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In situ tailoring of single superconducting junctions and nano-SQUIDs via current-induced atom migration

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We demonstrate the in situ engineering of superconducting nanowires via modulation of material properties through high applied current densities [1]. We show that the sequential repetition of such customized electro-annealing in a niobium nanoconstriction can broadly tune the superconducting critical temperature Tc and the normal-state resistance Rn in the targeted area. Once a sizable Rn is reached, clear magneto-resistance oscillations are detected along with a Fraunhofer-like field dependence of the critical current, indicating the formation of a weak link with adjustable characteristics [2]. Applying this method to aluminum nanoconstrictions, it is possible to modify their geometry and consequently their weak links' properties beyond the limit of current lithography techniques [3]. Furthermore, conducting parallel electromigration in aluminum SQUIDs allows us to investigate the evolution of the superconducting properties of the SQUID as function of the cross section of the weak links and eventually access a regime where the SQUID can be operated in the dissipative state. We will also discuss the possibility to change the local oxygen doping in constrictions made of High-Tc materials [4].

[1] V. Zharinov et al. Rev. Sci. Instrum. 89, 043904 (2018) [2] J. Lombardo et al. Nanoscale 10, 1987 (2018) [3] X.D.A. Baumans et al. Nat. Commun. 7, 10560 (2016) [4] X.D.A. Baumans et al. Small 13, 1700384 (2017)

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