Highlights

Activity D - Light-matter interaction and non-equilibrium dynamics in advanced materials and devices - 2021

NbReN: A disordered superconductor in thin film form for potential application as superconducting nanowire single photon detector

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The increasing demand for superconducting nanowire single photon detectors (SNSPDs) with improved performances compared to existing ones fosters the research activity in the field of material science. The current challenge is twofold and consists, on one hand, of improving the properties of superconducting materials already established for the fabrication of SNSPDs (mostly transition metal nitrides, such as NbN and NbTiN) , and, on the other hand, of finding alternative materials that can improve specific figures of merit of the existing SNSPD devices. A new superconductor, NbReN, in thin film form is synthesized by reactive dc sputtering to study its potential for the realization of SNSPDs with improved performances. The deposition conditions are systematically varied to optimize the superconducting and electrical properties of the resulting samples. Films with polycrystalline structure and moderate texture are obtained. The transport properties reveal that NbReN films have well- established superconducting ordering and behave as a dirty superconductors, with values of the critical temperature lower than its parent compound NbRe. The combination of disorder-dominated transport and low energy gap may in principle enhance the sensitivity to longer wavelength photons. Detection experiments are needed to confirm these expected performances.

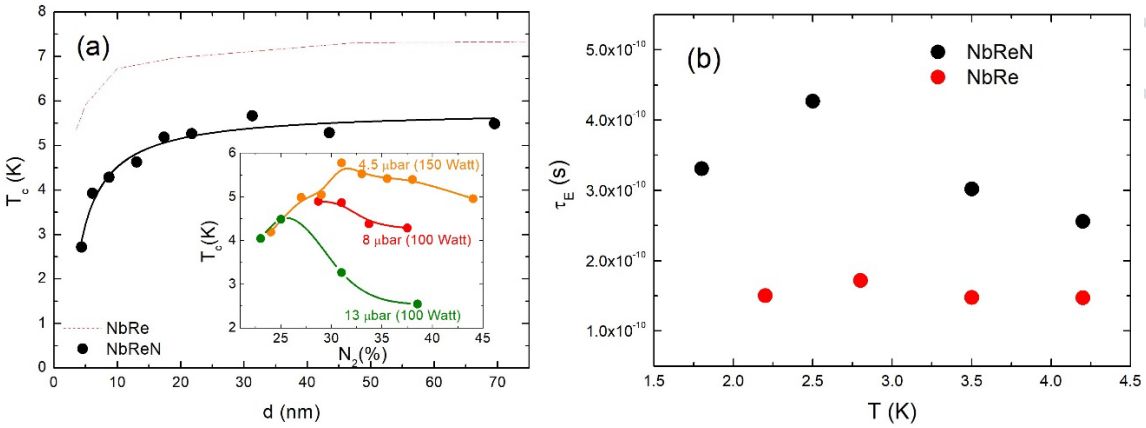

Fig. 1: (a) Thickness dependence of the superconducting critical temperature for NbReN films (filled circles) deposited at 150W and total pressure of 4.5 mbar, and NbRe films (dotted line). Inset: Critical temperature, T_c, as a function of the nitrogen concentration, $N_2^{\%}$, for films with fixed thickness (d_{NbReN}=36 nm) and deposited at different sputtering conditions (see labels for total pressure and power). (b) Temperature dependence of the quasiparticles relaxation times for NbReN and NbRe bridges evaluated at $\mu_0 H$ = 0.5 and 0.6 T, respectively.