Highlights

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Nonlinear current-voltage characteristics due to quantum tunneling of phase slips in superconducting Nb nanowire networks

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Superconductivity in 1D nanowires involves fundamental phenomena such as macroscopic quantum tunneling and quantum phase transitions. These systems can find applications in classical and possibly quantum information-processing devices, or they can be used as interconnects in electronic nanostructured devices. Quantum fluctuations of the superconducting order parameter were consistently revealed from both R(T) and V(I) measurements in superconducting Nb nanowire networks, consisting of about 30 interconnected wires, patterned on porous Silicon templates, a nanofabrication approach which can produce samples with physical properties resembling those of single nanowires. Indeed, Quantum Phase Slips (QPS) phenomenon is the dominant contribution to the transport properties of the system. All the data were coherently reproduced in the framework of theoretical models elaborated to describe QPS processes. The analyzed system, obtained starting from a robust and macroscopically large substrate, reveals fascinating quantum effects and shows high values of the critical current density. This last occurrence makes the system of potential use as 1D interconnection in complex nanodevices.

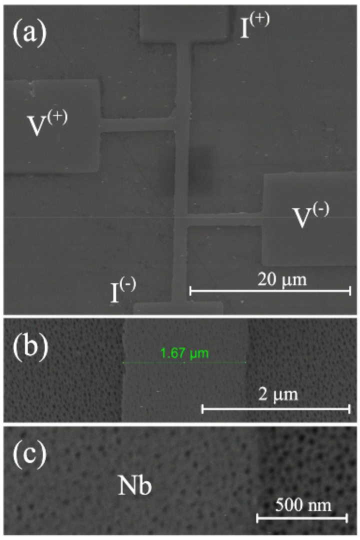

Fig. 1: FE-SEM images of the sample consisting of (a) a pair of current-carrying Nb electrodes, which contact the (L=30 µm, W=1.67 µm) nanoporous Nb film and a pair of voltage pads 10 µm apart, realized using EBL.. (b) Middle portion of the Nb film. (c) Zooming-in of the nanoporous Nb film edge. The average pore diameter and interpore distance are a=15 nm and d=50 nm, respectively.

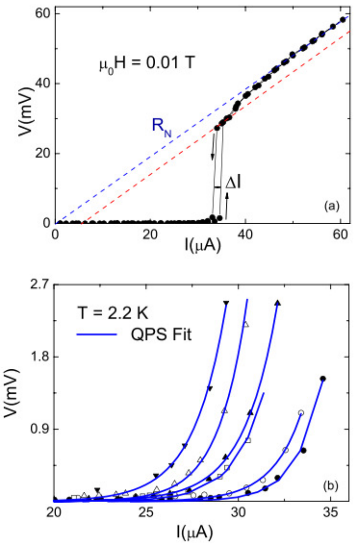

Fig. 2: (a) V(I) curve at T=2.2 K. The red (blue) line shows the resistance due to the single PS entering the sample (the normal-state resistance, R_N). (b) Nonlinear V(I) characteristics at different fields (0.01, 0.025, 0.05, 0.06, 0.08, 0.12 T, from right to left). Blue lines are the QPS fits to the data.