

Crossover from Ising- to Rashba-Type Superconductivity in Epitaxial Bi₂Se₃/Monolayer NbSe₂ Heterostructures

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Abstract: When two different materials are brought together, the resultant interface between them often shows unexpected quantum phenomena. For example, the interface between a topological insulator (TI) and an s-wave superconductor can host an unusual form of superconductivity known as topological superconductivity. Here, we grew the Bi₂Se₃/monolayer NbSe₂ heterostructures with different Bi₂Se₃ thicknesses using molecular beam epitaxy. We found that the gapless Dirac surface states are formed when the Bi₂Se₃ thickness is greater than 3 quintuple layers (QLs). Moreover, we observed the Rashba-type bulk conduction bands for the Bi₂Se₃ thickness greater than 2 QLs. Our observations are well interpreted by the first-principles calculations. By performing magneto-transport measurements, we found that the in-plane upper critical magnetic field of the superconductivity in Bi₂Se₃/monolayer NbSe₂ heterostructures is greatly suppressed when the Rashba bands emerge, indicating the occurrence of a crossover from Ising- to Rashba-type pairings. Our success in the synthesis of Bi₂Se₃/monolayer NbSe₂ heterostructures and the demonstration of the crossover from Ising- to Rashba-type superconductivity in these heterostructures provide more impetus for exploring the topological superconductivity in TI/superconductor heterostructures. This work is supported by Penn State MRSEC for Nanoscale Science (DMR-2011839), NSF-CAREER award (DMR-1847811), DOE grant (DE-SC0019064), NSF grant (DMR-1539916), and the Gordon and Betty Moore Foundation's EPiQS Initiative (Grant GBMF9063 to C. -Z. C.).