitation wavelengths. Intensities of these bands increase with the ion fluence up to 10^{12} cm^{-2}. The analysis of the PL spectra obtained in standard geometry allowed us to assume that the radiation-induced defects created in the track region are surrounded predominantly by Mg and O ions. In confocal geometry, upon different energy of excitation, the PL spectra of samples have been demonstrated the similar spectral shapes (emission bands), which have been tentatively ascribed to some of impurity centers in different charge states.

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