Objective:
Supercritical-insulating-supercritical (SIS) trilayers have been produced for Josephson Junction fabrication by thermal atomic layer deposition (ALD) processes. The trilayers are composed of alternating layers of TiN/Al2O3/TiN deposited in situ, in a thermal ALD reactor. The self-limiting nature of ALD enables precise control of tunnel-barrier insulator thickness by counting the number of ALD cycles during the junction insulator deposition step. The conformal nature of the deposition process ensures that Josephson junction sidewalls are uniformly insulated without the need for anodization.

Motivation:
The conformal nature of ALD makes this technique extremely attractive for depositing and patterning multiple layers of superconductors and insulators. ALD eliminates step-coverage problems, the need for sloped-side-wall etches, and the potential for a discontinuity when the superconductor crosses over a sharp step.

Atomic Layer Deposition and Fabrication description:
- film growth with a self-limiting nature of ALD is observed in a thermal ALD reactor. The self-limiting nature of ALD makes this technique extremely attractive for depositing and patterning multiple layers of superconductors and insulators.
- ALD eliminates step-coverage problems, the need for sloped-side-wall etches, and the potential for a discontinuity when the superconductor crosses over a sharp step.

Test results for ALD Josephson Junctions:
- Characteristics and gap voltage of a single junction indicate the possible presence of a second superconducting transition at higher temperature, which has not been observed in Tc checks of ALD TiN, where a single transition at 3.4K has been recorded. Further development is needed to reduce Ic by adding more Al2O3 cycles during trilayer deposition.
- To adjust Ic, additional Al2O3 cycles will be added during trilayer growth. The junction measured in the above plot is a 2.1 µm square junction.

Progress toward ALD SQUIDs:
- Using design rules established during the production of ALD Josephson junctions, we designed and fabricated a single-element, 6-µm-wide-base-electrode SQUID.

Summary:
We have demonstrated Josephson Junctions fabrication with Atomic Layer Deposition titanium nitride/aluminum oxide/titanium nitride trilayers. The conformal nature of ALD obviates the need for anodization of junction side-walls. Junctions produced have 100 µA critical current, which can be reduced by depositing additional cycles of Al2O3 during trilayer growth. The IV characteristics and gap voltage of a single junction indicate the possible presence of a second superconducting transition at higher temperature, which has not been observed in Tc checks of ALD TiN, where a single transition at 3.4K has been recorded. Progress has been made toward producing ALD SQUID devices, although the critical current of the Josephson Junctions needs to be reduced significantly, by adding cycles of Al2O3 to the junction barrier.