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GROUND STATE OF THE Gd^{+} ION IN THE $TmAl_3(BO_3)_4$ SINGLE CRYSTAL

Borates with the common formula $RM_3(BO_3)_4$ where R are rare-earth ions or yttrium, M are Al, Fe, Ga, Cr draw attention of researchers because of high luminescent and non-linear optical properties. Possible doping of the crystals by rare-earth ions and ions of iron group makes them interesting from the viewpoint of magnetism, because interaction of two magnetic subsystems results in a number of peculiarities. Despite a great number of papers dealing with study of this series of crystals, the available data about electron spin resonance (ESR) spectrum and the related ground state of doping paramagnetic ions are insufficient. For the rare-earth group, only ESR of Ce^{3+}, Er^{3+} and Yb^{3+}, Gd^{3+} were observed.

The aim of the present paper was studying of ESR spectrum of the interstitial Gd^{3+} ion in the $TmAl_3(BO_3)_4$ crystal in a wide temperature range.

The ground state of impurity ions of Gd^{3+} in the $TmAl_3(BO_3)_4$ single crystal was investigated by ESR method. It was found that Gd^{3+} substitutes the ion of trivalent thulium. The parameters of spin Hamiltonian were estimated (g_z = 1.986 ± 0.002, $g_x = g_y$ = 1.989 ± 0.002; b_2^0 = = (431 ± 0.13)·10^{-4} cm^{-1}; b_4^0 = (–13 ± 0.08)·10^{-4} cm^{-1}; b_6^0 = (0.4 ± 0.12)·10^{-4} cm^{-1}). The ratio of spin Hamiltonian parameters demonstrates that the spectrum is very close to merely axial one. The increase in the temperature results in reduction of ground state splitting. Temperature evolution of the spectrum is determined by heat expansion of the crystal.

Keywords: electron spin resonance, borates, rare-earth ions

Fig. 1. Crystal structure of $TmAl_3$ (BO_3)

Fig. 2. ESR spectrum (the first derivative) of the Gd^{3+} ion in a single crystal of $TmAl_3(BO_3)_4$ at temperatures, K: *1* – 3.8, *2* – 290. $B \| C_3$

Fig. 3. The angular dependence of the absorption spectrum of Gd^{3+} at T = 40 K

Fig. 4. Temperature dependence of the spin Hamiltonian parameters b_2^0 (*a*) and b_4^0 (*б*)