Single-gap superconductivity in Nb-doped $SrTiO_3$ and superconducting dome probed by microwave spectroscopy

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$SrTiO_3$ exhibits a superconducting dome (critical temperature T_c up to 0.4 K) upon doping with Nb, which successively fills multiple bands at the Fermi level. Using superconducting microwave stripline resonators [1] at frequencies 2 to 23 GHz and temperatures down to 0.02 K, we probe the low-energy optical response of superconducting $SrTiO_3$ with charge carrier concentration ranging from 0.3 to 2.2×10^{20} cm^{-3} across the superconducting dome. We determine the real and imaginary parts of the complex optical conductivity for frequencies below and above the superconducting gap 2Δ, and we analyze the optical response within the Mattis-Bardeen formalism and considering the influence of multiple bands and scattering.

We find single-gap optical behavior [2] although several electronic bands are superconducting and Nb-doped $SrTiO_3$ was so far believed to be a multi-gap superconductor [3]. This presence of only a single energy gap due to gap homogenization over the Fermi surface is consistent with the amount of defect scattering observed in Nb-doped $SrTiO_3$ and inevitable for such a doped material. Furthermore, we determine T_c, 2Δ, and the superfluid density throughout the superconducting regime of Nb-doped $SrTiO_3$, and all three quantities exhibit the characteristic dome shape as a function of Nb concentration.

References

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