

Two Level System Loss in Superconducting Microwave Resonators

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Abstract - High quality factor, i.e., low loss, microwave resonators are important for quantum information storage and addressing. In this work we study the resonance frequency and loss in superconducting coplanar waveguide resonators as a function of power and temperature. We find that there is increased loss at low power and low temperature. The increased loss is attributed to the existence of two-level systems (TLS) at the surfaces, interfaces, and in the bulk of insulators deposited on the structures. We show that both the temperature dependence of the resonant frequency and the power dependence of the loss can be used to find the TLS contribution to the loss. The TLS intrinsic loss tangent derived from the frequency shift data at high power is shown to agree well with the direct loss measurement at low power. The former allows for a relatively fast measurement of the TLS loss. As an example, we measure the properties of amorphous AlO_x deposited on the resonators and find a TLS loss tangent of 1×10^{-3} .

Index Terms - Two level system dielectric loss, superconducting resonators, low temperature physics

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