ABSTRACT

We report evidence of non-reciprocal dissipation-less transport in single ballistic InSb nanoflag Josephson junctions, owing to a strong spin-orbit coupling. We characterize these devices via magneto-transport measurements, with a focus on side-gate control of charge current. At sub-Kelvin temperatures, the junctions enter the Josephson regime, where a sizeable supercurrent develops. A complete analysis of Josephson effect dependence on back-gate, magnetic field and temperature is performed, which entails that these nanoflag-based junctions work in the short-ballistic regime. Applying an in-plane magnetic field, we observe an inequality in supercurrent for the two opposite current propagation directions. This demonstrates that these devices can work as Josephson diodes, with dissipation-less current flowing in only one direction. For small fields, the supercurrent asymmetry increases linearly with the external field, then it saturates as the Zeeman energy becomes relevant, before it finally decreases to zero at higher fields. We show that the effect is maximum when the in-plane field is perpendicular to the current vector, which identifies Rashba spin-orbit coupling as the main symmetry-breaking mechanism. Our experimental findings are consistent with a model for ballistic short junctions and show that the diode effect is intrinsic to this material. Our results establish InSb Josephson diodes as a useful element in superconducting electronics.