# Magnetic Gap of Fe-Doped $BiSbTe_2Se$

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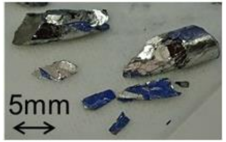
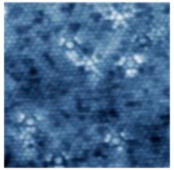
## Introduction

3D Topological Insulators possess a unique time-reversal invariant surface state, the so-called massless Dirac cone. Breaking time-reversal symmetry by magnetization opens the magnetic gap in the surface states. The massive Dirac state induces remarkable topological phenomena, such as the quantum anomalous Hall effect and topological electromagnetic effects. Fabricating heterostructures with other magnetic insulators or superconductors, the chiral edge states produce exotic quasiparticle states, such as axions, Majorana Fermions and magnetic monopoles.

There are two key factors in the observation of the surface-driven phenomena: the Fermi level is within the magnetic gap and the high bulk insulating nature. The common approach is to utilize a thin film of magnetic TIs by MBE. We have grown Fe-doped BiSbTe2Se single crystals and studied their properties be Scanning Tunneling Spectroscopy and Transport Measurements.



## Scanning Tunneling Spectroscopy

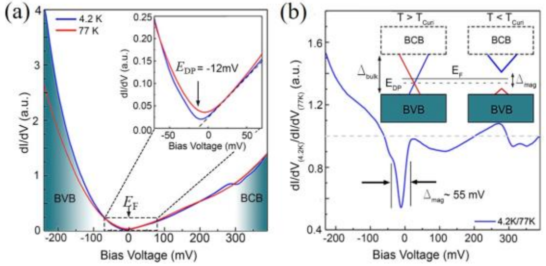



Fig.1. 2. Scanning tunnelling spectroscopy. (a) Average tunnelling spectra at 4.2 K (blue line) and 77 K (red line). The inset shows a highlight around the zero-bias voltage. The dashed line represents a linear dispersion approximation, and the arrow indicates the estimated Dirac point at −12 mV. (b) Normalized dI/dV spectrum of 4.2 K by the 77 K spectra. A clear 55 mV gap appears near the Dirac point. Insets are schematic surface structures below the Curie temperature.

## Conclusions

We investigated the surface band structures of Fe-BSTS via STS and IL-gated-transport measurements. The Scanning Tunneling Spectroscopy shows two notable features of the surface state: the DP near the Fermi level and the gapped states at the DP, implying a magnetic gap opening. The IL-gated-transport measurement combined with the two-band analyses also supports that the DP is near the Fermi level. Therefore, the Fe-BSTS bulk single crystal is a promising platform for detecting exotic topological phenomena.

## Transport Measurements

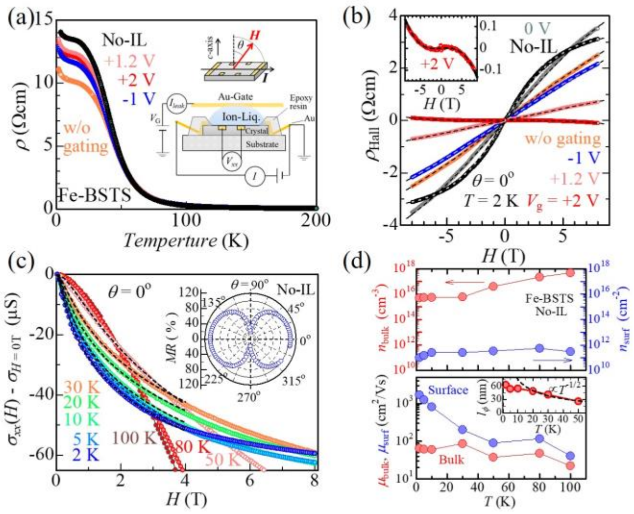



Fig.2. (a) Temperature dependence of resistivity with and without gating voltage. (b) Hall resistivity for various gating voltages at 2 K. Dashed lines represent the best fitting results by the two-band model. (c) Change in sheet magnetoconductance (without IL) with a perpendicular magnetic fields. The dashed black lines represent fitting results by the HLN model. The inset shows a polar plot of the magnetoresistance of the No-IL crystal with a magnetic field of 8 T at 2 K. (d) Temperature dependences of the carrier (top panel) and mobility (bottom panel) for the bulk and surface of the as-grown Fe-BSTS crystal. The inset is the temperature dependence of the phase coherence length obtained using the HLN model.

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