Quantum transport in (111)-oriented $Pb_{1-x}Sn_xSe$ topological crystalline insulator epilayers and quantum wells

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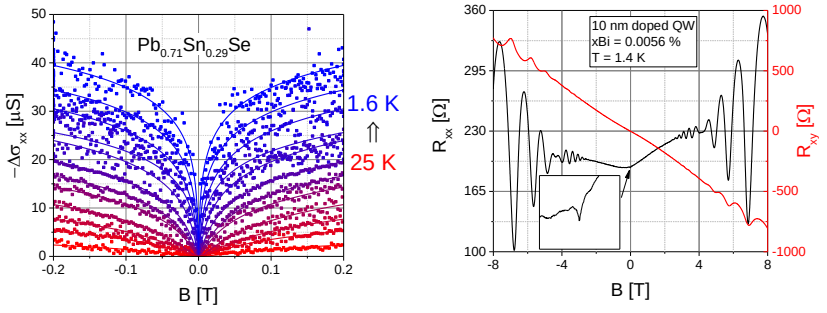
Topological materials are commonly identified by the presence of surface or edge states that are topologically protected by certain symmetry. The topological protection of topological crystalline insulators (TCI) class of materials is due to mirror symmetry [1], which can be broken by external perturbations, such as the electric field. Gate control over helicity degree of freedom of Dirac fermions lies in the heart of realization of an electronic analog of chiral metamaterials [2]. In this work, we made the first steps toward the realization of such a system through the growth of high-quality 2D TCI layers and studies of their properties with the use of quantum transport.

Here we report our results on the magnetotransport characterization of (111)-oriented $Pb_{1-x}Sn_xSe$ thin films that were MBE-grown on a BaF_2 substrate either directly or embedded between $Pb_{0.9}Eu_{0.1}Se$ barriers [quantum well (QW) structure]. The high structural quality of obtained samples was confirmed by RHEED, XRD, AFM and SEM investigations.

Magnetotransport measurements performed on epilayers reveal carrier density and mobility to be ~10^{19} cm^{-3} and ~10^3 cm^2/V s, respectively. In QWs carrier density was reduced by Bi doping and mobility was enhanced by an order of magnitude compared to epilayers. All studied epilayers showed well-pronounced positive magnetoresistance (MR) feature in the low magnetic field region. Though usually such behavior is identified as weak antilocalization effect and is interpreted as an evidence for TSS, we found it in epilayers with both trivial and topological compositions and also in tilted magnetic fields. A similar MR effect is observed in narrow QWs, with thicknesses ≤10 nm in perpendicular fields. All studied QWs show pronounced quantum oscillations of MR. Analysis of magnetotransport effects and properties will be presented.



Low-field temperature dependent positive MR observed TCI $Pb_{0.71}Sn_{0.29}Se$ in epilayers (left). Example of observed Shubnikov-de Haas oscillations found in $Pb_{0.75}Sn_{0.25}Se$ (right).

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[1] Y. Ando, L. Fu , *Annu. Rev. Condens. Matter Phys.* **6**, 361 (2015)
[2] L. Zhao, J. Wang, J. Liu et al., *Physical Review B* **92**, 041408(R) (2015)