**Search for Shubnikov-de Haas Oscillations in Pb1-XSnXSe Single Crystals**

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**Introduction**

 Class IV-VI narrow-gap compound semiconductors have been studied for decades due their potential use in novel technological instrumentation, such as infrared optoelectronics and thermoelectric devices. Materials like PbTe, PbSe, SnTe, and their mixed alloys have high dielectric constants and quite unusual infrared and electronic properties [1]. Recently, the interest in these alloys has been renewed, as they have been suggested to represent a new, non-trivial, topological phase called topological crystalline insulator (TCIs) [2]. PbSe and SnSe, the two parent compounds of Pb1-xSnxSe system, have what is commonly known as band inversion. In order to investigate their electronic properties, we performed transport measurements on Pb1-xSnxSe single crystals (x = 0 and 0.15), searching for Shubnikov-de Haas (SdH) oscillations.

**Experimental**

 For this experiment we used single crystals of Pb1-xSnxSe synthesized using a vapor-phase grown technique. We used freshly cleaved surfaces and electrical contacts were realized using gold wire and silver paste. Measurements of longitudinal and Hall resistance were performed in magnetic filed up to 18 T and temperature as low as 0.5 K, using the SCM 2 facility at the NHMFL.

**Results and Discussion**

 As it can be observed from Fig.1 (a), in the PbSe (x = 0) sample, SdH oscillations are resolved above 5 T, and we found a single frequency with F = 15 T, originating from the bulk L pocket in the BZ. Effective mass, Dingle temperature and free carrier scattering rate extracted from quantum oscillations are in good agreement with our results from optical measurements. In the sample with x = 0.15, SdH oscillations were resolved only above 15 T, as it can be seen in Fig.1 (b). The frequency of oscillations if significantly larger, F ≈ 90 T, consistent with an increase in carrier concentration, hence a larger Fermi surface, upon Sn doping.

**Conclusions**

 In conclusion, we successfully resolved two Shubnikov-de Haas oscillations in single crystals of Pb1-xSnxSe (x = 0 and 0.15) and found good consistency between SdH data and our previous optical measurements. We plan to complete the study for x = 0.15 at higher magnetic fields and search for SdH oscillations in samples with higher Sn concentrations.

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**References**

 [1] G. Nimtz and B. Schlicht, *Narrow Gap Semiconductors* (Springer Verlag Berlin Heidelberg New York Tokyo, 1983).

 [2] L. Fu, Phys. Rev. Lett. 106, 106802 (2011).

 

Fig.1 Shubnikov-de Haas oscillations in single crystals of Pb1-xSnxSe with x = 0 (a) and x = 0.15 (b). Insets show the data vs. inverse field, after subtracting the smooth background.