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High Q Dielectrics for Josephson Phase Qubits E. M. WEIG, M. ANSMANN, R. BIALCZAK, N. KATZ, E. LUCERO, R. MCDERMOTT, M. NEELEY, M. STEFFEN, J. M. MARTINIS, A. N. CLELAND, California NanoSystems Institute & Department of Physics, UC Santa Barbara — Dielectric loss in the bulk insulating material surrounding a superconducting phase qubit has recently attracted attention as a major source of decoherence. Dissipation arises from the excitation of a bath of two-level defects that is unsaturated in the limit of low microwave power and low temperature. This gives rise to much lower intrinsic Q factors than expected from material characterization typically performed in the saturated higher power or temperature regime. The density of these two-level systems in the insulator can be distinctively reduced by carefully choosing and engineering the dielectric material. We have investigated LC resonators fabricated using various amorphous dielectrics ranging from silicon dioxide or silicon nitride to silicon hydride (a-Si:H). The intrinsic Q factors of the materials have been measured at microwave frequencies in the unsaturated regime. The data demonstrates that by proper choice of material the dielectric loss tangent can be dramatically reduced, thus allowing for long coherence time phase qubits.

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