Approaching the Depairing Current in YBCO Nanowires and Ultra-low-noise nanoSQUIDs

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Superconductive devices at the nanoscale can have a fundamental role in shedding light into the mechanism leading to High Temperature Superconductivity (HTS). The study of the transport properties of HTS nanowires with dimensions much smaller than the Pearl length gives access to a regime where the local properties of the superconductor have a fundamental role. From the application point of view, the realization of reproducible HTS nanowires can open new perspectives for the realization of HTS nanoSQUIDs with unprecedented performance in a wide temperature range (mK to 80K) and high magnetic fields (Tesla range).
Here we report on the transport studies of $YBa_2Cu_3O_{7-x}$ (YBCO) nanowires with varying nominal width ranging from 300nm down to 30nm. All the wires were fabricated by conventional electron beam lithographic technique in combination with a hard carbon mask and Argon ion etching. The dependence of the critical current density as a function of the wire width shows a steep increase below 200 nm, with values approaching the depairing limit (Jc=3x10^{8}A/cm^2) for the smallest wires. NanoSQUIDs implementing two YBCO nanowires manifest an exceptional flux sensitivity below $1\mu\Phi_0/\sqrt{Hz}$ over a wide temperature range enabling the detection of magnetic nanoparticles in large magnetic fields.