

Nanocomposites and nanomaterials

Free volume in the MgGa₂O₄ spinel doped with Eu³⁺ ions studied with positron annihilation lifetime spectroscopy

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MgGa₂O₄ spinel doped with rare-earth ions are promising materials in a solid-state laser, thin-film electroluminescence displays, field emission displays and vacuum fluorescent displays, etc. In particular, magnesium gallate doped with Eu³⁺ ions has excellent luminescent properties in “red” and “orange” spectral region. The luminescent properties of these materials are well studied in [1]. In this work, we shall use positron annihilation lifetime spectroscopy (PAL) to analyze free volume in the pure MgGa₂O₄ spinel and MgGa₂O₄ doped with Eu³⁺ ions.

The PAL measurements with a full width at half maximum of 270 ps were performed with the ORTEC spectrometer using ²²Na source placed between two sandwiched samples. The obtained spectra were analyzed with LT 9.0 computer program and the best fitting results were obtained using four-component fitting procedures [2] with positron lifetimes t_1, t_2, t_3, t_4 and corresponding unity-normalized intensities I_1, I_2, I_3, I_4 . The radius of free volumes in the studied spinel was calculated using Tao-Eldrup model considering o-Ps “pick-off” lifetimes of the third and fourth components with lifetimes t_3 and t_4 . It is shown, that doping of MgGa₂O₄ spinel by Eu³⁺ ions results in increasing of free volume radius R_4 from 13.97 Å to 14.42 Å and decreasing of radius R_3 from 3.11 to 3.06 Å. It is established that void fraction in the studied materials increases from 3.08 % in pure MgGa₂O₄ spinel to 9.86 % in MgGa₂O₄ doped with Eu³⁺ ions.

1. Luchechko A., Kravets O., Kostyk L., Tsvetkova O. Luminescence spectroscopy of Eu³⁺ and Mn²⁺ ions in MgGa₂O₄ spinel // Radiation Measurements. – 2016. – **90**. – P. 47-50.
2. Klym H., Ingram A., Hadzaman I., Shpotyuk O. Evolution of porous structure and free-volume entities in magnesium aluminate spinel ceramics // *Ceramics International*. – **40(6)**. – 2014. – P. 8561-8567.