

Growth of Bi_2Se_3 on Ge (111): from 2D transport evidence to room temperature spin-to-charge conversion

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Topological insulators (TI) have gained much interest in the field of spintronics for the generation and the detection of pure spin currents. Indeed, three-dimensional TI are predicted to host exotic properties like topologically protected surface states (TSS), which show Dirac-like band dispersion and strong spin-momentum locking [1]. Although the transport in TIs grown on insulator has been widely studied, TI films grown on semiconducting substrate are still challenging because of the parallel conduction canal.

In this work, we report the growth of single crystalline Bi_2Se_3 thin film on slightly p-doped Ge (111) by molecular beam epitaxy. Germanium is an optically active material with a relatively long spin diffusion length ($l_{sf} \approx 10 \mu\text{m}$) and it is compatible with the current Si technology platform. We carried out low temperature and high field magnetotransport measurements on micro-fabricated Hall bars, our results highlight a 2D transport in TSS through the weak-antilocalisation (WAL) signature (Fig. 1a). We propose an innovative method to probe the spin-to-charge conversion of TIs by taking advantages of Ge optical properties. We designed microdevices (Fig. 1b) where pure spin currents with in-plane spin polarization are generated by optical spin orientation by scanning a laser beam at the edge of Pt bar [2,3]. Spin currents are then detected in a non-local geometry by the inverse Rashba-Edelstein effect in a Bi_2Se_3 bar at room temperature. These results open a new way of investigating the spin properties of topological insulators.

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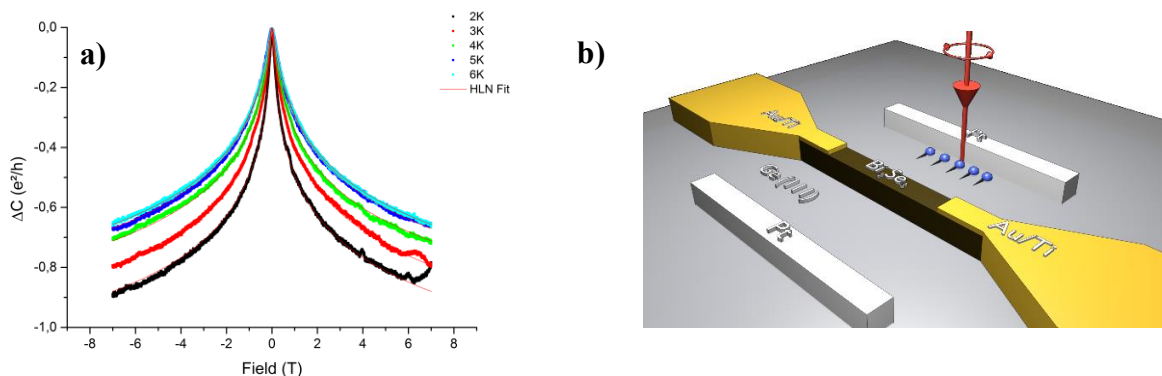


Fig 1. a) 4-probe longitudinal magnetoconductance of 10 QL Bi_2Se_3 film showing WAL effect (out-of-plane geometry). b) Scheme of the microdevice used for optical spin orientation.