Supercurrent modulation in InSb nanoflag-based Josephson junctions by scanning gate microscopy

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Abstract: We report the first Scanning Gate Microscopy (SGM) experiments on InSb nanoflags, and the first SGM experiments on Josephson junction devices, demonstrating local critical current modulation via the charged tip of the SGM.

InSb nanoflags represent an interesting platform for quantum transport and have recently been exploited in the study of hybrid planar Josephson junctions [1-4]. Due to the uncovered semiconductor surface, they are also good candidates for surface probe techniques. Here, we report Scanning Gate Microscopy (SGM) experiments on Nb-contacted InSb nanoflag-based Josephson junctions [5]. In the normal state, sizable conductance modulation via the charged tip of the SGM is recorded. In the superconducting state, we report the application of SGM to superconducting weak links, as shown in Figure 1. Our results demonstrate the possibility of manipulating the supercurrent flow across a semiconductor-superconductor heterostructure at a local level. The experimental findings are consistent with theoretical predictions and establish a way of investigating the behaviour of superconducting weak links. This raises the perspective of locally imaging the supercurrent flow [6], once the spatial resolution is significantly improved.

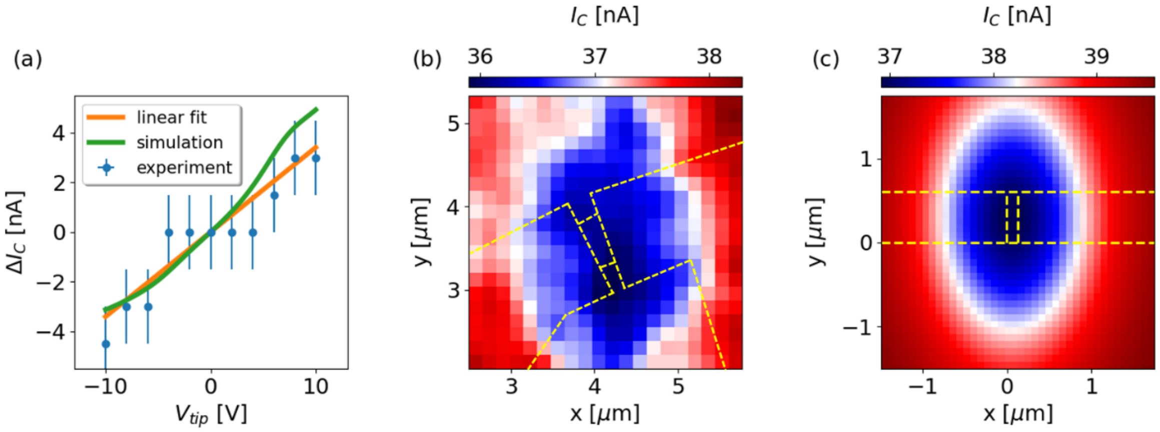

Fig. 1 SGM at 300 mK. (a) Critical current (with error bars) as a function of tip-to-sample voltage difference V_{tip} when the tip is placed close to the geometrical centre of the junction. The best linear fit to the displayed data is shown in orange, the result of numerical simulations in green. (b) SGM map measurement: 20 pixels × 20 pixels critical current map as a function of the position of the tip. $V_{tip} = -10$ V, $V_{bg} = 9.5$ V. (c) Numerical simulation of the tip-induced critical current modulation map. In (b) and (c), the device outline is indicated by the dashed yellow lines.

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