Chemical potential tuning and strain engineering in topological Half-Heusler thin films

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Heusler compounds have emerged as an exciting material system where realization of functional and tunable novel topological phases might be possible [1-2]. PtLuSb is one such compound that has recently been shown to host topologically non-trivial surface states [3]. However, the chemical potential was found to lie below the Dirac point of the surface states, consistent with p-type Hall conductivity, in our thin films [4]. One way to shift the chemical potential above the Dirac point is to substitute a few of the platinum (Pt) atoms in PtLuSb with gold (Au), which has one more electron compared to Pt. We have successfully synthesized thin films of Au alloyed PtLuSb with different Au concentrations, up to 50% ($Pt_{0.5}Au_{0.5}LuSb$). Employing a combination of the techniques of *in situ* angle-resolved photoemission spectroscopy and scanning tunneling spectroscopy along with transport measurements we will provide evidence of our ability to tune the chemical potential via substitution alloying in $Pt_xAu_{1-x}LuSb$ thin films.

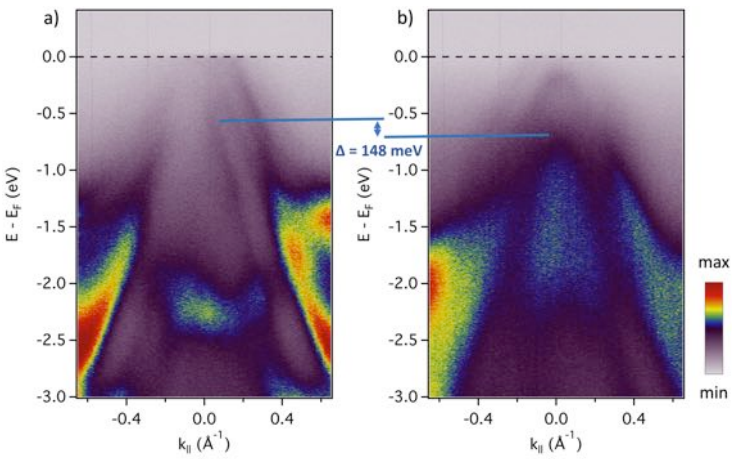

Figure 1. Energy-momentum *(E-k)* spectra of 15 nm thick (001) oriented **a)** PtLuSb **b)** $Pt_{0.62}Au_{0.38}LuSb$ thin film synthesized of InSb buffered GaAs substrate. The spectra were taken at an incident photon energy of 55 eV

Furthermore, PtLuSb being a semi-metal does not possess a bulk band gap. As a result, exotic transport and thermodynamic properties expected from topological surface states are often obscured by contributions from trivial bulk carriers. In this talk, I will present our efforts to address this issue by synthesizing compressively strained thin films on lattice mismatched substrate that is expected to lift the degeneracy of Γ_8 manifold, thereby opening a bulk band gap.

[1] S. Chadov *et al*, Nature Mater, 9, 541 (2010)
[2] H. Lin *et al*, Nature Mater, 9, 546 (2010)
[3] J. A. Logan *et al*, Nature Commun, 7, 11993 (2015)
[4] S. J. Patel *et al*, Appl. Phys. Lett., 104, 201603 (2014)
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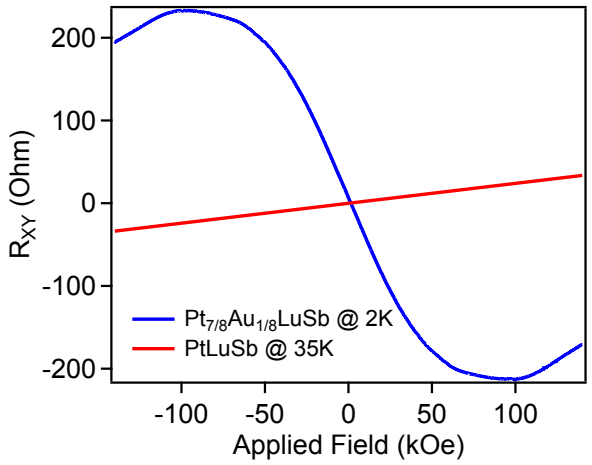
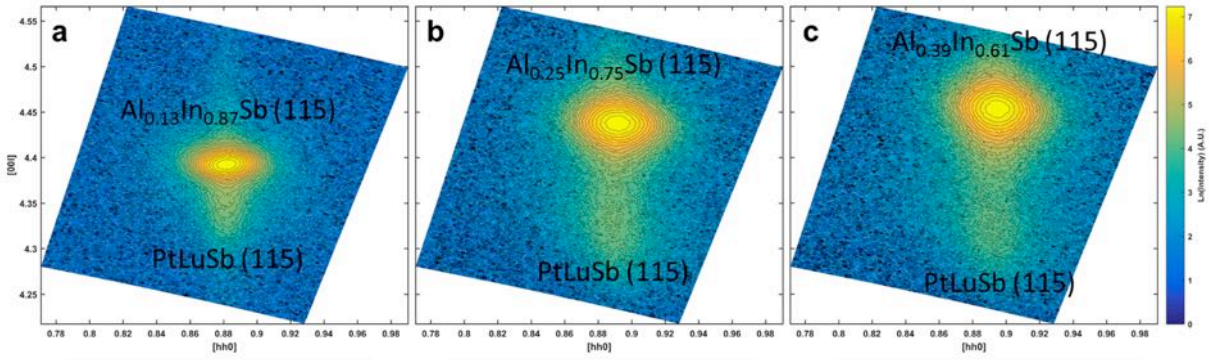


Figure S1: Hall resistances of 15 nm thick films of PtLuSb and $Pt_{7/8}Au_{1/8}LuSb$ taken at 2 K and 35 K, respectively showing a change from p-type to n-type behavior on alloying with gold (Au).



Buffer *a*:	6.435 Å
Strain (%):	-0.35%

Buffer *a*:	6.395 Å
Strain (%):	-0.97%

Buffer *a*:	6.346 Å
Strain (%):	-1.75%

Figure S2: Reciprocal space maps of 10 nm thick, compressively strained PtLuSb thin films showing thin films can be coherently strained upto 1.75%