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Topic: ALD TaN and ALD AlN Tunnel Barriers for Nb-based Superconducting Qubits

Abstract: Quantum computing – the process of storing, transmitting, and processing information that leverages quantum states of matter – offers a solution to specific problems where classical computation falls short. A number of physical systems are being developed for quantum computation; however, the question of what form quantum 'hardware' will take does not have an easy answer: each system faces unique obstacles to practical implementation. One of these systems, based on superconducting circuits, offers the use of CMOS-industry processing techniques for highly scalable qubit fabrication, yet has lower coherence times than some other quantum computing systems. Currently, all quantum computing implementations suffer from the 'scalability' question – how can tens of thousands of qubits be made with adequate precision and predictable performance characteristics?

The Josephson Junction (JJ) is the 'heart' of superconducting qubits. Fabrication of junctions with predictable properties is enabled by control over materials and interfaces, and process control across the wafer and from wafer to wafer. Here, I will describe the basic function and properties of Josephson Junctions and discuss our efforts to optimize the fabrication of these superconducting circuits to improve their performance. Control over tunnel barrier thickness is made possible by atomic layer deposition (ALD) of TaN and AlN, and the quality of the top and bottom interfaces made possible by in vacuo wafer transfer between integrated process chambers. Characterization of JJ performance will inform our efforts to test Nb/ALD-TaN/Nb and Nb/ALD-AlN/Nb JJs in superconducting qubits fabricated at 300mm wafer-scale.