Cavity-optomechanical devices based on exfoliable superconducting crystals of BSCCO

There has been a keen interest in exploring 2-dimensional materials for various device applications. Their electrical property spans over a wide spectrum ranging from insulating, semiconducting, metallic to superconducting behavior. From the family of the exfoliated thin crystals, the superconducting crystals are most attractive for developing cavity optomechanical devices. In this direction, we probe the mechanical properties of the exfoliated crystals of BSCCO. We perform mechanical compliance measurements using the nanoindentation technique and determine the pre-stress and Young's modulus of rigidity. While the pre-stress spreads over significantly from 5 $\mu N/m^2$ - 50 $\mu N/m^2$, Young's modulus lies in the range of 20 GPa to 30 GPa and does not show any prominent thickness dependence.

To develop cavity-optomechanical devices, we couple their mechanics to a superconducting coplanar waveguide microwave cavity. We demonstrate mechanical frequency tunability with external dc-bias voltage and quality factors up to 36600. Our spectroscopic and time-domain measurements show that mechanical dissipation in these systems is limited by the contact resistance arising from resistive outer layers. The temperature dependence of dissipation indicates the presence of tunneling states, further suggesting that their intrinsic performance could be as good as other two-dimensional atomic crystals such as graphene.