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Electrical Transport in $Bi_1Sb_1Te_{1.5}Se_{1.5}$ /α-$RuCl_3$ Heterostructure Nanodevices

Authors : Shoubhik Mandal, Debarghya Mallick, Abhishek Banerjee, R. Ganesan, P. S. Anil Kumar

Abstract : We report magnetotransport measurements in $Bi_1Sb_1Te_{1.5}Se_{1.5}$/$RuCl_3$ heterostructure nanodevices. $Bi_1Sb_1Te_{1.5}Se_{1.5}$ (BSTS) is a strong three-dimensional topological insulator (3D-TI) that hosts conducting topological surface states (TSS) enclosing an insulating bulk. α-$RuCl_3$ (namely, $RuCl_3$) is an anti-ferromagnet that is predicted to behave as a Kitaev-like quantum spin liquid carrying Majorana excitations. Temperature (T)-dependent resistivity measurements show the interplay between parallel bulk and surface transport channels. At $T < 150$ K, surface state transport dominates over bulk transport. Multi-channel weak anti-localization (WAL) is observed, as a sharp cusp in the magnetoconductivity, indicating strong spin-orbit coupling. The presence of top and bottom topological surface states (TSS), including a pair of electrically coupled Rashba surface states (RSS), are indicated. Non-linear Hall effect, explained by a two-band model, further supports this interpretation. Finally, a low-T logarithmic resistance upturn is analyzed using the Lu-Shen model, supporting the presence of gapless surface states with a π Berry phase.

Keywords : topological materials, electrical transport, Lu-Shen model, quantum spin liquid
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