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Fabrication and Testing of Re-AlOx-Re(or Al) Josephson Junctions for Phase Qubits[1] K. CICAK, S. OH, K. OSBORN, J.A. STRONG, D.P. PAPPAS, R.W. SIMMONDS, NIST, Boulder, R. MCDERMOTT, K.B. COOPER, M. STEFFEN, JOHN M. MARTINIS, UC Santa Barbara — We have successfully fabricated and characterized new Josephson junctions from UHV grown Re-AlOx-Re and Re-AlOx-Al trilayers with both epitaxial and amorphous base Re electrodes. Fabrication utilized optical lithography, ion-milling, and reactive-ion-etching techniques. When exposed to air ambient for days or even hours, Re films develop defect-like structures. Simple tests, optical, and AFM inspection showed that these defect-like "dots" are not true disorder in the Re film, and that they can be completely removed from films by solvents. 4-probe resistance measurements at room T show that junction resistance scales properly with the junction area. Preliminary devices show I-V characteristics with subgap leakage comparable to Al-AlOx-Al junctions. Junctions with epitaxial Re base layer and oxide barrier annealed in O_2 ambient show far superior I-V signatures (well defined voltage gap, small sub-gap current) compared to junctions with amorphous Re base layer and barrier annealed in vacuum. These investigations are presently underway in an attempt to eliminate the spurious resonators found in Josephson junction phase qubits.

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K. Cicak
NIST, Boulder

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