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Silicon oxide, nitride and oxynitride films as dielectric materials for superconducting detector applications

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Modern Cosmic Microwave Background (CMB) detectors are planar superconducting devices that employ striplines for the millimeter radiation transfer from a coupling antenna to a power readout Transition Edge Sensor (TES), as well as in-line filters to define the bandpass. Quality of dielectric materials separating signal lines and ground plane are crucial to determine yield of the fabrication process and the on-sky detector performance. Here we present the characterization of silicon oxide, nitride and oxynitride thin film dielectrics using XRD, SEM and AFM techniques. The samples were synthesized by using a variety of reactive physical vapor deposition methods, including DC, RF and high-impulse power magnetron sputtering. While the composition was controlled by adjusting the ratio between the working (Ar) and reactive (O2 and N2) gases, the films morphology and structure varied with deposition pressure, and RF bias on the sample stage. Then, these materials were patterned into superconducting (Nb) resonant structures consisting of planar spiral inductors and parallel-plate capacitors. Measurements of the megahertz resonant frequencies and Q-factor were made using custom signal generation and processing FPGA electronics. The results of these tests and optimized sputtering process for reduced dielectric loss in CMB detector fabrication will be discussed.

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Less than 5 years of experience since completion of Ph.D

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