MS13-2-8 Emergence of High-Coercivity Ferromagnetism and R3c-to-Pn21a Phase Transition in Single-crystalline Gd-doped $BiFeO_3$ nanowires
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Abstract
We fabricated single-crystalline, Gd-doped $BiFeO_3$ (BFO) nanowires using a hydrothermal technique. X-ray diffraction (XRD) data and high-resolution transmission electron microscopy (HRTEM) revealed pure single-phase crystalline $Bi_{1-x}Gd_xFeO_3$ (x = 0, 0.05, 0.10) nanowires of 40 - 60 nm diameter and their structural transformation from the rhombohedral R3c (for x = 0 and 0.05) to the orthorhombic Pn21a crystal structure (for x = 0.10). The addition of Gd^{3+} ions to the pure-phase BFO leads to remarkable changes in the structural and magnetic properties, which effects are caused by differences in the ionic-radii and magnetic moment between the Bi^{3+} and Gd^{3+} ions. According to the observed magnetization-field (M-H) and magnetization-temperature (M-T) curves, with increasing Gd^{3+} concentration, the saturation magnetization (M_s), squareness (Mr/Ms), coercivity (Hc), exchange-bias field (H_{EB}) and magnetocrystalline anisotropy (K) increased markedly, by Ms = 1.26 emu/g (640%), Mr/Ms = 0.19 (20.5%), Hc = 7788 Oe (4560%), H_{EB} = 501 Oe (880%) and K = 1.62 x 10^5 erg/cm^3 (3500%), for x = 0.10 relative to the data for x = 0. In such Gd-doped BFO nanowire samples, spin-canted Dzyaloshinskii–Moriya interaction, remarkable enhancements in the magnetocrystalline anisotropy as well as uncompensated surface ferromagnetic spin states in the antiferromagnetic core regions also were found. Such remarkable enhancements in Gd-doped BFO nanowires might offer a variety of spintronic applications.

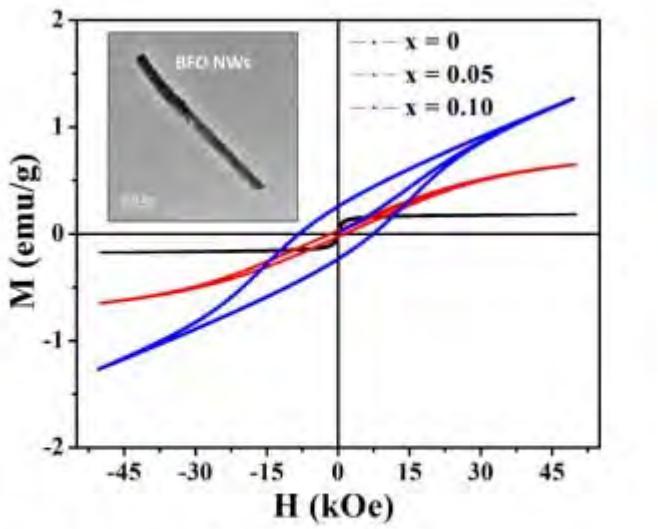

Fig. 1. Magnetization hysteresis (M–H) loops for samples measured at 300 K. The inset shows TEM images of BFO nanowire.