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Quality factor dependence on geometry and photon number in superconducting coplanar resonators MOE KHALIL, MICAH STOUTIMORE, HANHEE PAIK, University of Maryland and Laboratory for Physical Sciences, FREDERICK WELLSTOOD, University of Maryland, KEVIN OSBORN, Laboratory for Physical Sciences — The loss in coplanar superconducting resonators at low-photon number is not yet understood, and has implications on the achievable coherence of superconducting qubits. We have fabricated and measured high quality factor superconducting aluminum coplanar resonators on sapphire, all with a fundamental resonance frequency of approximately 6GHz, to facilitate the study of loss mechanisms including loss caused by two-level systems and radiation. We studied four resonator geometries that include a lumped-element resonator, a coplanar strip waveguide resonator, and two hybrid designs that contain a coplanar strip waveguide terminated by either a compact inductor or capacitor. The measurements are taken at 30mK with a probe frequency that is varied in amplitude and in some experiments a second drive frequency is also used to study the loss mechanism. We find that the internal quality factor of the resonators increases with photon number in a manner that is not merely explained by a surface distribution of independent two-level systems.

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