Abstract Submitted
for the MAR10 Meeting of
The American Physical Society

Thin film growth of epitaxial Re/Al_2O_3/Re/Ru trilayers for fabrication into Josephson junction based phase qubits MICHAEL R. VISSERS, JEFFREY S. KLINE, FABIO DA SILVA, DAVID S. WISBEY, WILLIAM F. EGELHOFF, DAVID PAPPAS, (National Institute of Standards of Technology) — We present a new growth recipe for creating single crystal thin film Re/Al_2O_3/Re/Ru epitaxial trilayers for fabrication into Josephson junctions, a critical component of the phase qubit circuit. The crystalline aluminum oxide barrier is sputter deposited at high temperature, and pinholes in the barrier can be reduced by tuning the oxygen concentration present during the sputtering process. The thickness of the Al_2O_3 barrier is monitored *in situ* using multi-wavelength ellipsometry. To maintain compatibility with current in-plane tunneling (CIPT) measurements, the thin top electrode is designed to consist of 30 nm Re and 5 nm Ru. The passivating Ru cap protects the underlying Re film from tarnishing when exposed to atmosphere, and also forms a conductive native oxide. CIPT measurements permit the study of the barrier tunneling characteristics prior to the wafer being processed into junctions. We utilize the RA products obtained from both the CIPT measurements and the fabricated tunnel junctions to optimize the trilayer growth architecture and procedure. This work was funded by the U.S. government and IARPA.

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Date submitted: 20 Nov 2009 Electronic form version 1.4