# Growth and magnetotransport properties of (111) $Pb_{1-x}Sn_xSe$ topological crystalline insulator epilayers

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Topological crystalline insulators (TCI) attract a lot of attention because topological surface states (TSS) protected by mirror symmetry can be controlled by external perturbations or by growth engineering, e.g. strain, temperature, composition, film thickness, etc [1]. Up to now most of TSS magnetotransport investigations have been focused on (100) oriented bulk single crystals. Studies of theoretically predicted TSS on other crystal surfaces, e.g. (111) or (110) [2], are certainly of interest but the preparation of bulk single crystals having such facets remains challenging.

In this work we report on the growth by molecular beam epitaxy of (111) oriented $Pb_{1-x}Sn_xSe$ heteroepitaxial layers on $BaF_2$ substrates and on their structural and magnetotransport investigations. Control of the growth conditions allows us to obtain high quality epilayers with Sn concentrations x = 0÷40% and thicknesses of 50 nm and 1 μm. Hall effect and magnetoresistance measurements are performed in the magnetic field up to 8 T at temperatures down to 1.6 K. In contrast to previously reported works for (100) oriented films [3], our thin $Pb_{1-x}Sn_xSe$ epilayers show weak anti-localization behavior regardless of whether the composition x corresponds to the trivial or topological side of the phase diagram, which can be attributed to a large value of spin-orbit coupling. Magnetoconductivity is fitted to the Hikami-Larkin-Nagaoka formula, and values of prefactor $\alpha$ and phase coherence length $l_\varphi$ are obtained. The measured thin films exhibit also quantum oscillations in high magnetic fields. Carrier density determined from Shubnikov-de-Haas (SdH) oscillations are more than order of magnitude smaller compared to the values obtained from Hall effect measurements, which may indicate that the observed SdH oscillations originate from the presence of TSS. For the thick films, large (up to 300%) non-saturating linear magnetoresistance is observed, paving the way for realization of magnetoresistive devices based on $Pb_{1-x}Sn_xSe$ epilayers.

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[1] Y. Ando, L. Fu , *Annu. Rev. Condens. Matter Phys.* **6**, 361 (2015).
[2] T. Hsieh, H. Lin, J. Liu, W. Duan, A. Bansil, L. Fu, *Nature Comm.* **3**, 982 (2012).
[3] C. Zhang, Y. Liu, X. Yuan, W. Wang, S. Liang, F. Xiu, *Nano Lett.* **15**, 2161 (2015).