

Towards Scalable, Available, and Capable Superconducting Qubits

Valla Fatemi^{1, +}

¹*School of Applied and Engineering Physics, Cornell University, Ithaca, New York 14853, USA*

In this seminar, I will present our team's recent efforts in developing high-performance superconducting qubits. Topics will include improving performance and processing windows of base layer films made from niobium and tantalum on silicon substrates, with special emphasis on the correlations between microwave quantum device performance and surface and interface materials properties [1,2]. Particularly, we found that we could reduce substrate temperatures for BCC Ta deposition well into the back-end-of-the-line process window via use of krypton as a sputtering gas. Transmon qubits with a twenty-micron capacitor gap made from these films exhibit quality factors exceeding fifteen million (coherence times up to 1 millisecond), demonstrating their performance with processing that is compatible with a greater number of tools. Additionally, I will highlight high-performance qubits made with Josephson junctions formed by a resist-free fabrication method and our efforts to make high-performance qubit fabrication more broadly available through developing standard process flows at the Cornell Nanoscale Facility.

- [1] Olszewski, Maciej W., Jadrien T. Paustian, Tathagata Banerjee, et al. "Low-Loss Nb on Si Superconducting Resonators from a Dual-Use Spintronics Deposition Chamber and with Acid-Free Post-Processing." *Applied Physics Letters* 128, no. 21 (2026): 214001. <https://doi.org/10.1063/5.0325435>.
- [2] Olszewski, Maciej W., Lingda Kong, Simon Reinhardt, et al. "Krypton-Sputtered Tantalum Films for Scalable High-Performance Quantum Devices." arXiv:2601.20091. Preprint, arXiv, January 27, 2026. <https://doi.org/10.48550/arXiv.2601.20091>.

This prototype was primarily supported by the Microelectronics Commons Program, a DoW initiative, under award number N00164-23-9-G061. Funding (or Partial funding) for shared facilities used in this prototype was provided by the Microelectronics Commons Program, a DoW initiative, under award number N00164-23-9-G061.

- [1] Banerjee, Tathagata, Stephen Daniel Funni, Saswata Roy, Judy J. Cha, and Valla Fatemi. "Resist-Free Shadow Deposition Using Silicon Trenches for Josephson Junctions in Superconducting Qubits." arXiv:2604.09796. Preprint, arXiv, April 10, 2026. <https://doi.org/10.48550/arXiv.2604.09796>.

⁺ Author for correspondence: vf82@cornell.edu