Abstract Submitted
for the MAR09 Meeting of
The American Physical Society

Crystalline Silicon Dielectrics for Superconducting Qubit Circuits

DAVID HOVER, WEINA PENG, STEVEN SENDELBACH, MARK ERIKSSON, ROBERT MCDERMOTT, University of Wisconsin Madison — Superconducting qubit energy relaxation times are limited by microwave loss induced by a continuum of two-level state (TLS) defects in the dielectric materials of the circuit. State-of-the-art phase qubit circuits employ a micron-scale Josephson junction shunted by an external capacitor. In this case, the qubit T_1 time is directly proportional to the quality factor (Q) of the capacitor dielectric. The amorphous capacitor dielectrics that have been used to date display intrinsic Q of order 10^3 to 10^4. Shunt capacitors with a Q of 10^6 are required to extend qubit T1 times well into the microsecond range. Crystalline dielectric materials are an attractive candidate for qubit capacitor dielectrics, due to the extremely low density of TLS defects. However, the robust integration of crystalline dielectrics with superconducting qubit circuits remains a challenge. Here we describe a novel approach to the realization of high-Q crystalline capacitor dielectrics for superconducting qubit circuits. The capacitor dielectric is a crystalline silicon nanomembrane. We discuss characterization of crystalline silicon capacitors with low-power microwave transport measurements at millikelvin temperatures. In addition, we report progress on integrating the crystalline capacitor process with Josephson qubit fabrication.

David Hover
University Wisconsin Madison

Date submitted: 20 Nov 2008 Electronic form version 1.4