ABSTRACT:

Metastable LaMn7O12: From Bulk HP Synthesis to Film Stabilization

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(LaMn3)Mn4O12 (LMO) belongs to the family of the quadruple perovskite (QP) structures with general formula (AA'3)B4O12. It derives from the pristine cubic structure of simple perovskites ABO3 by applying a very large rigid tilt of the BO6 octahedra, leading to a denser structure, which is typically stabilized by high pressures synthesis; indeed, LMO exhibits a slightly distorted monoclinic structure, that can be stabilized in bulk form only at pressure synthesis above 4 GPa [1]. It also shows intriguing megnetic properties: at TN,A' =21 K, the Mn3+¸ ions at the A' site order antiferromagnetically to form AFM coupled ferromagnetic planes, at TN,B =78 K, the Mn3+ ions at the B-sites order antiferromagnetically (AFM) in a canted structure, giving rise to a weak ferromagnetic (FM) response. Concomitant to the latter ordering, LMO undergoes a ferroelectric transition with saturation polarization of = 0.56μC cm- 2 [2]; this is a remarkable value for a polycrystalline samples that could be furtherly enhanced in single crystals or thin films.
Having this in mind, we successfully deposited LMO epitaxial thin films on (101)-oriented YAlO3 single crystal by pulsed laser deposition. X-ray diffraction, transmission electron microscopy and Raman spectroscopy demonstrate the growth of essentialy pure (100) oriented single-crystalline LMO film with no structural relaxation up to 100 nm thick layer. Preliminary results on magnetization, ferroelectric and pyrocurrent measurements on properly patterned LMO epitaxial films, confirm the AFM transitions of the bulk phase and probe the magneto-electric copling and the electric polarization.

[1] A. Prodi et al., Phys. Rev. B 79, 085105 (2009)
[2] A. Gauzzi et al., Appl. Phys. Letters, 115(15):152902 (2019).