The Superconducting Transition in Highly Resistive NbTiN Nanowires.

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Superconducting thin-film materials with a high normal-state resistivity are of interest as building blocks for quantum devices and radiation detectors. However, the very disordered nature of these materials gives rise to a strong competition between electron localization and superconductivity, leading to a superconductor-insulator transition with increasing disorder[1]. Prior to this transition the electronic properties are expected to become inhomogeneous even for uniform structural disorder. This leads to the question how superconductivity manifests itself in these resistive materials.

We present measurements of the normal-to-superconducting transition of NbTiN nanowires, with a thickness of 8 nm, widths varying from 50 nm to 400 nm, and a normal-state resistivity of ~ 160 $\mu\Omega$cm. Each width shows a smooth superconductive transition at $T_C = 10.5$ K, consistent with the Aslamazov-Larkin theory for two-dimensional wires. Close to T_C however, measurements of the critical current and the critical magnetic field of the nanowires reveal that the resistive state is reached in a series of steps, each adding a typical resistance of $5 - 10$ kΩ to the wire. Moreover, from the critical currents we obtain a higher critical temperature than observed in the zero-bias resistive transition. From this, we conclude that in a certain temperature regime the wire is resistive while localized superconductivity is still present.

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[1]For example Sacépé *et al*, Nature Physics **7**, 239 (2011)