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Anomalous low-temperature magnetic ordering and spin-phonon coupling in BiFeO$_3$ thin films

MANOJ SINGH, Department of Physics and Institute of Functional Nano Materials, University of Puerto Rico, PR, USA, RAM KATIYAR, Department of Physics and Institute of Functional Nano Materials, University of Puerto Rico, PR, USA, W. PRELLIER, Laboratoire CRISMAT, CNRS, ENSICAEN, Caen Cedex, France, H.M. JANG, Department of Materials Science and Engineering, Pohang University of Science and Technology, Pohang, Korea, W. PRELLIER COLLABORATION, H. M. JANG COLLABORATION, RAM S. KATIYAR TEAM — Low-temperature magnetic properties and Raman spectra of epitaxial BiFeO$_3$ (BFO) thin films grown on (111) SrTiO$_3$ substrates have been studied. Zero-field-cooled (ZFC) and field-cooled (FC) magnetization curves showed a large discrepancy beginning at a characteristic temperature which did depend on the magnetic-field strength, suggesting a spin-glass-like behavior of the epitaxial BFO film with R3c symmetry. For all three major A$_1$-symmetry Raman modes (138, 170, and 214 cm$^{-1}$), there was a good linear correlation between the mode-frequency softening and the square of the in-plane magnetization in the temperature range between 80 and 300 K. These observations were ascribed to the spin-phonon coupling below the Néel temperature ($T_N = 643$ K).

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