Microwave Loss Measurements of Copper-Clad Superconducting Niobium Microstrip Resonators on Flexible Polyimide Substrates

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***Abstract*—In this work, we investigated how different under and capping layers on patterned Nb films impacted the rf losses of flexible thin-film superconducting microstrip transmission line resonators measured in a frequency range from 2-20 GHz. We studied how different thicknesses of Ti (10 and 50 nm) underlayer, used for adhesion, impacts conductor losses. We also studied Cu (20, 50, 100, and 200 nm) capping layers and how they affect conductor loss. These studies were carried out on 20 _m thick spin-on polyimide (PI-2611) thin films and characterized at various cryogenic temperatures between 1.2 K and 4.2 K. The results indicate normal-superconductor (Ti/Nb) and superconductor-normal (Nb/Cu) bilayer structures have increased surface resistance, which leads to an increase in microwave loss when compared to Nb-only signal traces. We quantified this additional loss by extracting resonator quality factors for weakly coupled resonators with various conductor stack-ups. Our experimental results can help inform decisions regarding material stack-ups when designing multi-conductor, multi-layer superconducting flexible cables intended for use with ultra-low temperature electronic systems.**

***Keywords*— Microwave, resonator, conductor loss, superconducting proximity effect, polyimide.**

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