Premature switching currents of the superconducting Al shell in hybrid InAs-Al nanowires

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Hybrid superconductor-semiconductor nanostructures have been widely explored in the context of topological superconductivity [1, 2] and for the development of hybrid superconducting qubits [3]. For the above research directions, it is crucial to have a clean superconductor-semiconductor interface, e.g. achieved by means of epitaxial growth [4-5], to warrant a strong superconducting proximity effect. Among the different explored material platforms, InAs semiconductor nanowires covered by an epitaxial Al shell have been arguably one of the most studied systems. Surprisingly, in spite of the large number of experimental works that make use of hybrid InAs-Al nanowires, there are very few studies addressing the superconductivity of the Al shell [6-7]. This is important as the shell is directly responsible for inducing superconductivity on the semiconductor wire via proximity effect. In this work, we provide a detailed characterization of the superconductivity of the Al layer in full-shell InAs nanowires by DC transport measurements. Our results point towards premature switching currents of the nanowires driven by the nucleation of phase slips [8-9] followed by heat dissipation [10-11]. For certain conditions, we observe states with an intermediate resistance between zero and the normal resistance, suggesting the stabilization of a normal state segment within the nanowire (phase slip center).

References

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