## Highlights

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# Control of bulk superconductivity in a BCS superconductor by surface charge doping via electrochemical gating

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The electrochemical gating technique is a powerful tool to tune the surface conduction properties of various materials by means of pure charge doping, but its efficiency is thought to be hampered in materials with a good electronic screening. We show that, if applied to a metallic superconductor (NbN thin films), this approach allows the observation of reversible enhancements or suppressions of the bulk superconducting transition temperature, which vary with the thickness of the films. These results are interpreted in terms of a proximity effect, and indicate that the effective screening length depends on the induced charge density, becoming much larger than that predicted by a standard screening theory at very high electric fields.

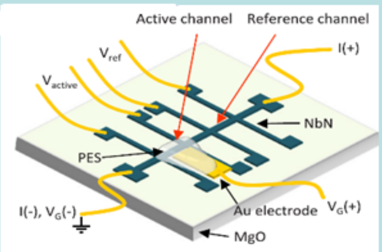


Fig.1: Scheme of the samples: The NbN strip is 135 µm wide, with current pads on each end and four voltage contacts on each side, spaced by 946 µm from one another. This geometry allows one to measure the voltage drop across different portions of the strip at the same time, thus defining an active (gated) and a reference (ungated) channel. The pristine film has a thickness of 39.2 ± 0.8 nm. Subsequent steps of Ar-ion milling are used to reduce the thickness to 27.1 ± 1.5, 18.3 ± 1.7, and finally 9.5 ± 1.8 nm. To perform EDL gating measurements, we cover the active channel and the gate counterelectrode placed on its side [made of a thin Au flake] with the liquid precursor of the cross-linked polymer electrolyte system, which was later UV cured.

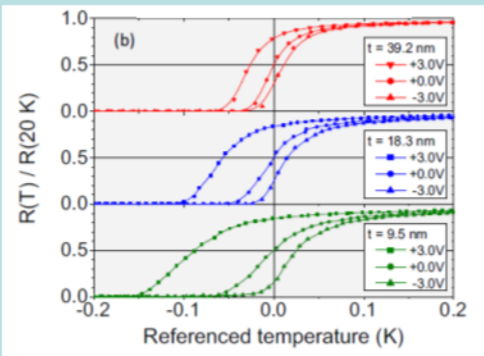


Fig.2: Effect of a gate voltage $V_G$ = ±3 V on the R(T)/R(20 K) vs T curves for three values of thickness: 39.2, 18.3, and 9.5 nm. The referenced temperature is defined as $T^* = [T-T_c^{ref}]_{VG} - [T_c^{active}-T_c^{ref}]_0$ .