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Characterization of quantum-regime dielectric loss of aluminum oxide using superconducting LC resonators CHUNQING DENG, MARTIN OTTO, ADRIAN LUPASCU, University of Waterloo — We report low-temperature measurements of dielectric loss of thin layers of aluminum oxide. The experiments are performed by measuring the microwave transmission of coplanar waveguides coupled to LC resonators where the capacitor contains the dielectric to be characterized. We develop a method, based on systematic approximations of transfer functions, to analyze the measured transmission curves. The fit of the resonance curves yields not only the loss tangent of the dielectric, but also the relation between the voltage on the capacitor and the excitation voltage. The latter is a nonlinear relation which has to be properly taken into account when analyzing the power dependence of dielectric loss. We find that the loss tangent of the aluminum oxide increases with decreasing capacitor voltage and temperature and reaches a constant value around 2×10^{-3} at sub-single photon levels. Our results are qualitatively in agreement with the two-level system defect model. Despite large loss, compact resonators based on these dielectrics have potential applications in microwave amplifiers. These results are relevant to understanding decoherence in superconducting quantum devices.

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