Towards reduced dielectric losses in superconducting quantum circuits

María Benito-Gomes [1,2]
Gemma Rius [1]

[1] *Instituto de Microelectrónica de Barcelona – Centro Nacional de Microelectrónica (IMB-CNM), CSIC. Carrer dels Til.lers s/n, Cerdanyola del Vallès, 08193, Spain*
[2] *Departament de Física, Universitat Autònoma de Barcelona, Bellaterra 08193, Spain*

maria.benito@imb-cnm.csic.es,
gemma.rius@csic.es

Superconducting circuits is one of the most popular platforms used for prospective quantum computers. However, e.g. state-of-the-art resonators still report losses at least one order of magnitude higher than predicted for pure bulk dielectric losses, which has been commonly attributed to Two-Level-Systems (TLS) of amorphous materials, such as native oxides.
Indeed, despite having been studied for decades, materials-induced decoherence is still one of the major challenges to overcome.
Most of the bibliography has focused so far on reducing TLS in terms of metal growth procedures, surface preparation methods, and other fabrication-related characterization [1]. We aim to tackle the issue by benchmarkable ***metal/substrate combinations,*** *i.e.* using the same fabrication procedures and resonator's geometry, in order to make informed analyses of the substrate-related dielectric losses. It is aimed to fill the gap of current comparisons from meta-analysis [2], where differences in chip design and fabrication steps can limit comparisons validity.

Here, I will present some of the recent results obtained for ***Aluminium Superconducting Resonators,*** *which have been patterned on* ***substrates such as Sapphire, Silicon, and Silicon Carbide***. Transfer measurements as a function of applied microwave power and operating temperature are employed to extract the internal quality factor of each resonator, while a dedicated design, "tapered" resonators with equivalent coupling to feed line, is used for estimating the TLS surface density.

References

[1] Oliver, William D., and Paul B. Welander. "Materials in superconducting quantum bits." MRS bulletin 38.10 (2013): 816-825.
[2] McRae, Corey Rae Harrington, et al. "Materials loss measurements using superconducting microwave resonators." Review of Scientific Instruments 91.9 (2020).

Figures

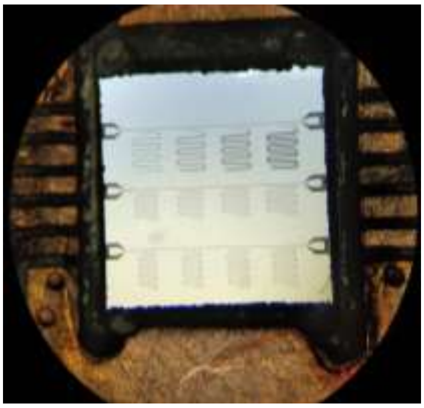

Figure 1: SC Al/Sapphire resonators designed with different surface participation ratios