Magneto-transport studies on topological crystalline insulator SnTe thin film

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Introduction/Motivation

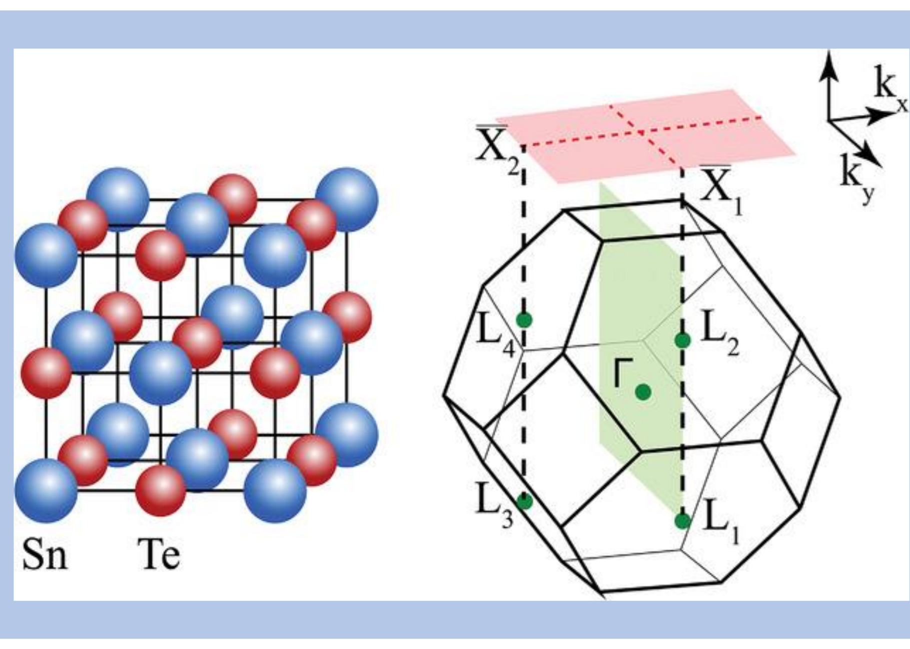
Topological crystalline insulator

- High spin-orbit coupling & Spin-momentum locking at surface states
- Surface states are protected by the crystalline symmetry
- The study of electronic transport through the topological surface states is hampered by the contribution from the bulk. Nanostructuring of these materials will allow to enhance the contribution from surface states.

SnTe

- Narrow band gap IV-VI semiconductor (band gap: 0.18 eV)
- Cubic rock salt crystal structure at room temperature
- Lattice parameters: a=0.63 nm

SnTe lattice & Brillouin zone

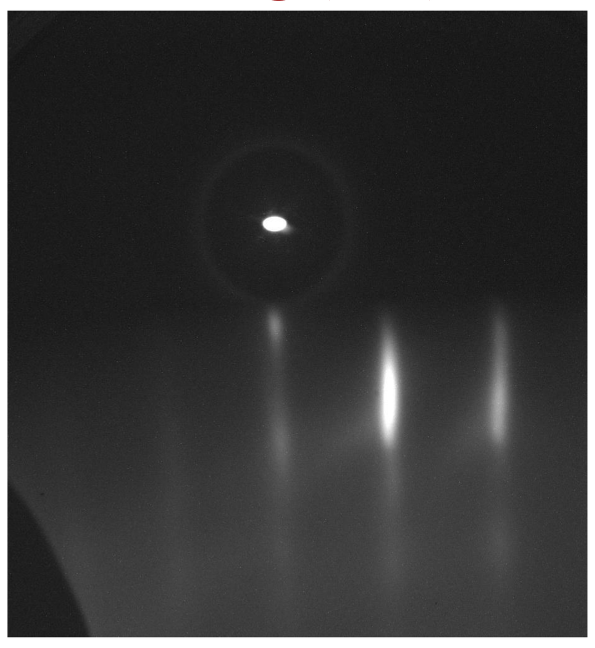


Experimental Methods

Sample details

- The SnTe thin film was grown by molecular beam epitaxy (MBE) technique
- Base pressure : 10^{-9} mbar
- Thickness of SnTe film: 100 nm
- Substrate: GaAs (100) with CdTe buffer layers

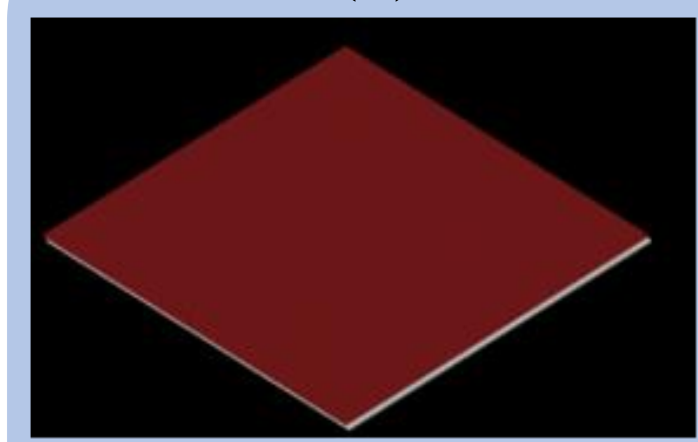
RHEED image Along (100)



In-situ RHEED image during the growth of SnTe thin film through MBE

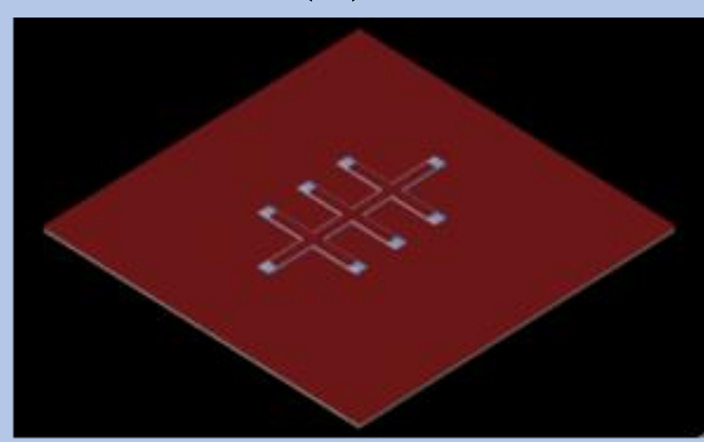
Sample fabrication steps

(1)



SnTe with e-beam resist

(2)

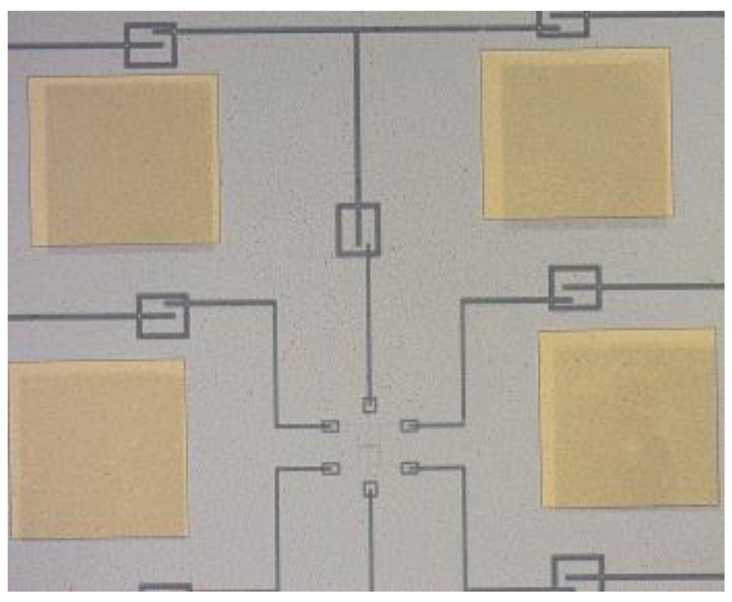


Patterning and etching

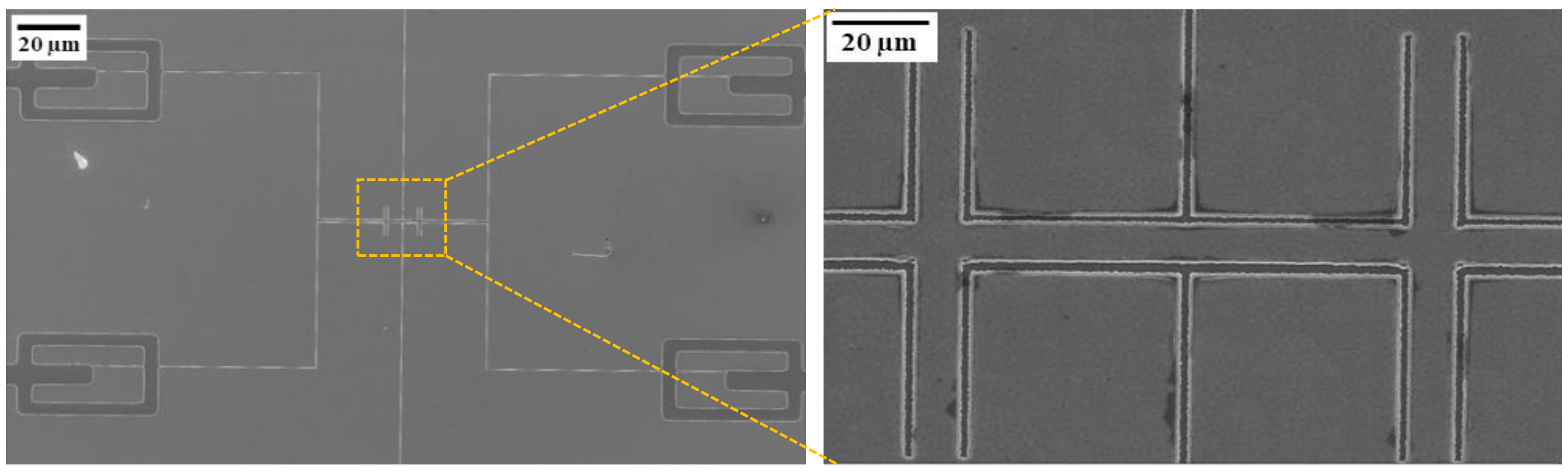
(3)

Gold contact pads

Optical microscopy image



SEM Image of the SnTe Hall bar

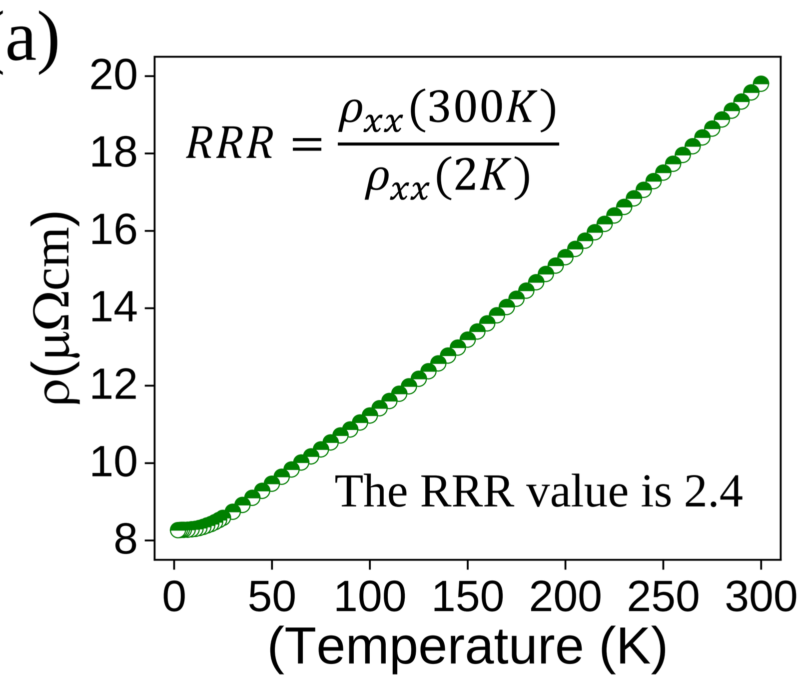


Hall bar fabrication

- Hall bar pattern was obtained using electron beam lithography & ICP-RIE etching
- Hall bar width: 750 nm
- Hall bar length: 10.15 µm

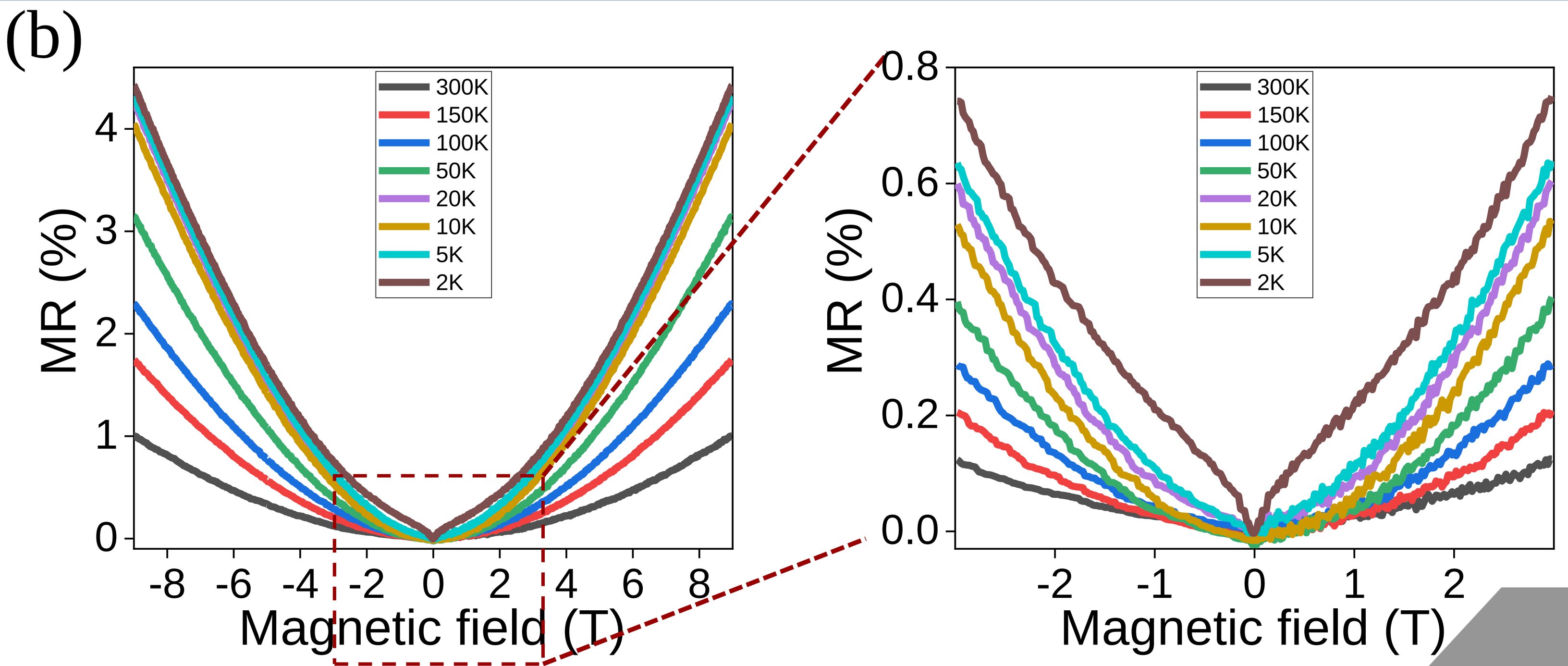
Magneto-transport study

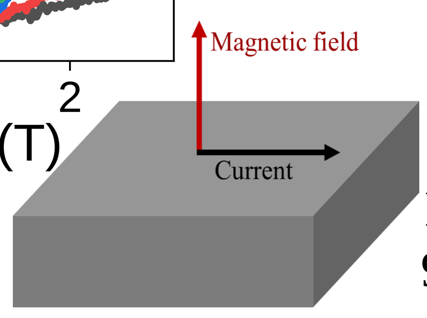
(a)



Temperature dependence of resistivity from 300 K to 2 K

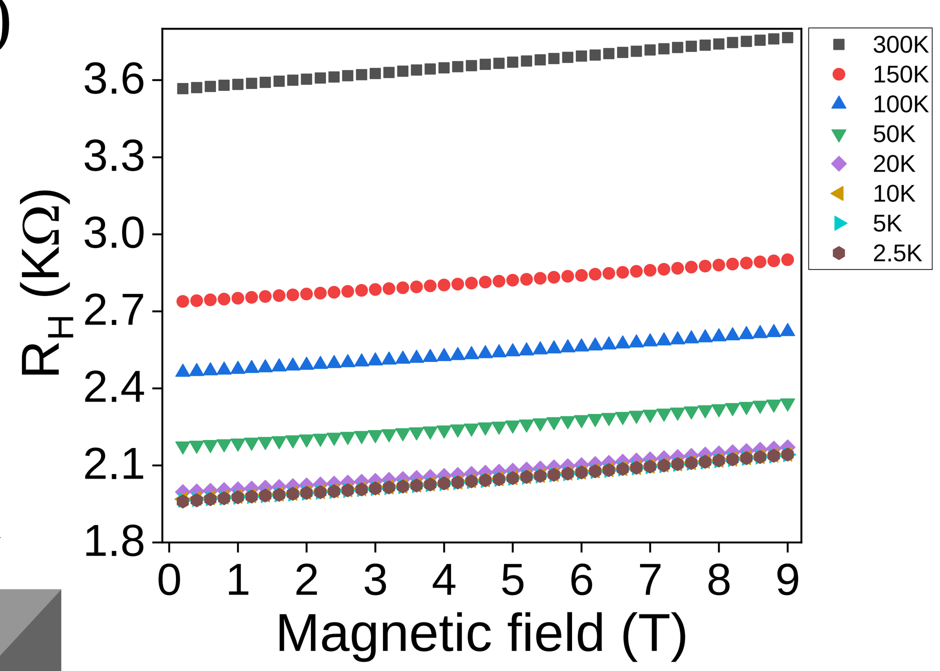
(b)





Magnetoresistance up to a magnetic filed of 9 T at temperatures from 300 K to 2 K

(c)



Hall resistance up to a magnetic field of 9 T at temperatures from 300 K to 2.5 K

Summary

- Resistivity was measured as a function of temperature and magnetic field.
- Temperature dependence of resistivity shows metallic behavior.
- At 2 K around zero magnetic fields, we observed a cusp which can be attributed to weak anti-localization in the transport by the surface states [5, 6].
- The p-type carrier concentration was calculated from the Hall resistance and found to be ~ 3×10^{18} cm^{-3}.

References

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