Highlights

ACTIVITY B Superconducting and correlated low dimensional materials and devices for quantum electronics and spintronicst - 2020

Electrodynamics of Highly Spin-Polarized Tunnel Josephson Junctions

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PHYSICAL REVIEW APPLIED 13, 014017 (2020)

The continuous development of superconducting electronics is encouraging several studies on hybrid Josephson junctions (JJs) based on superconductor-ferromagnet-superconductor (SFS) heterostructures, as either spintronic devices or switchable elements in quantum and classical circuits. In this work, we provide an extensive characterization down to dilution temperatures of tunnel ferromagnetic JJs with an insulating ferromagnetic barrier (GdN), on devices with different barrier thickness. We demonstrate that a modeling of the I(V) curves within a microscopic approach, namely the Tunnel Junction Microscopic (TJM) model, allows to disentangle the dissipation effects due to the environment from the intrinsic dissipation processes, and to establish a protocol for the determination of the electrodynamic parameters, such as junction quality factor, subgap resistance and capacitance, as a function of the barrier thickness. The relevance of this work resides in providing the scaling behavior of the electrodynamic parameters, which represents a fundamental step for the feasibility of tunnel-ferromagnetic JJs as active elements in quantum and classical circuits, and are of general interest for hybrid tunnel junctions. Therefore, this study provides a pathway to the engineering of tunnel-ferromagnetic JJs for specific applications in superconducting hybrid qubits.

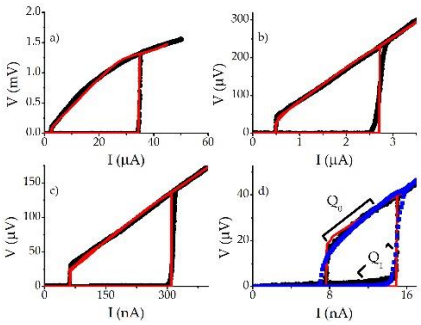

Fig. 1: The measured *I* -*V* curves at 4.2 K (black points) and TJM model simulation (red curve) for spin-filter JJs with thicknesses of (a) 2.5, (b) 3.0, (c) 3.5, and (d) 4.0 nm. The blue squares in (d) represent the frequency-dependent RCSJ model fit curve, obtained for $Q0 = 2.8$ and $Q1 = 0.13$.

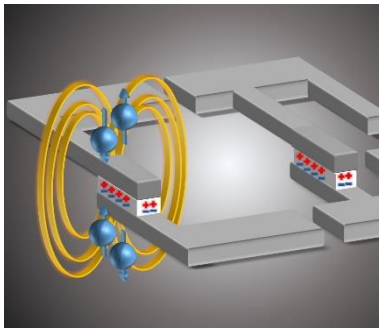

Fig. 2: Picture of a tunnel ferromagnetic JJ integrated in a qubit design for novel superconducting hybrid quantum devices.