Topological phases in $Sn_{1-x}In_xTe(001)$ layers

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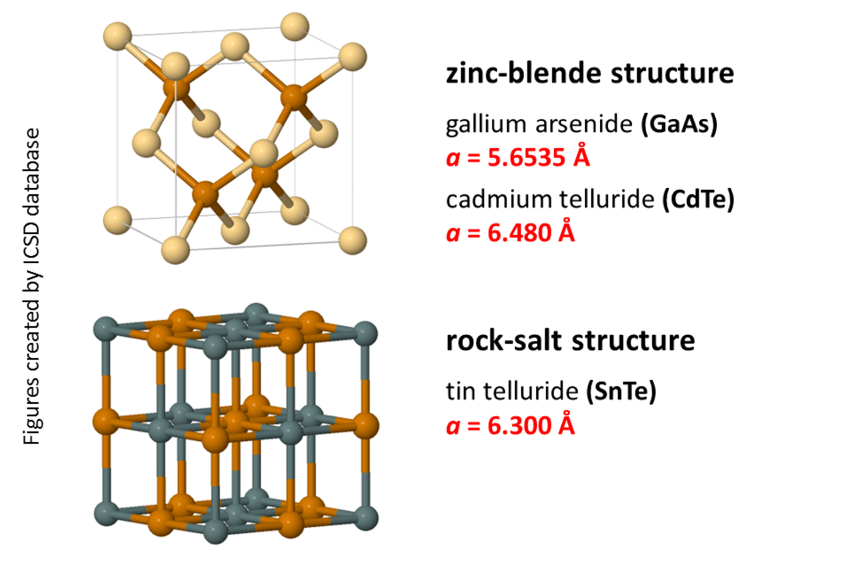
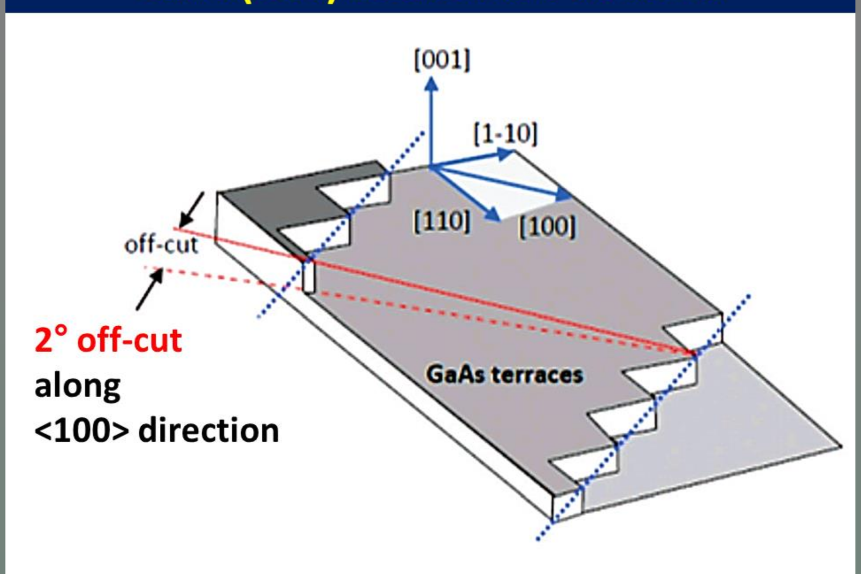
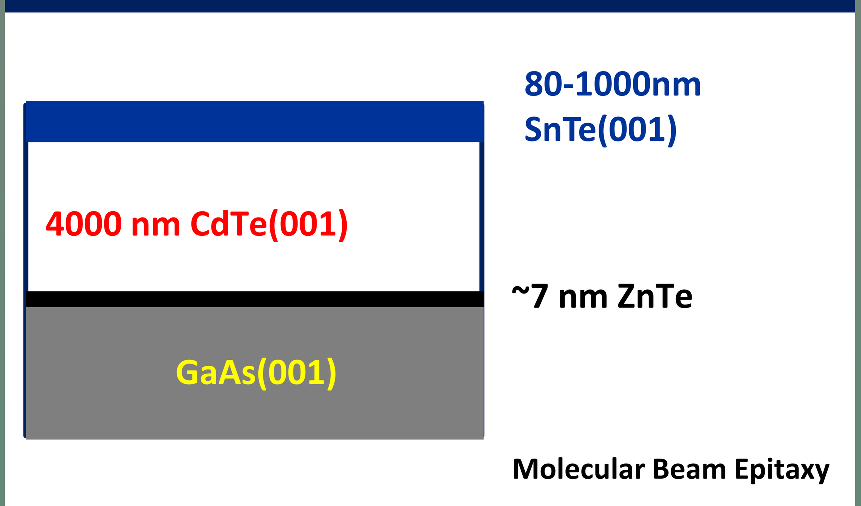
Unit cells of GaAs, CdTe and SnTe



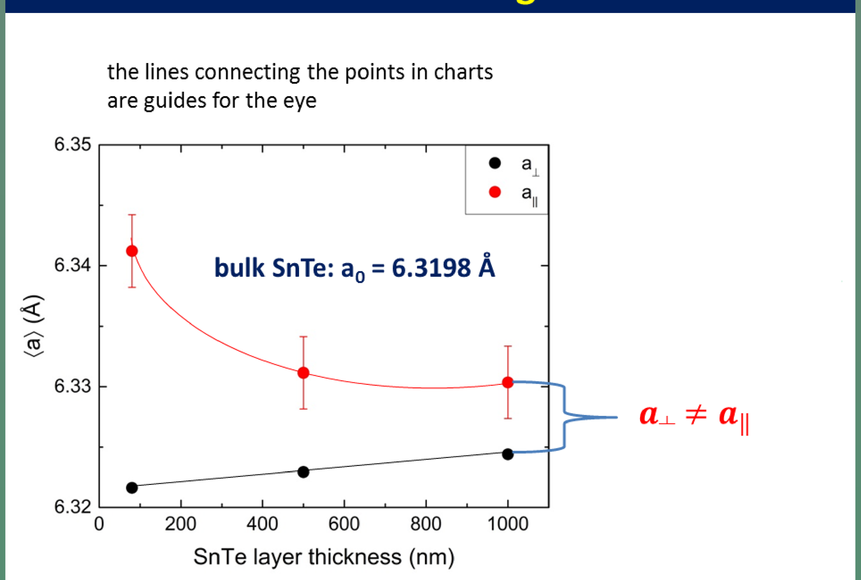
GaAs(001) substrate's scheme



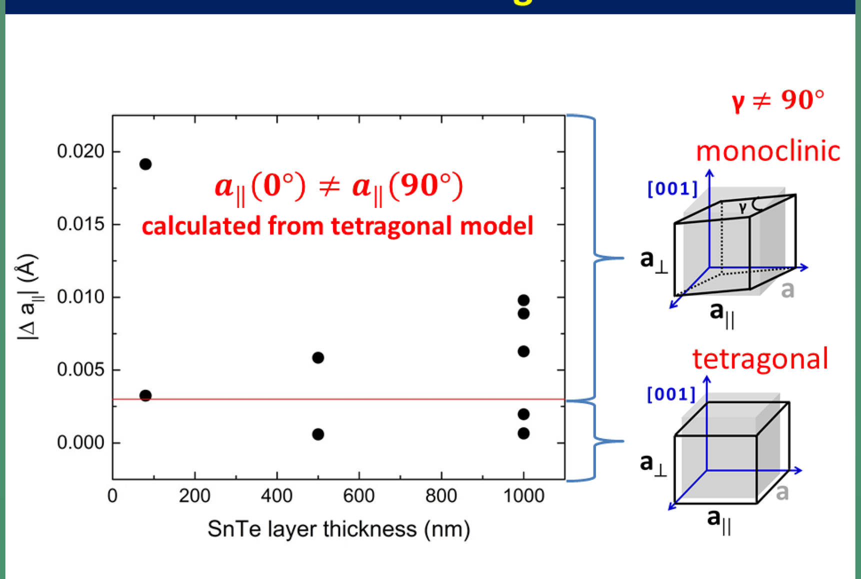
Heterostructure's scheme



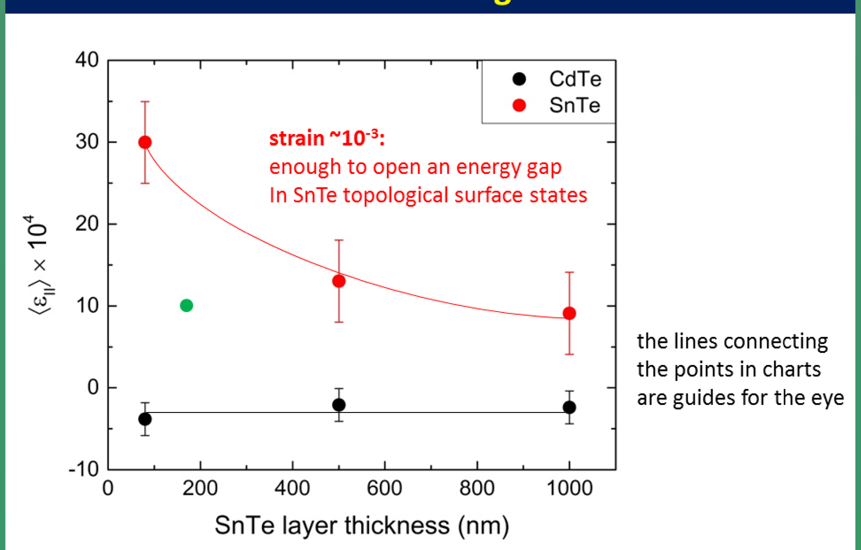
SnTe unit cell distortion magnitude and order



SnTe unit cell distortion magnitude and order



Impact of a SnTe layer thickness on horizontal strain magnitude in SnTe



Description of the project

SnTe-based narrow-gap semiconductors are scientifically promising materials, known, among others, from their topological and thermoelectric properties [1-3]. Structural investigations performed recently by us also gave interesting results, suggesting a possibility of obtaining in MBE-grown layers of topological crystalline insulator SnTe(001) a deformation-induced energy gap in the surface states by depositing this material on a special substrate, which can work as a source of monoclinic in-plane unit cell distortion with the strain value ~10^{-3} [4].

The started new research involves further modification of SnTe properties by incorporating In to its crystal lattice in order to change its electronic band structure and obtain other topological phases (Dirac and Weyl semimetals), predicted by theoreticians for $Sn_{1-x}In_xTe$ [5, 6]. The aim of the planned proposal for a beam-time at SOLARIS is an ARPES study of the electronic band structure of samples with $Sn_{1-x}In_xTe(001)$ layers, deposited on the same kind of a substrate as SnTe(001) layers [4]. The new material has been grown for this project in a frame of collaboration with the team from the Department of Physics, University of Notre Dame, Indiana, United States; this team reported lately a growth of high quality layers of $Sn_{1-x}In_xTe$ on other substrate [7]. We need the data concerning the band structure of the studied material to check whether the desired topological semimetals are obtained.

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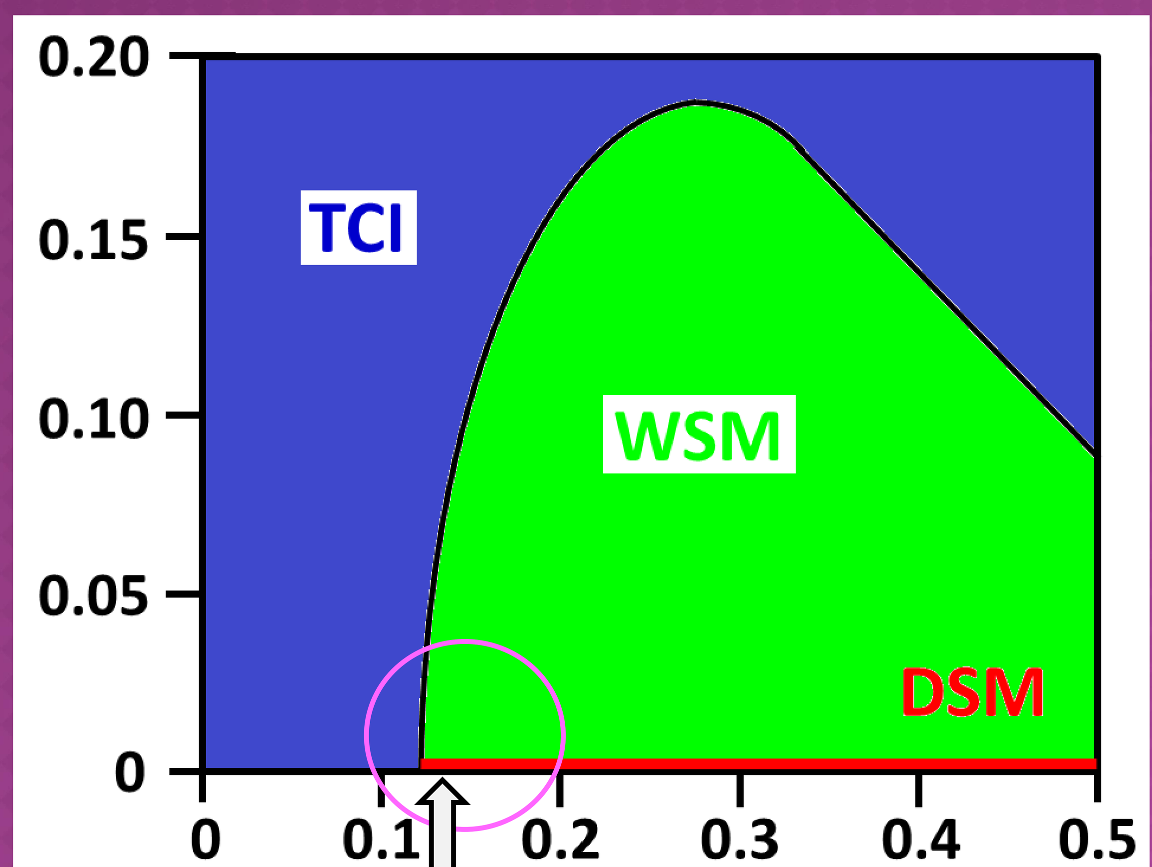
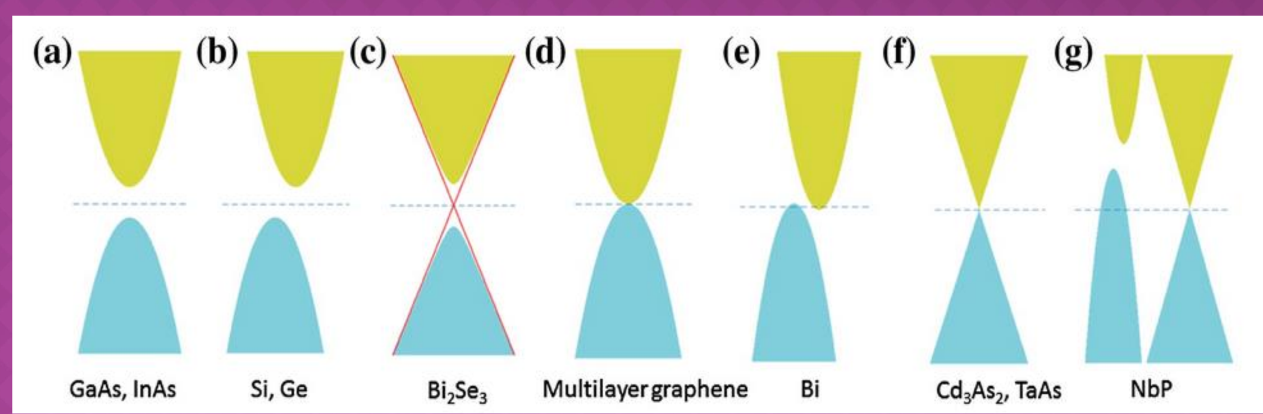
Topological phase diagram of bulk $Sn_{1-x}In_xTe$ based on [5]



phase transitions:
TCI→DSM: for $x \geq 0.12$
DSM→WSM: caused by a strain

(a) direct bandgap semiconductor
(b) inirect bandgap semiconductor
(c) topological insulator
(d) semimetal with valence band and conduction band touching
(e) semimetal with valence band and conduction band overlapping in different momentum point
(f) topological semimetal owns linear energy dispersion in the bulk
(g) topological semimetal has additional hole pockets near the Weyl point



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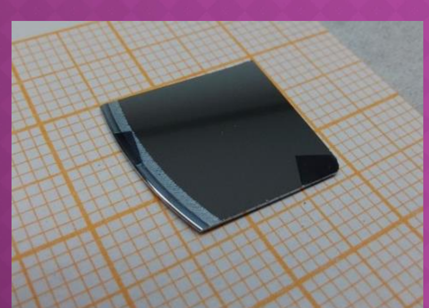
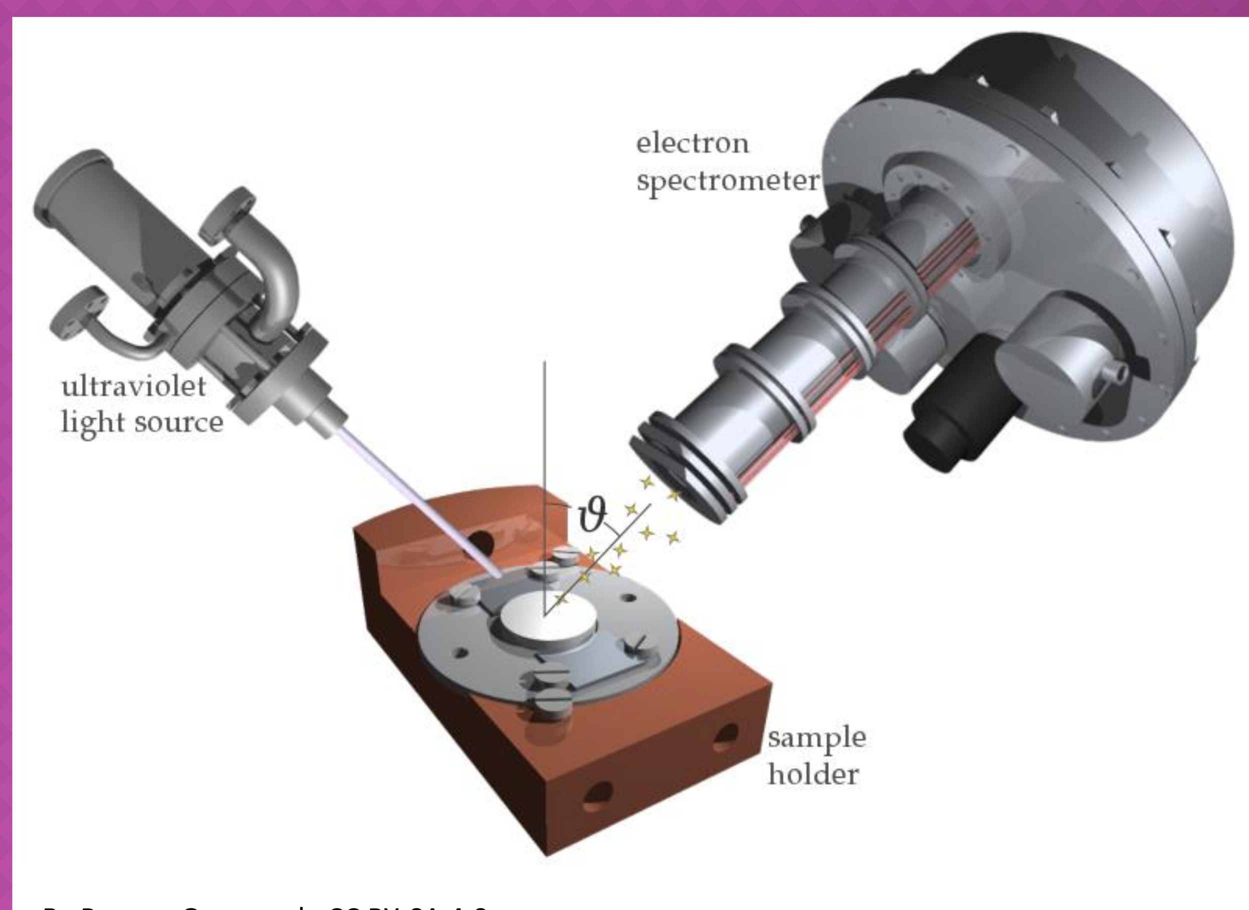
Research idea: investigation of $Sn_{1-x}In_xTe(001)$ layers



80-1000nm $Sn_{1-x}In_xTe(001)$
x=0-0.2
cap:
amorphous bilayerTe/Se
evaporation:
Se: 65°C-90°C
Te: up to 220°C

The main research technique: ARPES



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European Union
European Regional Development Fund
European Funds
Smart Growth
Republic of Poland
FNP Foundation for Polish Science
Narodowe Centrum Nauki

This research was partially supported by:
- the Foundation for Polish Science through the IRA Programme, co-financed by EU within SG OP, Grant No. MAB/2017/1 (T. Story, T. Wojtowicz);
- the NCN Grants: UMO 2017/27/B/ST3/02470 (E. Łusakowska, W. Wołkanowicz) and UMO 2019/35/B/ ST3/03381 (P. Dziawa, J. Sadowski).