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Spin-phonon interaction of mixed-phase $BiFeO_3$ films studied by Raman spectroscopy YI-CHUN CHEN, YEN-CHIN HUANG, Department of Physics, National Cheng Kung University, WEN-I LIANG, YING-HAO CHU, Department of Material Science and Engineering, National Chiao Tung University — Multiferroic $BiFeO_3$ (BFO) has ferroelectricity and antiferromagnetism at room temperature, and so was motivated for novel magnetoelectric applications. When a BFO film is epitaxially grown on the $LaAlO_3$ (LAO) substrate, the strong compressive strain will transform BFO to a mixed-phase state, including rhombohedrally (R-) and tetragonally (T-) distorted monoclinics. The stripe-shape R-BFO is embedded in T-BFO matrix, forming periodic domains which possess enhanced piezoelectric response and spontaneous magnetization. Moreover, the magnetic R-BFO phases can be switched by external electric fields. Here, in order to study the mechanism of strain induced magnetic properties, we report a detailed Raman study of the mixed-phase BFO. The phonons of each phase are distinguished by an in-situ testing system combining an atomic force microscope (AFM) and a Raman spectroscope. When external magnetic fields are applied, a low-frequency phonon mode of T-BFO phase changes due to the magnetostrictive effect. Variations of mixed-phase phonons versus temperature are also studied, which show that phonon shifts of high-frequency modes are contributed from phonon-phonon anharmonic interaction; by contrast, the shifts of low-frequency modes are due to spin-phonon interactions.

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