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Improved Physical Properties of Ni-doped $BiFeO_3$ Ceramic

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Recently, multiferroic materials have attracted much attention due to their fascinating fundamental physical properties and potential technological applications in magnetic/ferroelectric data storage systems, quantum electromagnets, spintronics, and sensor devices. Among single-phase multiferroic materials, $BiFeO_3$, in particular, has received considerable attention because of its very interesting magnetoelectric properties for application to spintronics. Enhanced ferromagnetism was found by Fe-site ion substitution with magnetic ions. In this study, $BiFe_{1-x}Ni_xO_3$ (x=0 and 0.05) bulk ceramic compounds were prepared by solid-state reaction and rapid sintering. High-purity Bi_2O_3, Fe_3O_4 and NiO powders were mixed with the stoichiometric proportions, and calcined at 450°C for 24 h to produce $BiFe_{1-x}Ni_xO_3$. Then, the samples were directly put into the oven, which was heated up to 800°C and sintered in air for 20 min. The crystalline structure of samples was investigated at room temperature by using a Rigaku Miniflex powder diffractometer. The Raman measurements were carried out with a Raman spectrometer with 514.5-nm-excitation Ar+-laser source under air ambient condition on a focused area of 1-μm diameter. The field-dependent magnetization and the temperature-dependent magnetization measurements were performed with a vibrating-sample magnetometer. The x-ray diffraction study demonstrates the compressive stress due to Ni substitution at the Fe site. $BiFe_{0.95}Ni_{0.05}O_3$ exhibits the rhombohedral perovskite structure R3c, similar to $BiFeO_3$. The lattice constant of $BiFe_{0.95}Ni_{0.05}O_3$ is smaller than of $BiFeO_3$ because of the smaller ionic radius of Ni3+ than that of Fe3+. The field-dependent magnetization of $BiFe_{0.95}Ni_{0.05}O_3$ exhibits a clear hysteresis loop at 300 K. The magnetic properties of $BiFe_{0.95}Ni_{0.05}O_3$ were improved at room temperature because of the existence of structurally compressive stress.

Keywords: Multiferroic, $BiFeO_3$, Magnetic properties, Ferroelectric properties