

Silicon Fin Based Josephson Junctions: Performance and Interfaces

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Josephson Junctions (JJs) are a central building block of superconducting qubits and related technologies, but are known to host defects (so-called Two Level Systems, or TLS) which negatively impact the performance of quantum devices. Traditionally, JJs have been built around amorphous oxide barriers, which have long been thought to inherently host TLS. Here, we present a Josephson Junction based on a crystalline silicon fin, as proposed in the “FinMET” concept [1,2].

Our fin-based Josephson Junctions are fabricated using an anisotropic KOH etch on 110 Si using a SiN hard mask, creating fins approximately 1-2 μm tall and less than 20 nm thick. [3] Angle deposited aluminum forms electrodes on either side of the silicon fin, with the SiN forming a shadow mask that prevents shorting of the two electrodes over the top of the fin.

To test the performance of our fin-based JJs, we construct RF-SQUID style devices with the fin-based JJ acting as both a JJ and capacitor shunting a planar inductor. By measuring the resonant frequency of these structures as a function of the magnetic field threading the RF-SQUID loop, we see periodic modulation, unambiguous evidence that our fin-based element is acting as a Josephson Junction. Additionally, we search for and observe individual TLSs coupling to our device, inferring through their strong coupling that they are located within our fins. In future work, we aim to test whether these TLS originate from defects in the aluminum-silicon interface or from the silicon fin itself, and develop methods for decreasing their density and impact on circuit performance.

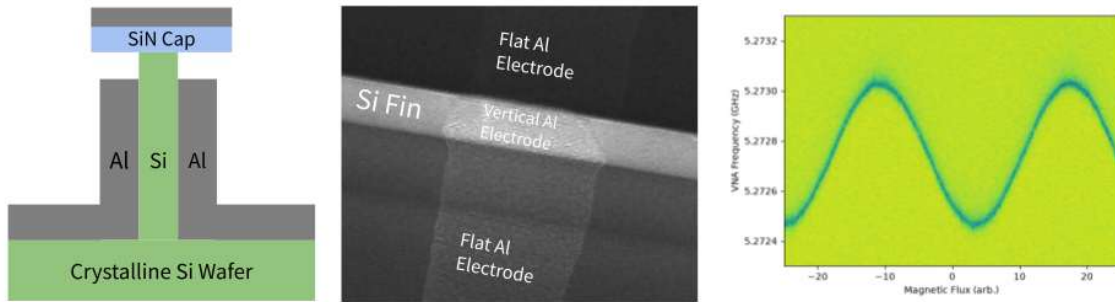


Figure 1: (Left) schematic cutaway of our fin-based JJ. (Center) SEM image of a fabricated fin-based JJ. (Right) Resonant frequency of the RF-SQUID circuit, showing modulation with applied magnetic flux and demonstrating that the fin element acts as a Josephson Junction.

[1] Goswami, A., McFadden, A.P., Zhao, T. *et al. Appl. Phys. Lett.* **121**, 064001 (2022)

[2] McFadden, A.P., Goswami, A., Zhao, T. *et al. npj Quantum Inf* **11**, 11 (2025).

[3] Wu, Y., van Schijndel, A.J.T., McFadden, A.P. *et al. arXiv:2609.32826* (2026).

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