A 200-mm Superconducting Platform for the Microwave Characterization of Magnetic Materials at Low Temperature

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The growing importance of thin film magnetic materials in quantum information transport and memories [1] necessitates their characterization at cryogenic temperatures. Magnons, the collective excitations of spins, couple to microwave photons via dipolar interactions, offering long coherence length for extended information exchange. Combining high spin densities with high-quality microwave cavities allows for strong magnon-photon coupling [2].

In this context, we have developed superconducting circuits to probe ferromagnetic resonance of magnetic materials at low temperature. Our approach leverages 200-mm processes with industrial grades to fabricate multiple planar superconducting structures: coplanar waveguides, spiral inductors, and low-impedance resonators. These structures enable us to probe magnons in YIG and Py from 8K down to 20 mK with large SNR and versatility. In particular, we compare broadband coplanar waveguides and spiral inductors for analysing these dynamics. Using high-quality, low-impedance lumped element resonators, we achieve strong coupling between photons and magnons [3].

References

[1] D. D. Awschalom et al., IEEE Transactions on Quantum Engineering 2, 1 (2021).

[2] J. T. Hou and L. Liu, Phys. Rev. Lett. 123, 107702 (2019).

[3] X. Zhang et al., Phys. Rev. Lett. 113, 156401 (2014).

Figures

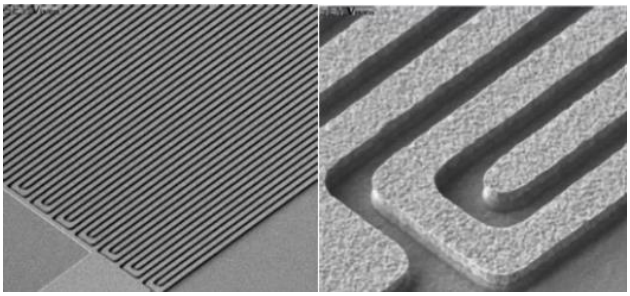

Figure 1: SEM image of superconducting meander structures processed in a 200-mm foundry.

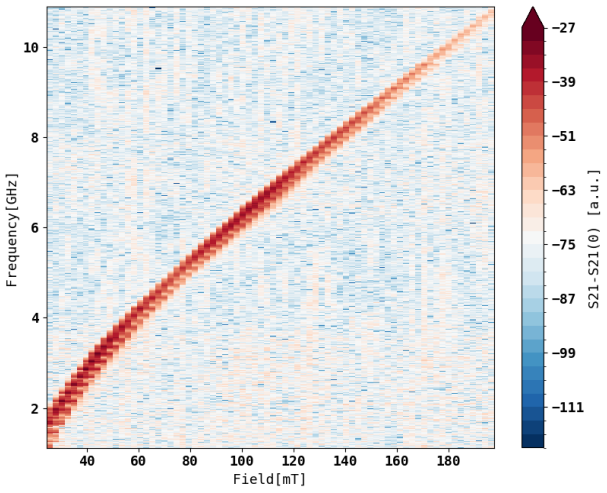

Figure 2: Transmission measurement (S21) of a spiral inductor with a 100nm thick YIG thin film on GGG glued on top at 4K. Sweeping the external static magnetic field changes the ferromagnetic resonance frequency of the YIG which follows the Kittel equation.