Ultrasonic and optical properties and emission of Er3+/Yb3+ doped lead bismuth-germanate glass affected by Bi+/Bi2+ ions

ABSTRACT

Rare earth doped heavy metal oxide glasses instead of silicates are interesting research area, especially, for their potential application in optoelectronics. In addition, contribution of different bismuth ionization states in photoluminescence spectra is still an open question. In this research work, [GeO2]60–[PbO]40−x–[½Bi2O3]x, glass hosts where x=0, 10, 20, 30, and 40 mol% and 0.5 wt% of Er2O3 and 1.5 wt% of Yb2O3 as doping agents were studied. The activated heavy metal oxide glass samples were synthesized by conventional melt quenching method. The optical properties were studied by refractive index, UV–visible absorption and photoluminescence (PL) measurements, and explained in terms of the Judd–Ofelt theory. The glass was also studied by ultrasonic measurements and showed that the velocity of sound is lower in Pb-rich samples. Our results also, showed that emission intensities are higher in host glasses with lower sound velocities, which is attributed mainly to multiphonon relaxation. In addition, variation of PL intensities with increase of bismuth composition was related not only to the variation of Debye temperature and refractive index; but also, to the increase of Ω6 in Pb-rich samples due to the ligand field and existence of Bi2+/Bi+ ions in Bi-rich glasses.

Keyword: Er3+/Yb3+ doping; Bi-doping; Ultrasonic measurement; Photoluminescence; Judd–Ofelt theory; Multiphonon relaxation