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Low-loss Microstrip Transmission Line Fabricated with Improved Liftoff Process

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The μ-Spec integrated spectrometer operating at ~500 GHz, employs thin film superconducting Nb microstrip transmission lines deposited directly on a thin (450 nm) single-crystal silicon dielectric. This single-crystal silicon layer is chosen as the dielectric layer due to its low intrinsic loss, with the goal of achieving both high-efficiency and precise phase control in a compact spectrometer architecture. To avoid roughening or etching through the thin single-crystal silicon dielectric a liftoff technique was developed for patterning these microstrip transmission lines and ground plane structures. This two-layer liftoff process was designed for use with sputter deposition and resulted in a US patent. Although this original technique provided precise control of linewidth, results of initial prototype spectrometer devices and separate diagnostic co-planer waveguide resonator devices showed that unexpected loss was being introduced due to the lift-off process. This extra loss was believed to be due to the "tails" (thin tapered regions) at the edge of the metal traces resulting from the sputtering process, as well as an amorphous oxide layer at the Nb-Si interface. We have since demonstrated an improved lift-off technique, which provides a clean metal-Si interface and removes the loss-inducing tails by a two-step selective etching method. This results in a decrease in microwave loss by more than an order of magnitude when measured in co-planar waveguide microwave resonator structures. We present these microwave test results and also SEM and TEM images of the microstrip interfaces and edge profiles before and after application of the improved process.

Student (Ph.D., M.Sc. or B.Sc.)

N

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