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Using Atomic Layer Deposition for Josephson Junction Quantum Bits ALAN ELLIOT, GARY MALEK, RONGTAO LU, SIYUAN HAN, JUDY WU, University of Kansas Dept. of Physics & Astronomy, H.F. YU, G.M. XUE, S.P. ZHAO, Beijing National Laboratory for Condensed Matter Physics, Chinese Academy of Sciences — Ultrathin dielectric tunneling barriers are critical to Josephson junction (JJ) based superconducting quantum bits (qubits). However, the prevailing technique of thermally oxidizing aluminum via oxygen diffusion produces problematic point defects, such as oxygen vacancies, which are believed to be a primary source of the two-level fluctuators that contribute to the decoherence of the qubits. Atomic Layer Deposition (ALD) of aluminum oxide (Al_2O_3) is a promising alternative to resolve the issue of oxygen vacancies in the Al_2O_3 tunneling barrier, and its self-limiting growth mechanism provides atomic-scale precision in tunneling barrier thickness control. ALD has been implemented in a high-vacuum magnetron sputtering system for *in situ* deposition of ALD-Al_2O_3 tunneling barriers in superconductor-insulator-superconductor (SIS) JJs. The modifications made to the Al surface during ALD were explored with ellipsometry and atomic force microscopy, and ALD-Al_2O_3 barriers were grown on Nb to form Nb/Al2O3/Nb JJs. Preliminary low temperature measurements of current-voltage characteristics of the Josephson junctions made from these trilayers confirmed the integrity of the ALD-Al_2O_3 barrier layer.

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