ARPES studies of transition metal / topological crystalline insulator interface

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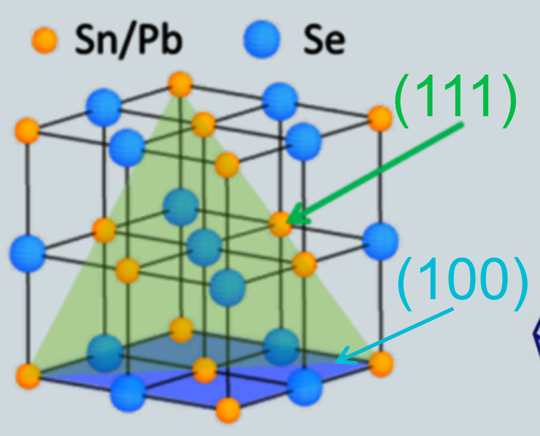
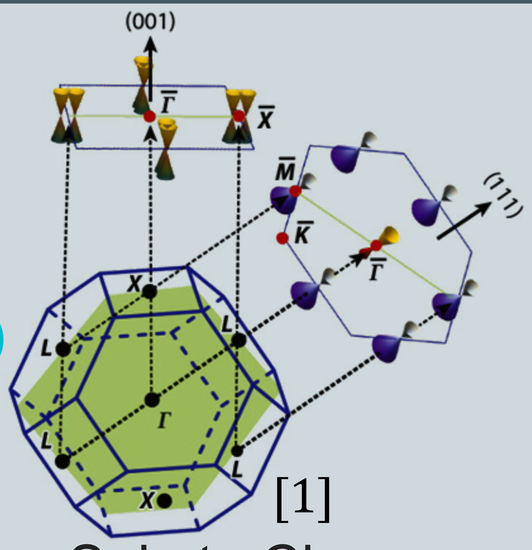
Introduction & Motivation

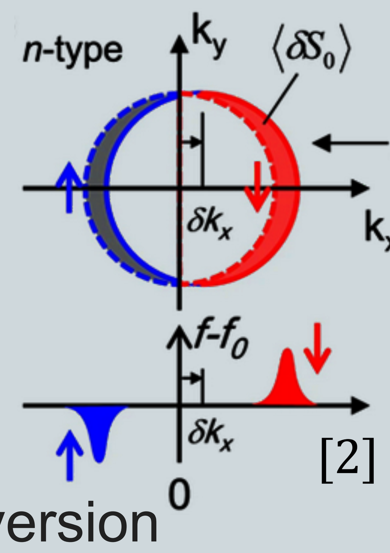
TSS - Topological surface states

Topological Crystalline Insulators (TCI):
- TSS exists on (001) and (111) surfaces
- (001) surface - Non-polar
- (111) surface - Polar
- (TSS) protected by mirror symmetry of (110) surface



PbSnSe:
Rock salt structure





Spin to Charge conversion
Edelstein effect

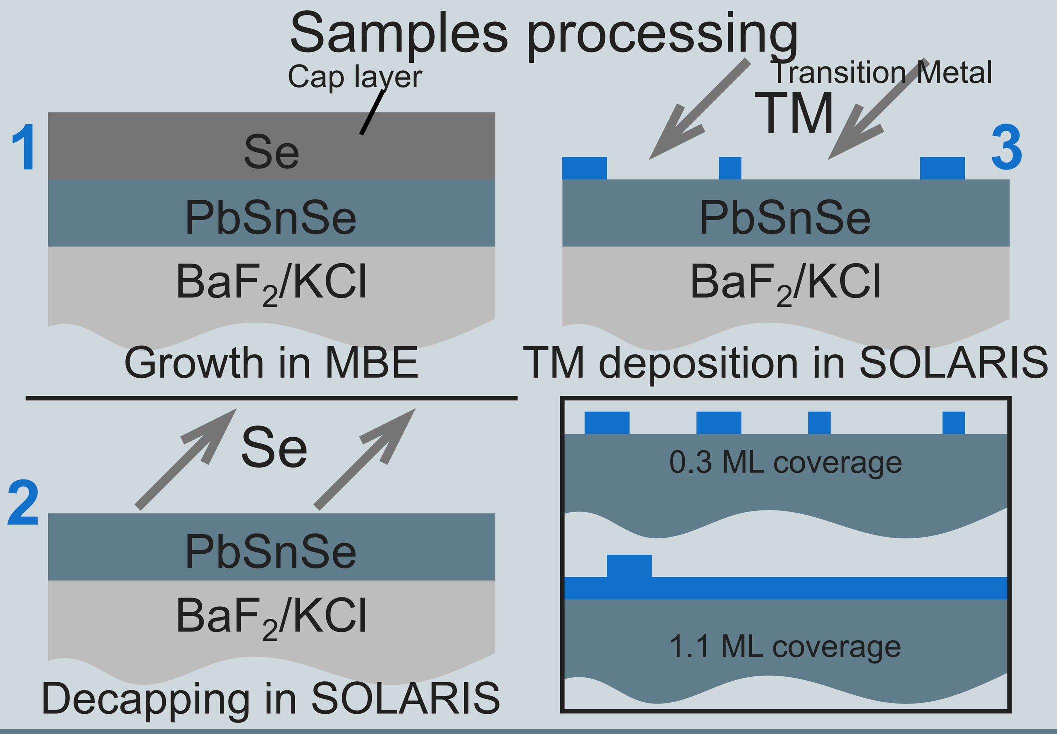
Fundamental point

Magnetic (TM) dopants on the surface
Do they open band gap resulting in surface magnetism? [3]

Application

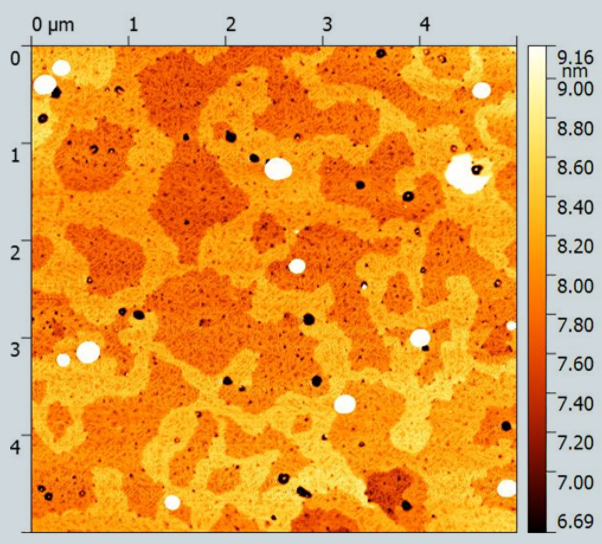
What happens at **magnetic material/ topological crystalline insulator** interface? (Transition Metal)

$Pb_{1-x}Sn_xSe$ TCI preparation



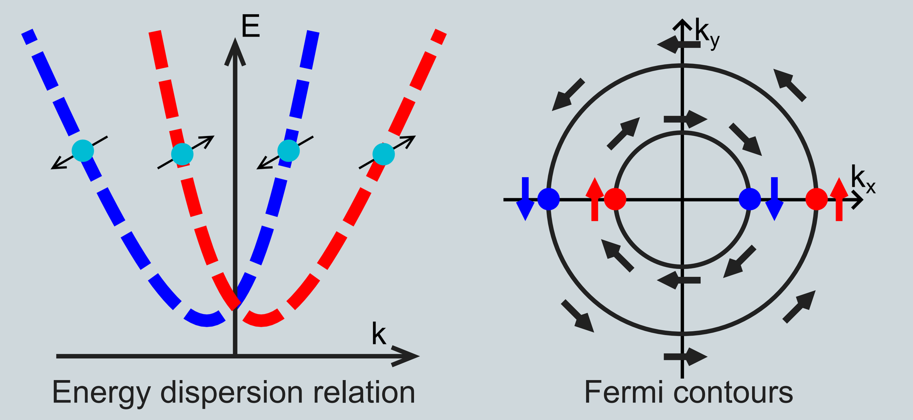
MBE growth 1μm thick $Pb_{0.7}Sn_{0.3}Se$

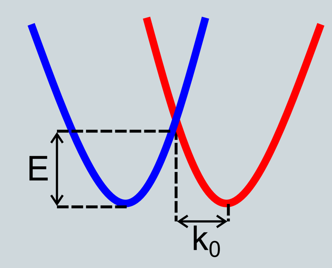
RHEED



AFM

Rashba splitting



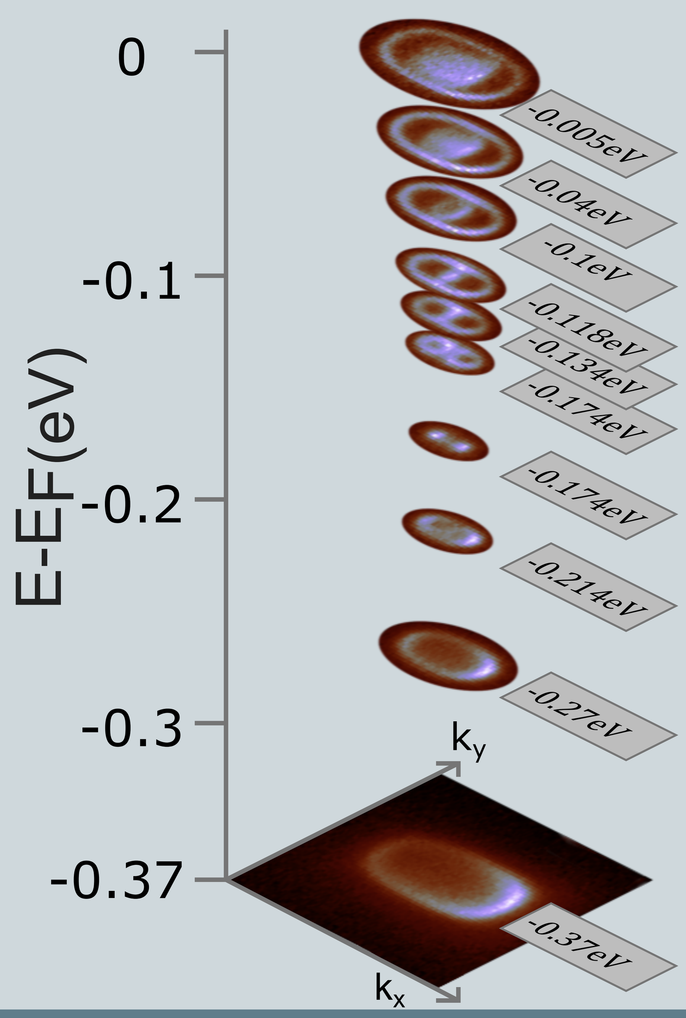


Rashba parameter

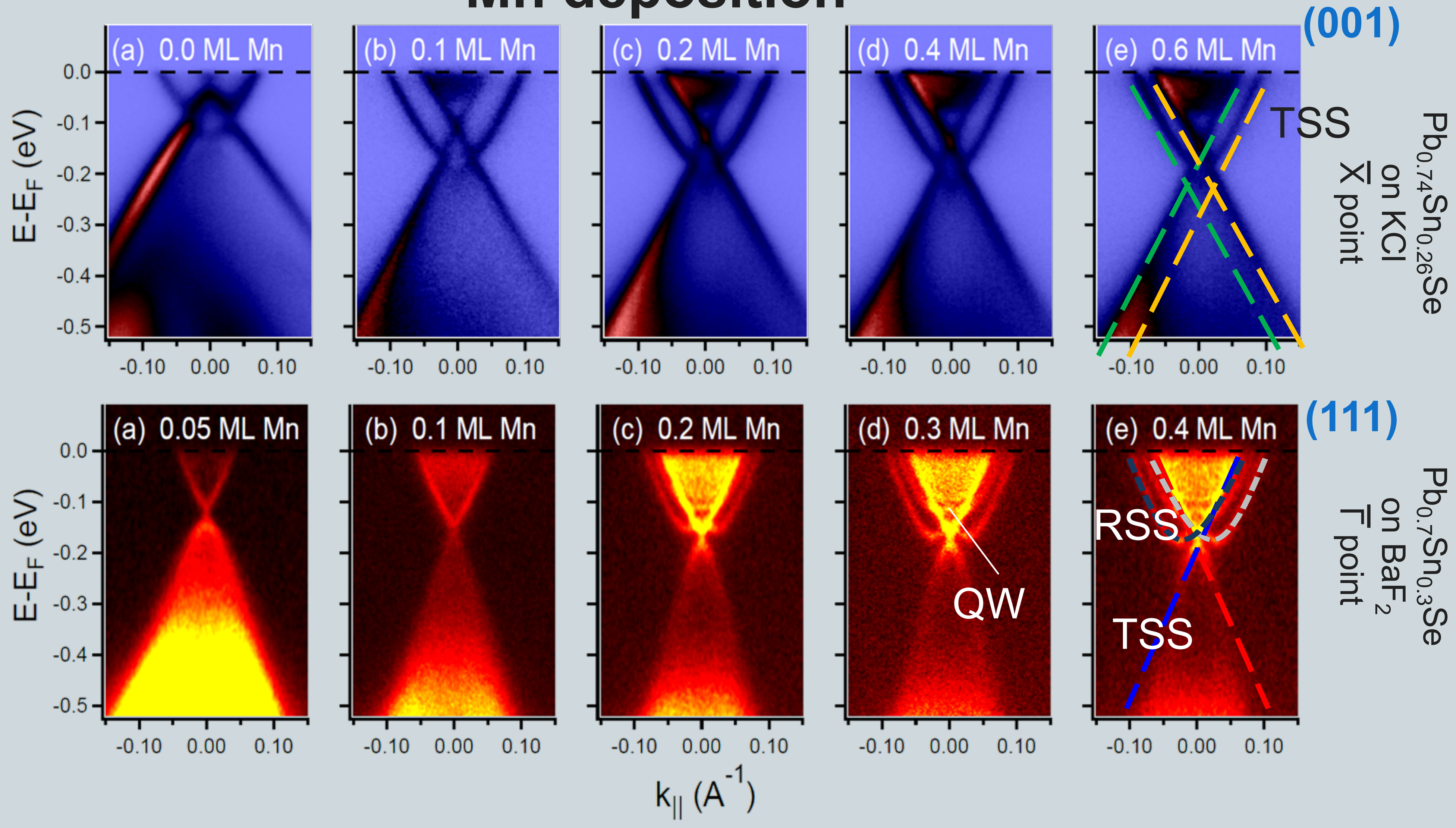
$\alpha_R = 2E/k_0$

ARPES results

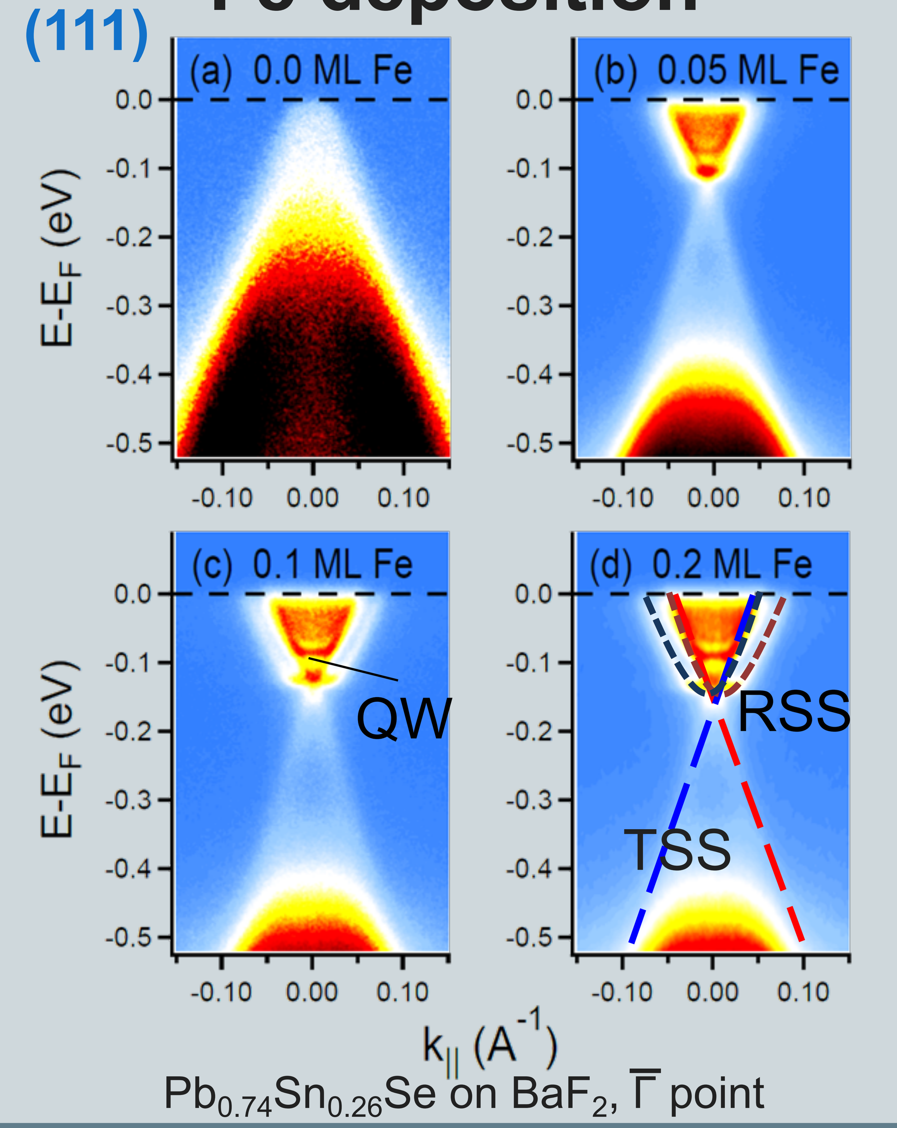
$Pb_{0.74}Sn_{0.26}Se$ + 0.1ML Mn
Constant energy surface map
KCl (001)



Mn deposition



Fe deposition



$Pb_{0.74}Sn_{0.26}Se$ on BaF_2, $\bar{\Gamma}$ point

Summary

- Rashba Splitted Surface States (RSS) in conduction band (CB) for (111) samples
- Possibility to tune Rashba parameter α_R in range 0 to 1.5 eV·Å in function of deposited TM
- Decrease of separation in k-space between Dirac points of the double Dirac cone for (001) samples

In contrast to theoretical prediction [3] magnetic doping of TCI surface did not open TSS band gap.
E_F is shifted upwards into conduction band due to metal deposition n-doping.
Fe and Mn submonolayer deposition on PbSnSe (111) resulted in band bending (due to additional charge accumulation on the surface) causing formation of quantum well near surface as well as Rashba splitting.
Rashba effect was absent for (001) oriented films since this plane contains both metal and chalcogen atoms.
Decrease in Dirac cones separation may be caused by dephasing of wave functions for Dirac cones in presence of electric field introduced by surface doping.

References

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