Low-Temperature Magnetoresistance Hysteresis in Vanadium-doped $Bi_2Te_{2.4}Se_{0.6}$ Single Crystal Topological Insulators

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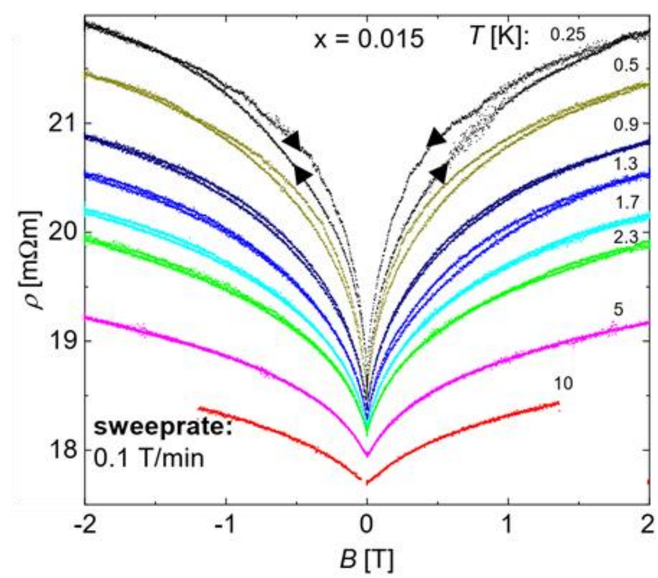
Topological surface states (TSS) have been convincingly detected by angle-resolved photoemission experiments in three-dimensional (3D) topological insulator crystals (TIs) [1]. However, we demonstrated recently that transport measurements in 3D Bi_2Se_3 single crystals often show effects due to the co-existence of TSS and bulk states and their respective contributions are not easily disentangled [2, 3]. Further, we reported on a magnetoresistance *hysteresis* in Vanadium-doped $Bi_2Te_{2.4}Se_{0.6}$ single crystals at low temperatures [4], which show gapless TSS and where doping with Vanadium shifts the chemical potential into the bulk band gap. This magnetoresistance hysteresis depends on the sweep-rate and the magnetic field direction [4]. To date, the origin remains to be clarified.

In this work [5], we examine magnetotransport at *ultra-low* temperatures (from 250 mK to 10 K) in $Bi_{2-x}Te_{2.4}Se_{0.6}$ single crystals with concentrations of Vanadium x = 0, 0.015 and 0.03. The resistivity, carrier density, and mobility below 10 K are constant and the magnetoresistance shows weak anti-localization, as expected for low-temperature transport dominated by gapless surface states in 3D topological insulators. We investigate the sweep-rate dependent magnetoresistance hysteresis for fields up to 1.5 T with respect to the doping concentration x of Vanadium, which shifts the chemical potential near or away from the Dirac point. The hysteresis is most pronounced when 3D bulk states and quasi-two-dimensional topological states both contribute to the transport (x = 0 and 0.03), but it is mostly suppressed when the topological states dominate transport (x = 0.015). We propose that the origin of the hysteresis lies in different spin-dependent scattering rates for surface states and in the bulk. Inductive effects due to time-varying fields may produce non-equilibrium in the topological surface states, so that scattering is required to restore the equilibrium distribution in static magnetic fields.



Magnetoresistance of $V_xBi_{2-x}Te_{2.4}Se_{0.6}$ with x = 0.015. The arrows indicate the sweep direction of the magnetic field [4].

References

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