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INVESTIGATION OF CRYSTAL AND MAGNETIC STRUCTURES OF MULTIFFERROIC MATERIALS

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Lead iron tungsten oxide, Pb(Fe2/3W1/3)O3 (PFW), is one of the well-known magnetoelectric relaxors which may be considered as the prototype for fundamental understanding of the magnetoelectric interactions. It is a ferroelectric and antiferromagnetic perovskite, in which the cations (Fe3+ and W6+) are randomly distributed in the octahedral B-site positions. The ferroelectric Curie temperature TC for PFW has been indicated to occur between 170-190 K. In addition, PFW is an attractive material for some technical applications, e.g., thick film capacitors. The disordered magnetoelectric perovskite lead iron niobate, PbFe1/2Nb1/2O3 (PFN), is also well known as an intriguing candidate for manufacturing many electronic and electromechanical devices. PFN exhibits ferroelectric and antiferromagnetic properties with a Neel temperature in the range 143-170 K. However, the nature of the magnetic ordering in PFN remains poorly understood. Solid solutions in the PFW-PFN system have been studied as potential dielectric materials for multilayer capacitors. The low Curie temperature of PFW can easily be shifted upwards forming a solid solution with PFN. As a result, the multicomponent system may exhibit more attractive multifunctional properties near room temperature. Detailed experimental data on structural and magnetic properties of PFW-PFN solid solutions are currently unavailable. Further investigations of PFW-based solid solutions are relevant. We have chosen to study the compositions of (xPbFe2/3W1/3O3-(1-x)PbFe1/2Nb1/2O3) (x=1.0, 0.6, 0.1). The knowledge of relationship between magnetic and crystal structure of such compounds, which can be obtained from high-pressure and low temperature investigations, are very essential for understanding the nature and mechanism of physical phenomena observed in it. In addition, the detail studies of structural changes under extreme conditions were not carried out.
In present work were performed neutron diffraction studies of (xPbFe2/3W1/3O3-(1-x)PbFe1/2Nb1/2O3) (x=1.0, 0.6, 0.1) at high pressures and low temperatures. Neutron powder diffraction measurements at high pressures up to 7 GPa were performed with the DN-12 diffractometer at the IBR-2 high-flux pulsed reactor [FLNP, JINR, Dubna, Russia] using the sapphire anvil high-pressure cell. In order to improve the understanding of the lattice instabilities the Raman spectroscopy studies of the vibration spectra of the compound under pressure up to 30 GPa were performed. The crystal structures of these compounds also have been studied by X-ray diffraction at high pressures. Pressure and temperature dependences of the volume, unit cell parameters and of magnetic moments of antiferromagnetic (AFM) phase, Neel temperature were obtained for the compounds of solid system (xPbFe2/3W1/3O3-(1-x)PbFe1/2Nb1/2O3) (x=1.0, 0.6, 0.1). With increasing temperature and pressure, slight decreasing of the magnetic moments of iron ions in PFWO were observed, however, although the crystal structure remains stable up to high pressures with a space group Pm-3m. Some Raman modes have been found on the Raman spectra, which in such compounds are correlated with the existence of nanoregions, however, with increasing pressure, these modes noticeably widen and vanish.
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