Properties of high-angle Fe(Se,Te) bicrystal grain boundary junctions

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APPL. PHYS. LETT. 104, 162601 (2014)

Abstract

The pairing symmetry in the new iron-based superconductors is still matter of debate, particularly because of the possibility of the existence of a reversing sign s+- of the order parameter. In this work, we report on the characterization of Fe(Se,Te) grain boundary Josephson junctions fabricated on a 45° [001] tilt symmetric (22.5°, 22.5°) $SrTiO_3$ bicrystal substrate. We find that the IV characteristics of these weak links may be described by the resistively shunted junction model, with an excess current I_{exc} increasing with the junction dimensions (see Fig. 1). The presence of an excess current and the very low normal-state resistance values are typical of superconductor-normal metal-superconductor Josephson junctions, characterized by high-transparency barriers. We observe that the I_cR_n products of the smallest junctions are of the order of 30 μV, suitable for the fabrication of dc-SQUIDs. Moreover, all the junctions on the same substrate are characterized by the same critical current densities J_c, of the order of 10^4 A/cm^2, independently of the junction width. We have developed a model describing the critical current distribution in coplanar geometries, as is the case of bicrystal junctions. As a result, J_c = const is in agreement with our model and demonstrates the good quality of the junctions. Moreover, uniform critical current densities is what is expected in the case of s-wave symmetry of the order parameter (s++ or s+- indifferently). In fact, for different order parameter symmetries than s-wave, the high angle of the substrate and the presence of faceting along the bicrystal line would result in large scattering of the critical current densities, not observed in our samples.

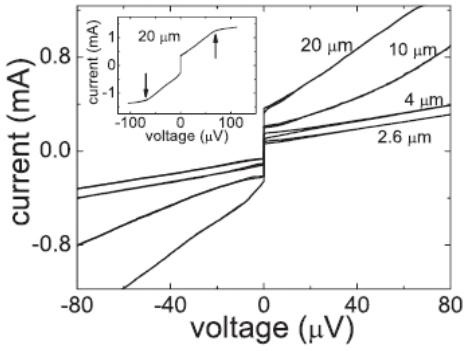

FIG. 1. Current-voltage characteristic of 45° [001] tilt bicrystal GBJs with different sizes measured at T = 4.2 K. In the inset, the IV characteristic of a junction 20 μm wide shows peaks due to flux motion.