Experimental efforts to realize time-reversal invariant topological superconductors

Satoshi Sasaki, A. A. Taskin, Kouji Segawa, and Yoichi Ando

Institute of Scientific and Industrial Research, Osaka University, Japan

Recent discovery of topological insulators (TIs) characterized by topologically protected gapless surface states stimulated the search for an even more exotic state of matter, a topological superconductor (TSC). The TSC is also predicted to have a topologically protected gapless surface state consisting of massless Majorana fermions as its distinctive characteristic. Low-carrier-density semiconductors with a strong spin-orbit coupling and a Fermi surface that is centered around time-reversal-invariant momenta, such as superconducting doped TIs, are predicted to be prime candidates for TSCs.[1] Following this prediction, we studied the nature of superconductivity in doped TIs, $Cu_xBi_2Se_3$ and $Sn_{1-x}In_xTe$, by employing conductance spectroscopy.[2,3] Since $Cu_xBi_2Se_3$ is inherently inhomogeneous and it turns out to be difficult to elucidate the mechanism of superconductivity, high-quality single crystals of $Sn_{1-x}In_xTe$ with 100% superconducting volume fraction could be a promising material. I will present our latest results together with recent spectroscopy data from other groups, and summarize the current understanding of topological superconductivity in superconducting doped TI families. This work was supported by JSPS KAKENHI 24740237 and AFOSR (AOARD 124038), and done in collaboration with M. Kriener (Riken), K. Yada, M. Sato, Y. Tanaka (Nagoya), and L. Fu (MIT).

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