Growth of Candidate Polar Metal Hexagonal Half Heuslers

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Hexagonal half Heuslers (space group P63mc, LiGaGe-type structure) have recently been proposed as a new hyper-ferroelectric materials system. In these ABC intermetallic compounds, layers of B and C atoms form a buckled honeycomb lattice, resulting in a net polarization along the c axis that is robust against the depolarizing field [1]. Moreover, many of these compounds exhibit large Rashba coefficients and magnetic order, making them a promising system for finding multiferroics [2]. However, demonstration of these properties and understanding the mechanism for hyper-ferroelectricity require high quality epitaxial films, which haven't yet been demonstrated.

Here we demonstrate the first epitaxial growth of LaPtSb and LaAuGe. These compounds are grown on *c*-plane Al2O3 by solid source MBE, using an Sb adsorption controlled window for LaPtSb, and by flux matching for LaAuGe. Symmetric 2theta-omega (Fig. 1) and in-plane rotation (phi scans Fig. S1) x-ray diffraction measurements confirm that the films are epitaxial and single crystalline, with the desired LiGaGe-type buckled hexagonal structure. RHEED patterns confirm well-ordered surfaces with surface reconstructions. Through a combined analysis of cross sectional TEM, second harmonic generation (SHG), and angle-resolved photoemission spectroscopy (ARPES) measurements, we are exploring the coupling of polar distortions to electronic structure and magnetism in these materials.

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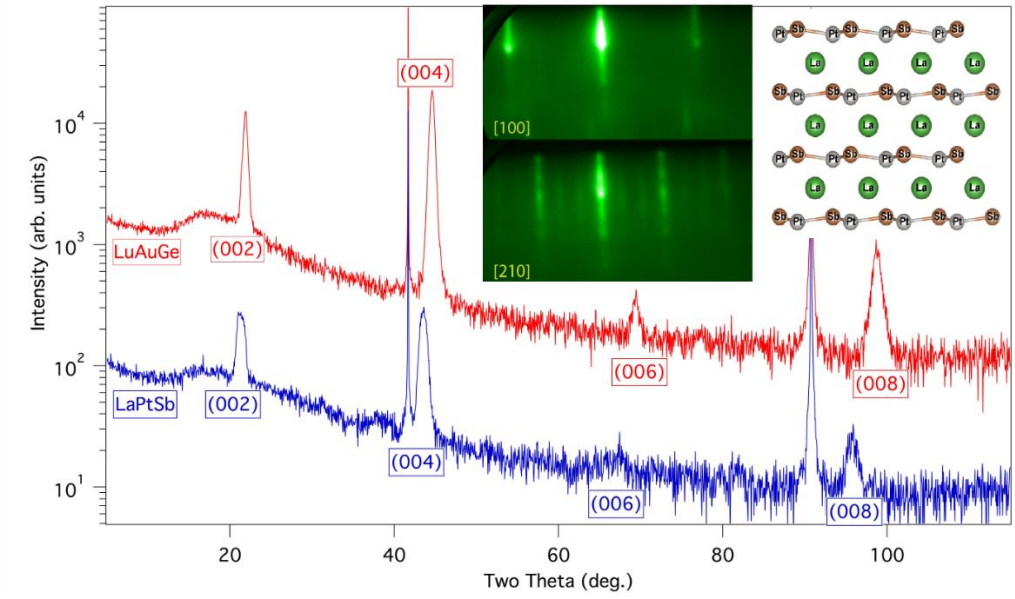

Fig1 2theta-omega XRD scan of LaAuGe and LaPtSb. The insets are RHEED patterns of LaAuGe along [100] and [210] direction and crystal structure of LaPtSb viewed from [010] direction.

[1] Kevin F, Phys. Rev. Lett. **112**,127061 (2014).
[2] Awadhesh Narava, Phys. Rev. B. 92.220101(R) (2015).
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Supplementary Page

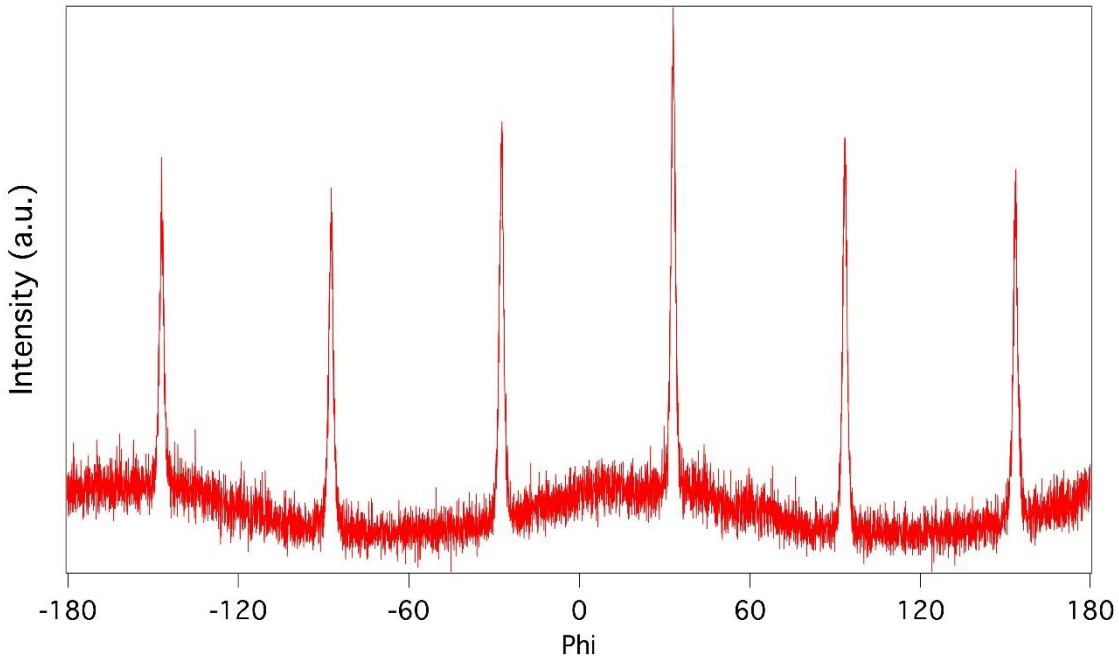

Fig. 1S Phi scan of LaPtSb {102} reflection.

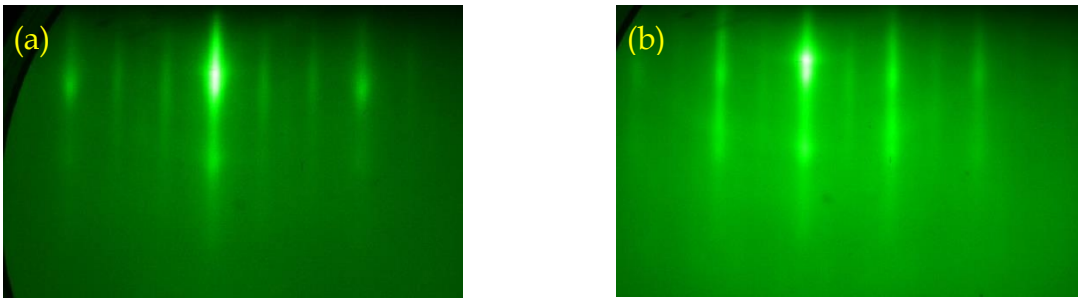

Fig. 2S RHEED of LaPtSb with incident electron beam along (a) [100] and (b) [210] direction.