Nanoscale Andreev Reflection Spectroscopy on Bismuth-Chalcogenide Topological Insulators

C. R. GRANSTROM, I. FRIDMAN, University of Toronto, R. X. LIANG, University of British Columbia, H. LEI, C. PETROVIC, Brookhaven National Laboratory, SHUO YANG, K. H. WU, Chinese Academy of Sciences, J. Y. T. WEI, University of Toronto & Canadian Institute for Advanced Research — Andreev reflection (AR) is the basic mechanism underlying the superconducting proximity effect which, at the interface between a topological insulator (TI) and a spin-singlet superconductor, can induce chiral $p$-wave pairing in the TI. Despite this novel importance, it is not well understood how AR is affected by the unique attributes of a three-dimensional TI, namely the Dirac dispersion and helical spin-polarization of its surface states. In this work, we use both $s$-wave and $d$-wave superconducting tips to perform AR spectroscopy at 4.2 K on flux-grown $\text{Bi}_2\text{Se}_3$ and $\text{Bi}_2\text{Te}_3$ single crystals, as well as epitaxial $\text{Bi}_2\text{Se}_3$ thin films grown on $\text{SrTiO}_3$ substrates by molecular beam epitaxy. These AR measurements are complemented by scanning tunneling spectroscopy, in order to characterize the superconducting tip as well as the doping level and surface condition of the TI sample. Our data are analyzed using BTK theory, in light of the characteristic band structure of bismuth chalcogenides, to elucidate how the band structure affects the AR process.

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