PHASE TRANSITIONS, SPIN-PHONON AND ELECTRON-PHONON INTERACTIONS IN MULTIFERROIC $RFe_3(BO_3)_4$ AS STUDIED BY OPTICAL SPECTROSCOPY OF PHONONS AND MAGNONS

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Multiferroic iron borates $RFe_3(BO_3)_4$ (*R*FB) are intensively studied as they demonstrate noticeable magnetoelectric effect [1]. Besides, they demonstrate strong interaction of different internal subsystems, including not only charge and magnetic, but also lattice and electronic ones. RFB's possess trigonal *R*32 crystallographic structure which can be turned into $P3_121$ one [2,3] at low temperatures, for *R*FBs with small RE^{3+} ions (Eu-Yb), while all of them experience antiferromagnetic ordering at temperatures $T_N \sim 30$ - 40 K [4]. In this work, the study of the phonon spectrum is presented for several members of *R*FBs in a wide range of temperatures (5-300 K) by means of Raman and infrared (IR) spectroscopies, with emphasis of noticeable spin-lattice and electron-phonon interactions[3,5].

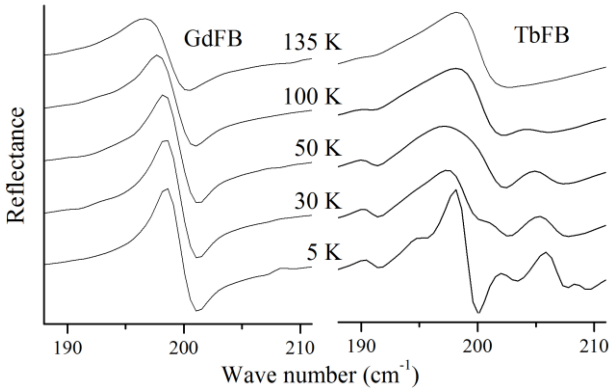

Fig 1. Comparison of reflection spectra in the region of a single E phonon near 197 cm^{-1} for GdFb and TbFB at several temperatures. Interaction with a CF excitation of Tb^{3+} ion leads to the formation of coupled electron-phonon modes.

The number and symmetries of vibrational modes are in good agreement with factor-group analysis for the *R*32 structure. In the low-temperature structural phase the number of phonon modes increases considerably due to a tripling of the primitive crystal cell. The most interesting effect found in the vibrational spectra of $RFe_3(BO_3)_4$ is the influence of the magnetic ordering upon phonon modes. Both Raman and IR modes experience shifts and changes of their intensities. We attribute this effect to the magnetostriction and an enhancement of unharmonicity below T_N. Raman scattering on magnons and electronic excitations also gives a new information on the magnetic ordering. Comparative study of temperature-dependent polarized IR reflection spectra of GdFB and TbFB single crystals revealed a formation of the 4f-electron-phonon coupled mode in TbFB (see Fig. 1).

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