Abstract

Topologically non-trivial systems have emerged as a new area of research in condensed matter physics. The study of topologically nontrivial electronic systems is important because they provide a platform to experimentally investigate new low-energy excitations. In this thesis, I will discuss three such systems:Conventional Superconductivity in $PdTe_2$: $PdTe_2$ is a unique topological system where type II Dirac semimetallic phase coexists with a superconducting phase. This combined nature offers an interesting material candidate for investigation of possible topological superconductivity. We have performed high-resolution scanning tunnelling spectroscopic (STS) measurements to study the nature of superconductivity in this system. Theoretically, it has been speculated that superconductivity in such systems will be unconventional in nature. However, our experiments provide direct evidence of conventional superconductivity in $PdTe_2$. High spin-polarization in Sb_2Se_3: Most of the A_2B_3 type chalcogenides (e.g. Bi_2Se_3, Bi_2Te_3 and Sb_2Te_3 etc.) are well known topological insulators. Though Sb_2Se_3 is a member of the same group, it is a band insulator under ambient conditions. A prominent quasiparticle interference (QPI) pattern observed in STM conductance mapping indicates the presence of backscattering, which is forbidden for a topological insulator. Interestingly, like most of the topological insulators, Sb_2Se_3 shows a high spin polarization (69 %) in transport current. To understand the origin of such high spin polarization, we performed band structure calculations which revealed presence of two trivial surface states with one undergoing large splitting due to Rashba type SOC and leading to high spin polarization. Tip-induced superconductivity in $Pb_{0.6}Sn_{0.4}Te$: The emergence of tip-induced superconductivity (TISC) has offered a possible way to detect topological superconductivity induced by a point contacts. We performed similar experiment on a topological crystalline insulator (TCI) $Pb_{0.6}Sn_{0.4}Te$ with non-superconducting tips. Our experiments revealed that Ag/$Pb_{0.6}Sn_{0.4}Te$ and Pd/$Pb_{0.6}Sn_{0.4}Te$ point-contacts behave as a superconductor. As expected for a superconductor, we observed a sharp resistive transition at 6 K which evolved systematically with an applied magnetic field. This is also confirmed through temperature and magnetic field dependent studies of the point contact spectra. Moreover, on the basis of H_c Vs T_c phase diagram we predict that the induced superconductivity is conventional in nature. Furthermore, I will discuss low temperature and high vacuum point contact probe designing and fabrication.