Strain-driven electronic structure and magnetic behaviors in orthorhombic $YMnO_3$ thin films

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Abstract

Multiferroic orthorhombic $YMnO_3$ (*o-YMO*) is one of the most studied members in the rare-earth manganites owing to the rich emergent physical phenomena and, in particular, the tunability obtainable by external parameters, such as strain and chemical composition. The *o-YMO* exhibits simultaneous ferroelectric and weak ferromagnetic properties at low temperatures in bulk form. However, when it was stabilized in thin film form by epitaxial strain originated from the lattice mismatch between film and substrate, it was found that the associated electronic and magnetic properties of *o-YMO* could be modified markedly. Specifically, in this report, we investigate the structure and magnetic properties of *o-YMO(00l)* grown on $SrTiO_3$*(100)* substrate by pulsed laser deposition (PLD). We identify the phase as well as the shift left and misalignment of thin film via x-ray diffraction (XRD) θ-2θ and ϕ-scan. The strain in film inherent from the slight lattice mismatch between film and substrate evidently altered the tilting of manganese-oxygen octahedral unit, resulting in substantial changes the electronic structure of *o-YMO.* Namely, both of the *Mn-O* and *Y-O* bond lengths become longer along *c*-axis and shorter in *ab* plane leading to spectral weight shifting between e_g and t_{2g} orbitals. Consequently, the Néel temperature of the obtained *o-YMO* film increases to 43.4K, as compared to 40 K reported for the bulk *o-YMO.* Moreover, the magnetization measurements show an enhancement of magnetization remnant and coercive field, when applying a magnetic field parallel to the *ab* plane. The results will be presented and discussed.

Keywords – orthorhombic $YMnO_3$ thin film, X-ray diffraction (XRD) θ-2θ and ϕ scan, X-ray absorption spectroscopy (XAS), temperature-dependent magnetization (M-T), field dependent magnetization (M-H).