

六方晶 TbFeO₃ 薄膜のスピン・電荷における反フェローフェロ相転移

Antiferroic-to-ferroic phase transitions in spin and charge of hexagonal TbFeO₃ film

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[Introduction] Rare-earth iron oxides ($R\text{FeO}_3$) are known as multiferroic materials. In contrast to the most stable orthorhombic (o -) perovskite structure, showing the ferroelectricity only below a few K, metastable hexagonal (h -) $R\text{FeO}_3$ shows spontaneous ferroelectric polarization even at room temperature [1]. The ferroelectric and magnetic properties of h - $R\text{FeO}_3$ highly depend on the ionic radius of R^{3+} . Ferroelectric properties of h - $R\text{FeO}_3$ with $R^{3+} = \text{Dy}^{3+}$ – Lu^{3+} have been studied thus far. In this study, we studied multiferroic properties of h - TbFeO_3 film, in order to clarify the effect of smaller R^{3+} than that of Dy^{3+} – Lu^{3+} .

[Experiment] h - TbFeO_3 films were fabricated on epitaxial ITO-buffered (111) YSZ single crystal substrates by PLD method. Out-of-plane magnetization was measured by superconducting quantum interference device (SQUID) magnetometer. Permittivity was measured by LCR meter. Ferroelectric properties were analyzed by the ferroelectric tester.

[Results and discussion] Figure (a) shows polarization versus electric field (P – E) curves of the h - TbFeO_3 film. It exhibited antiferroelectricity at 200 K and ferroelectricity at 175 K. Such antiferroelectric behavior was also observed in h - DyFeO_3 film. Thus, a use of small R^{3+} ions is effective to obtain antiferroelectric phase in h - $R\text{FeO}_3$ system. Figure (b) shows the magnetization versus temperature (M – T) curve. It has positive and negative peaks at 30 and 10 K, respectively, indicating that temperature-induced phase transition occurs associated with the spin reorientation [1]. The inset of Fig. (b) shows M of the film as a function of magnetic field (H). At 10 K, double hysteresis loop was observed, indicating that antiferromagnetic to ferromagnetic transition is also realized by applying different H .

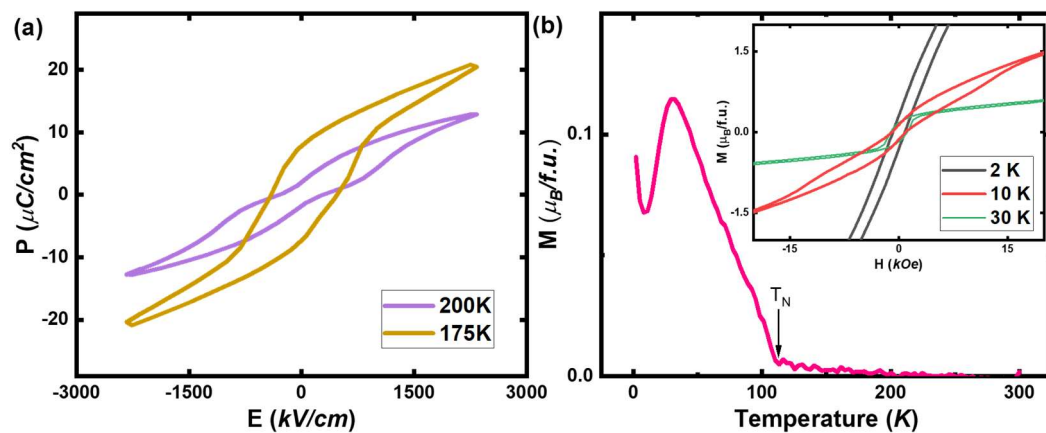


Figure (a) Polarization versus electric field curves of the h - TbFeO_3 film at 175 and 200 K. (b) The magnetization versus temperature curve. The inset shows magnetization versus magnetic field curves.

<Reference> [1] M. Li *et al.*, *Phys. Chem. Chem. Phys.*, 22, 14415 (2020).