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Effects on Film Stress on Quality Factors of Niobium Resonators

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Film stress has been long known to affect the properties and performances of thin superconductors. In the quantum computing field, a slightly compressive film (~ -100 MPa) has been shown to be ideal for making superconducting-insulating-superconducting (SIS) junctions, no analogous study has been done for superconducting resonators. Anecdotal evidence suggests compressive films show lower loss when patterned as millimeter wavelength transmission lines. We plan to test this relationship using narrow-band microstrip resonators and studying resonator quality factor (Q) with film stress, with film stress varying from -700 MPa (compressive) to 300 MPa (tensile). The devices are single-layer Nb lumped-element kinetic inductance detectors (LEKIDs) with resonance frequencies between 0.6-1.7 GHz. Around 200 nm of Nb is deposited onto high resistivity silicon wafer via sputtering under varying chamber pressures and the film stresses are subsequently measured. The wafers are then patterned via optical lithography and dry etched with fluorine plasma. We measure the resonance Q and T_c for each film using a helium dilution refrigerator.

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

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

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Primary authors: TANG, Qing Yang (University of Chicago); BARRY, Pete (Cardiff University); SHIROKOFF, Erik (University of Chicago)

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