INL/EXP-19-54966-Revision-0

Electronic and transport properties of topological material GdxSb2-xTe3

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Electronic and transport properties of topological material $Gd_xSb_{2-x}Te_3$

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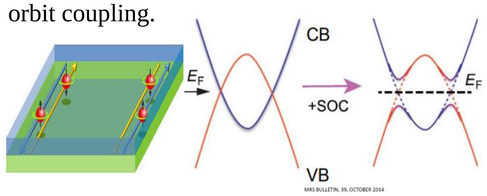
Motivation

Topological Insulator (TI):

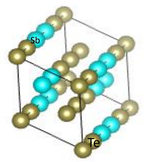
❖ Bulk band gap like an ordinary insulator but have protected conducting states on their edge or surface.

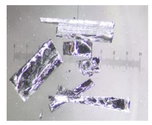
- ➢ Due to spin-momentum locking, spin polarized electrons can move through surface.
- ➢ Band inversion as a result of strong spin orbit coupling.

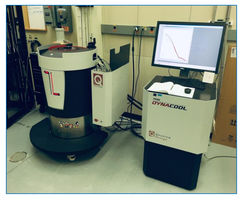


Gd doped TI ($Gd_xSb_{2-x}Te_3$) :

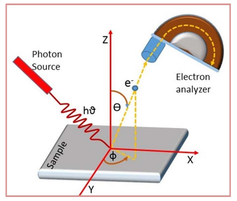
❖ Trigonal, space group: R3m [166]
❖ Parent Sb_2Te_3 is a strong TI.
❖ Energy band gap ~0.3 eV
❖ Crystal synthesis by flux method.
❖ Characterized by XRD and EDS.







PPMS



ARPES

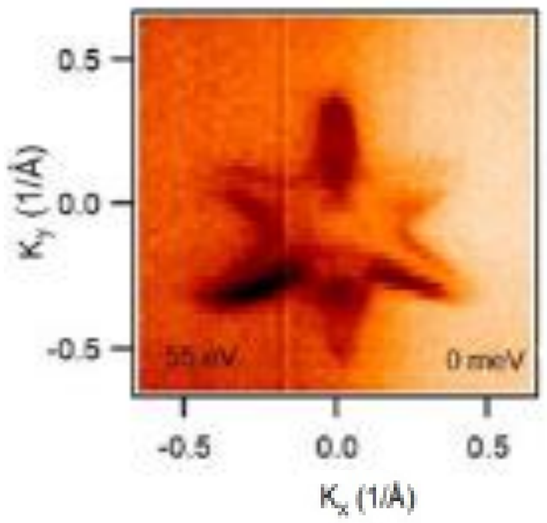
❖ Direct experimental technique based on the photoelectric effect.

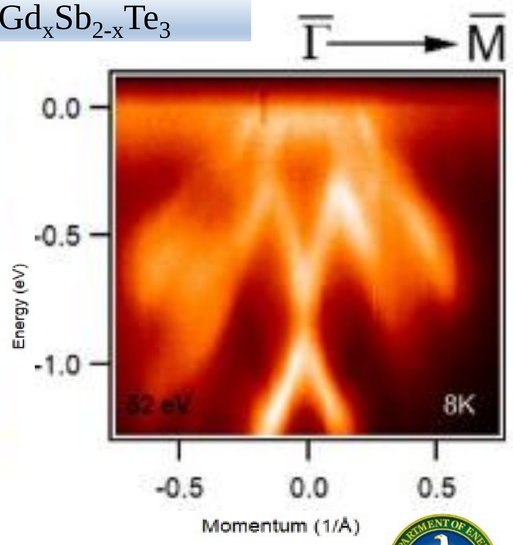
$E_{kin} = h\vartheta - \Phi - |E_B|$

$P_{||} = \hbar k_{||} = \sqrt{2mE_{kin}}.\sin\Theta$

✓ Tuning Fermi energy by doping.
✓ Studies of electronic properties of this material.
✓ One of the best thermoelectric material.
✓ Archetypical TI (Sb_2Te_3)

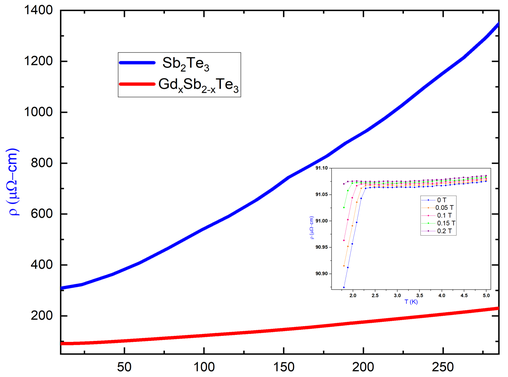
Fermi surface and Dispersion map of $Gd_xSb_{2-x}Te_3$





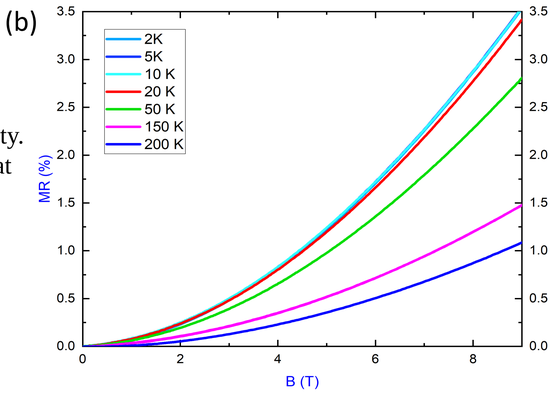
Transport and Magnetization properties of $Gd_xSb_{2-x}Te_3$

(a)



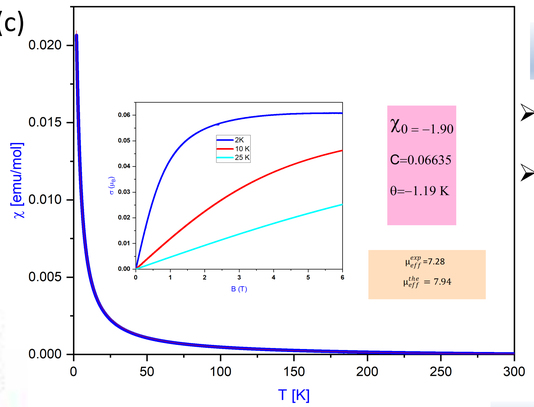
➢ Metallic conductivity.
➢ Anomaly at 2.3 K??

(b)



➢ Relatively low MR~3.5%
➢ No saturation up to 9T.

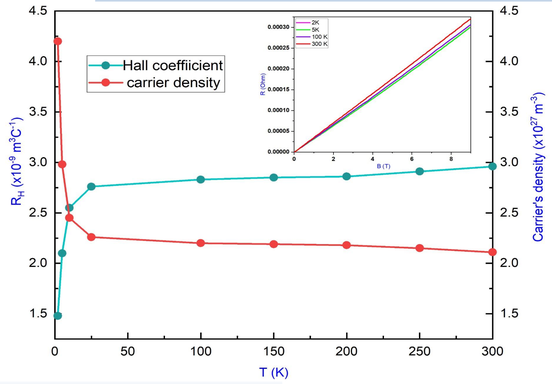
(c)



$\mu_J^{exp} = 0.060\ \mu_B$
$\mu_J^{the} = 2\ \mu_B$

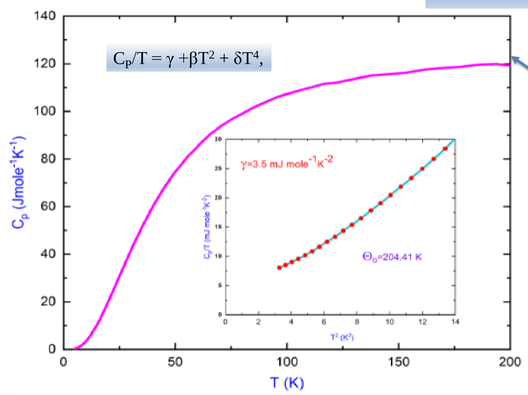
➢ Determine Gd content.
➢ Good agreement with EDS (1% Gd).

Hall resistivity and carrier concentration



➢ Positive (ordinary) Hall effect.
➢ Holes dominant.

Heat capacity measurement



Dulong Petit limit 3Rn~125 Jmole^{-1}K^{-1}

➢ For parent Sb_2Te3, γ=0.7±0.7 mJ mole^{-1}K^{-2}

Conclusion:

❖ Successfully synthesized $Gd_xSb_{2-x}Te_3$.
❖ Significant influence of Gd on electronic properties.
❖ Magnetism: excellent probe of small Gd concentration in $Gd_xSb_{2-x}Te_3$.

To be continued….

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