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Frequency Noise in Superconducting Thin-Film Resonators SHWETANK KUMAR, Caltech, PETER DAY, HENRY LEDUC, BENJAMIN MAZIN, JPL, MEGAN ECKART, JIANSONG GAO, Caltech, JONAS ZMUIDZINAS, Caltech — We present the results of low temperature (120 – 1200 mK) noise measurements performed on thin-film superconducting niobium resonators fabricated on a silicon substrate. The devices studied use coplanar waveguide (CPW) transmission lines and have resonance frequencies of around 4 GHz and quality factors in the range of Q $\sim 10^4$ to 10^6. These resonators are similar to those used to make novel photon detectors and read out charge qubits. These resonators show excess frequency noise which varies as approximately $f^{-1/2}$. This excess noise limits the sensitivity of our photon detectors and likely effects the qubit performance as well. Two level systems (TLS) in amorphous thin-film dielectrics and oxide tunnel barriers have been shown to cause dissipation and decoherence in phase qubits. We suggest that noise in our resonators is also caused by TLS most likely near the surfaces of the substrate and metal films. To test this idea, we have measured the frequency shift, the quality factor and the frequency noise as a function of the device temperature and the microwave readout power. The frequency shift data agrees well with existing weak field TLS theory. We also find that the frequency noise decreases with increasing readout power and temperature and that decreased noise at higher powers is not due to simply device heating.

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