Low temperature electrical transport of nanoflakes of strong topological insulator $BiSbTe_{1.25}Te_{1.75}$

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Abstract: We report the electrical transport properties of exfoliated nano flake of a 3-dimensional strong topological insulator BiSbTe1.25Se1.75. Here, we demonstrate the role of the bulk insulating states as well as the surface 2-D metallic states in transport. This substitution of Sb and Te on Bi2Te3 leads to placing the Fermi level on the surface Dirac cone. Insulator like behaviour (bulk contribution) was observed above 50K, whereas surface dominated metallic behaviour was observed below 50K, evident from resistance versus temperature measurements. Magneto-transport measurements reveal the existence of Dirac fermions and a nontrivial Berry phase of π as evident from the observed 2-D weak anti localization(WAL) effect. WAL was fitted using Hikami-Larkin Nagaoka equation and the variation of phase coherence length with temperature indicated 2-D Nyquist dephasing, involving electron-electron interaction. Hall measurements upto 50K gave linear n-type metallic behaviour. At higher temperatures, it starts becoming nonlinear and from 100K onwards, it shows that the 3-D bulk is p-type semiconductor. It indicates that the Fermi level is in the bulk bandgap, above the surface Dirac cone, but below the intrinsic level. We also observed universal conductance fluctuations in our samples.

Reference: Yoichi Ando, J.Phys.Soc.Jpn, 82,102001(2013)

Figures:

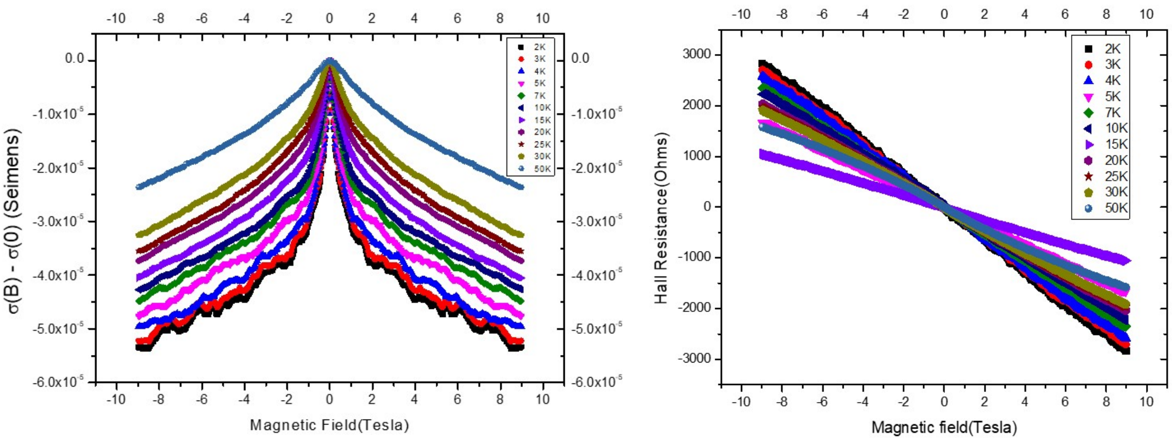

Figure 1: a)Weak antilocalization observed upto 50K.HLN fit indicates both top and bottom surfaces contribute to metallic conduction upto 50K.b)Hall resistance as a function of temperature indicates that the Fermi level is above the Dirac point and the surface behaves like an n-type metal

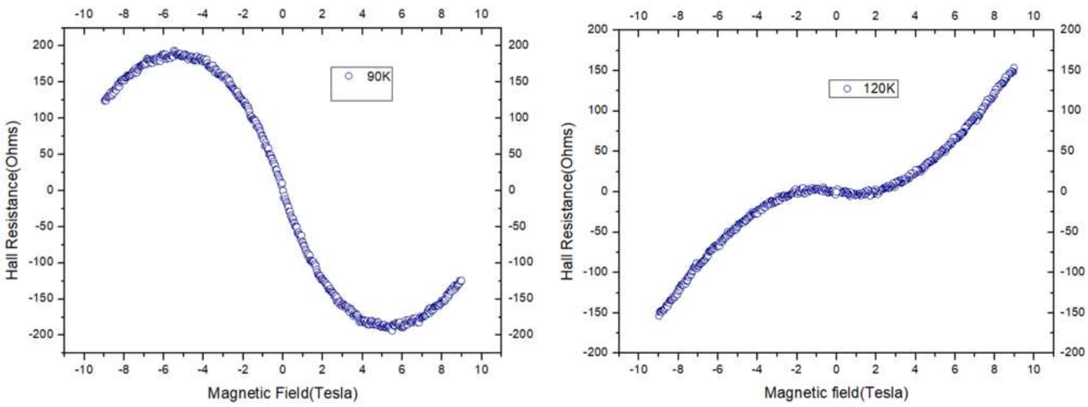

Figure2: Non linear Hall effect observed above 50K, because of contribution from bulk.The Hall coefficient changes sign and shows p-type behaviour from the bulk.This indicates that the Fermi level is close to bulkvalence band,where as the Dirac point is below the Fermi level.

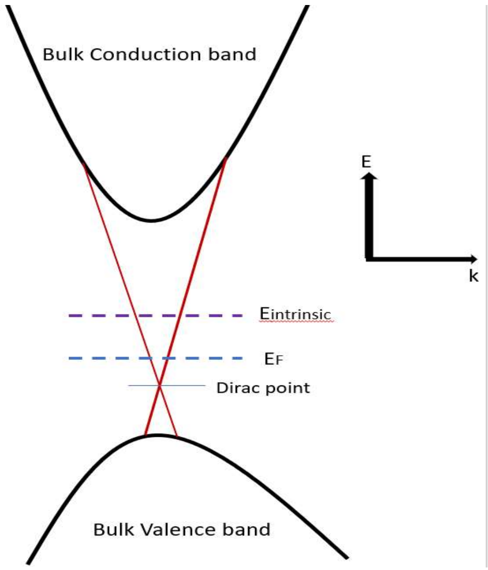

Figure 3: The qualitative band picture shows that Fermi level is above the Dirac point in the bulk bandgap, giving n-type metallic behaviour at low temperatures(upto 50K)But, the Fermi level is below the intrinsic midpoint level of the gap, giving p-type contribution from the bulk as observed from the non-linearity and slope change and a complete switching from n-type to p-type carriers at higher temperatures.