Project 4.3 Topological Aspects of Superconductivity and Ferromagnetism in Group IV Chalcogenides - an Experimental Approach

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Background:

Topological crystalline insulators (TCI) represent the family of topological materials, in which mirror symmetry of crystal unit cell ensures topological protection of massless Dirac-like surface states. The IV-VI compound SnTe, having the rock-salt crystal symmetry and the nontrivial band ordering at the L points of the Brillouin zone is the prototypical TCI material with topological surface states residing at the {001}, {110} and {111} surfaces. The mixed crystals Pb1-xSnxSe and Pb1-xSnxTe belong to TCI family under the condition that their conduction and valence band have inverted band ordering.

Aim:

The general research aims to disentangle the effects of inverted band structure and topological surface states on superconducting and magnetic properties of group IV chalcogenides, namely Pb1−xSnx(Se;Te) family of semiconducting compounds. This material system is the first and still the only experimentally verified materials realization of topological crystalline insulator. Therefore we will focus on variety of mixed crystals like Pb1-xSnxSe, Pb1-xSnxTe and Pb1-x-ySnxMnyTe, where the latter will bring the ferromagnetic flavor to the study.

The project milestones are:

- electrical and magnetic identification of the mechanism of superconductivity existing in topological crystalline insulators and their ferromagnetic counterparts,
- experimental verification of magnetic susceptibility dependence on temperature and magnetic field, reported earlier in bismuth based topological insulators and not yet found in topological crystalline insulators,
- revealing the existence of massless Dirac fermions by registering the Fermi energy dependence of the susceptibility by the use of gated structures based on molecular beam epitaxy grown thin films.

Requirements:

Experience in experimental work (documented by publications and / or reference letters) with a strong preferences for those who have already worked with transport and magnetic properties of dilute magnetic semiconductors. Good knowledge of English in speech and writing. The ability to work independently and to effectively cooperate and communicate with other members of the group (including those working in experiment), and with external colleagues.

The selected candidate will be tasked with:

- magnetoelectric measurements in wide range of temperatures and magnetic fields and conducting SQUID based magnetometric measurements,
- development of experimental set-up and seeking new practical approaches to overcome challenges related with the execution of the project

- data reduction, synthesis of the obtained experimental results and their presentation as seminars, reports and publications.

Funding:

Scholarship: grant funding of 4500 PLN per month, before subtracting obligatory employer and employee social security contributions (~15%), for 10 months. Afterwards, standard Polish PhD scholarship (about 2100 PLN/month net in years 1-2, 3240 PLN/month net in years 3-4).

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