

## POLYVALENCE STATES AND ANTI-SITE DEFECTS OF IRON IONS IN $MgAl_2O_4$ OPTICAL NANOCERAMICS\*

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Optical ceramics are promising media for doping with a wide spectrum of impurity ions with an unfilled d shell. Of particular interest are ions that are fundamentally capable of providing optical transitions with the emission of photons in the IR range. At the same time, to create a material that provides the necessary optical characteristics in the IR range, it is necessary to implement a number of factors in the matrix, such as a wide transmission range in the infrared region, chemical and mechanical resistance.

In this work, optically transparent aluminum-magnesium spinel nanoceramics were chosen as a solid-state matrix for doping.  $MgAl_2O_4$  is an optimal candidate due to the wide range of optical transmission ( $\lambda \sim 0.16 - 6.6 \mu m$ ) and the presence of two types of cationic sublattices providing both divalent and trivalent cationic states. Iron ions were chosen to modify the optical properties in the IR range. It is known that divalent iron ions localized in close-packed oxygen structures of the tetrahedra type provide splitting of the ground 5D term into the  $5T^2$  ground and  $5E$  excited states, the transition energy between which lies in the IR range. The purpose of this work is to study the optical characteristics of transparent  $MgAl_2O_4$  nanoceramics doped with iron ions.

Optical nanoceramics were synthesized by sintering a compact made from monodispersed spinel and  $Fe_2O_3$  nanopowders. Optical reflection and absorption spectroscopy methods have been used to establish a set of excited states associated with both  $Fe^{2+}$  and  $Fe^{3+}$  impurity ions. A shift of the excited states of the  $Fe^{2+}$  ions to the region of high energies, due to their localization in defective positions, has been found. Strong absorption in the UV spectral region is associated with the presence of both impurity  $Fe^{3+}$  ions and intrinsic optically active centers of the F and  $F^+$  - type. An analysis of the photoluminescent spectra indicates the presence of at least two types of impurity  $Fe^{3+}$  ions with different spectral and kinetic characteristics. New bands were also found in the PL spectra of spinel, associated with the localization of impurity  $Fe^{3+}$  ions in the tetrahedral sites of the crystal lattice. The photoluminescence intensity of  $Fe^{3+}$  ions undergoes strong concentration quenching as the impurity iron increases from 0.04 Fe% to 2 Fe%, while the sample itself becomes opaque in the visible spectral range.

Thus, it has been shown that as a result of the modification of the optical characteristics of the aluminum-magnesium spinel with iron ions, polyvalent optically active Fe centers are formed, localized both in normal and defect positions.

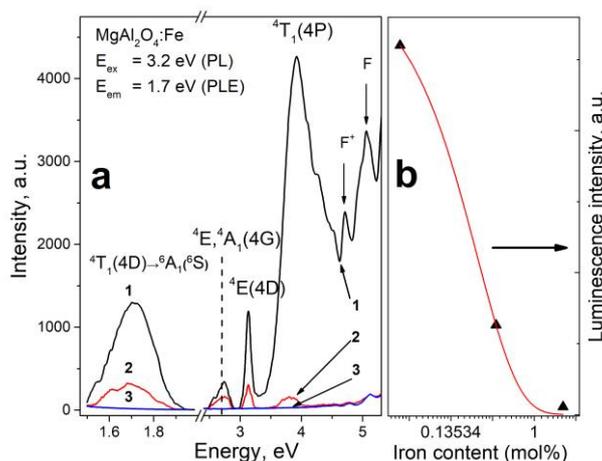


Fig.1. Spectra of  $Fe^{3+}$  ions PL and PLE - a. Iron content is 0.04, 0.4, 2 % for 1, 2 and 3 on picture. A concentration quenching is shown at - b.

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