

Proximity effects of thin Ti/Al bilayers probed by arrays of superconducting CPW resonators

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Modifying the critical temperature (T_c) of conventional superconductors by the proximity effect, stacking with low superconducting-gap or normal metal films, is a common engineering approach. Its application enables applications in the field of astronomy, such as the detection of low-frequency photons [1, 2], or provides efficient quasiparticle (QP) trapping, which effectively reduces losses in high-frequency superconducting devices [3]. Yet, experimental studies of operating superconducting resonator devices remain limited.

In this paper, we evaluate the combination of Ti and Al thin films in arrays of coplanar waveguide (CPW) superconducting resonators. Geometries and layout had been designed in view of realizing parametric assessment, to be able to apply improvements in fabrication while obtaining robust performances in reference superconducting materials (Al). The basic testing platform consists in arrays of eight frequency-multiplexed resonators. Our previous study allowed systematic assessments in coupling strength and bath temperature responses, to establish reference performances of 100 nm thick Aluminium CPW resonators [4]. We replicated the same systems with several combinations in thickness of Ti/Al bilayers.

Beyond performance benchmarking, which proven comparable in quality and reproducibility, the resonator testing platform has provided direct access to thin film material properties. We observe a clear

increase in the kinetic inductance fraction by over a factor of 2 (from 5% to 11%), showing potential for the development of tunable kinetic-inductance detectors. Moreover, from the relative frequency shift as a function of bath temperature (see Fig. 1), we estimated T_c with a spread of $\Delta T_c \approx 0.4$ K arising from the individual resonator-fitted values, which converges with the values obtained in $R(T)$ measurements of the same films. Our CPW arrays method proves highly sensitive to proximitized effects, e.g., nanometer-scale variations in the Ti thickness can be determined.

Additionally, we have been able to identify that the temperature-dependent empirical behaviour of Ti/Al resonators cannot be fully explained by the Mattis-Bardeen theory, asking for advanced models such as a conceptual framework using Usadel's equations for proximitized films.

References:

- [1] [Zhao \(2023\)](#)
- [2] [Kubo \(2025\)](#)
- [3] [Riwar \(2019\)](#)
- [4] Benito-Gomes & Rius (In prep.)

Figures

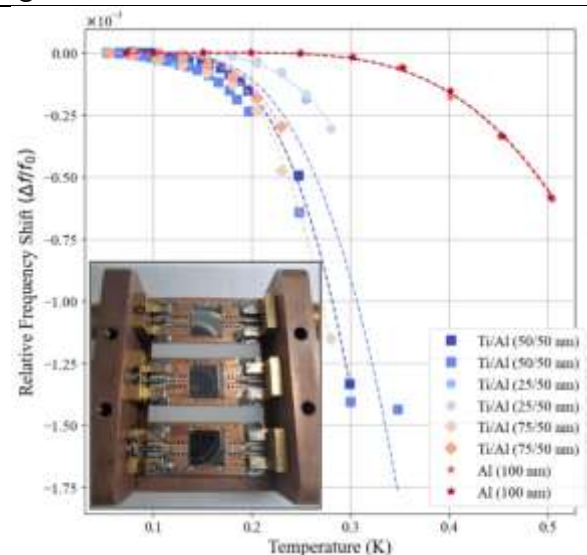


Fig. 1: Comparison of the temperature-dependent relative frequency shift for (red) 100 nm Al, (light blue) 25/50 nm, (darker blue) 50/50 nm, and (light red) 75/50 nm Ti/Al CPW resonators.