Abstract Submitted
for the MAR08 Meeting of
The American Physical Society

Materials for superconducting qubits: Measurements of dielectric loss at low temperatures AARON O'CONNELL, M. ANSMANN, R.C. BIALCZAK, R. MCDERMOTT, M. HOFHEINZ, N. KATZ, E. LUCERO, M. NEELEY, H. WANG, E.M. WEIG, J.M. MARTINIS, A.N. CLELAND, UC Santa Barbara —
The energy relaxation time (T_1) of the Josephson phase qubit is significantly impacted by the microwave loss in the dielectric materials used in fabrication. This loss mechanism is most likely due to the qubit coupling to a fermionic bath of two-level defect states embedded in the dielectrics. At high temperatures or high excitation voltages, these states can become saturated, so that the low loss tangents reported in the literature do not accurately represent the material performance at low temperatures and very small excitation energies. We have probed the microwave ($\sim$6 GHz) loss tangents of a number of common thin-film dielectrics at $\sim$100mK, using very low excitation voltages, in order to obtain values for the loss tangents relevant to quantum computation. We present these loss tangent data, and illustrate a technique to extract material values from measurements of the quality factors of coplanar waveguide resonators.

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Date submitted: 30 Nov 2007 Electronic form version 1.4