Field-resilient supercurrent rectification in $NbSe_2$ van der Waals Josephson junction

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Abstract

Systems exhibiting non-reciprocal or rectifying transport characteristics are the building blocks of semiconductor technology. The dissipative nature of transport on these systems not only causes huge power losses but also limits the operational speed [1]. In pursuit of alternatives, supercurrent rectifying devices have been proposed and explored recently. Superconducting systems, such as thin films and Josephson junctions, void of both inversion and time-reversal symmetries, are explored in this regard [2]. While the Pauli paramagnetic field limit puts an upper bound on observing supercurrent rectification, the demonstrated functionalities are limited to only low magnetic fields. In contrast, many quantum and classical technologies require operation at higher magnetic fields. In this work, we present an $NbSe_2$–$NbSe_2$ van der Waals Josephson junction diode, exhibiting supercurrent rectification in a wide range of magnetic fields [3]. For lower magnetic fields, the supercurrent rectification efficiency increases with the magnetic field and saturates to ~40 % for fields ~1 T and beyond. We also conduct a time-domain demonstration of supercurrent rectification using various waveforms. Our system's high magneto-chiral anisotropy ($\sim 10^4\,T^{-1}\,A^{-1}$) obtained with an AC excitation ensures excellent rectification even in high magnetic fields, making it suitable for both quantum and classical logic circuits with minimal dissipation.

References

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