Epitaxial growth and strain-related optical properties of polar magnetic $PbVO_3$ thin films

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Tetrahedron-based perovskite $PbVO_3$ (PVO) is an intriguing polar magnetic material because its strong tetragonal distortion allows VO_5 square-pyramidal structure rather than VO_6 octahedron. Bulk PVO is known to show the unique features of 2-dimensional antiferromagnetic ordering and large pyroelectric polarization. In a single-crystal bulk, the ground state of magnetic ordering of PVO is degenerated by C- and G-type configurations [1] and its transition temperature is reported as T_N=47 K [2]. In this study, we fabricated epitaxial PVO thin films on $LaAlO_3$ (LAO) (001) and $SrTiO_3$ (STO) (001) substrates by pulsed laser deposition with off-stoichiometric condition [3]. Structural properties of the epitaxial PVO thin films with respect to mechanical strain induced by lattice mismatch with substrates were investigated by X-ray diffraction, high-resolution transmission electron microscopy, Raman scattering spectroscopy. As a result, abnormal lattice elongation of the PVO thin films along c-axis and consequent octahedral distortion were observed. Our magnetic measurement exhibits a clue for this exotic phase at low temperature, which is a direct evidence for change of the exchange interaction between two adjacent d_{xy} electrons of the V^{+4} ions. The phenomenon is attributed to the elongation of the c-axis lattice parameter of the PVO thin-films. In addition, the experimental characterizations of linear and nonlinear optical properties for the PVO thin films were performed through spectroscopic ellipsometry and second harmonic generation (SHG), respectively. Symmetry breaking along c-axis in PVO thin films were demonstrated by using SHG signal with nonlinear susceptibility and Fresnel's formula fitting.

References

[1] D. Singh, Phys. Rev. B 73, 094102 (2006)
[2] K. Oka et al. Inorg. Chem. 47, 7355 (2008)
[3] S. H. Oh et al., J. Phys. D: Appl. Phys. 47, 245302 (2014).