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Crossover between Weak Antilocalization and Weak Localization of Bulk States in Ultrathin Bi_2Se_3 Films HUICHAO WANG, HAIWEN LIU, YANFEI ZHAO, YI SUN, X.C. XIE, JIAN WANG, International Center for Quantum Materials, School of Physics, Peking University, Beijing 100871, China, CUIZU CHANG, KE HE, XUCUN MA, QI-KUN XUE, State Key Laboratory of Low-Dimensional Quantum Physics, Department of Physics, Tsinghua University, Beijing 100084, China, HUAKUN ZUO, ZHENGCAI XIA, Wuhan National High Magnetic Field Center, Huazhong University of Science and Technology, Wuhan 430074, China
— We report studies on the 5 nm thick Bi2Se3 topological insulator films which are grown via molecular beam epitaxy technique. The angle-resolved photoemission spectroscopy data show that the Fermi level of the system lies in the bulk conduction band above the Dirac point, suggesting important contribution of bulk states to the transport results. In particular, the crossover from weak antilocalization to weak localization in the bulk states is observed in the parallel magnetic field measurements up to 50 Tesla. The measured magneto-resistance exhibits interesting anisotropy with respect to the orientation of parallel magnetic field B// and the current I, signifying intrinsic spin-orbit coupling in the Bi2Se3 films. Our work directly shows the crossover of quantum interference effect in the bulk states from weak antilocalization to weak localization. It presents an important step toward a better understanding of the existing three-dimensional topological insulators and the potential applications of nano-scale topological insulator devices.

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