Design and fabrication of cryogenic probe for penetration depth measurements down to 1.8 K

Saurabh. K. Bose, Kartikeswar Senapati, and R. C. Budhani

Condensed Matter - Low Dimensional Systems Laboratory, Department of Physics, Indian Institute of Technology Kanpur, Kanpur - 208016, India

We describe the design and fabrication of an efficient cryogenic probe for measurements of magnetic penetration depth (λ) down to 1.8 K. Penetration depth provides fundamental information about the strength and type of superconducting coupling in Meissner and mixed states and sets the length scale for vortex dynamics. Our probe employs the novel single coil self inductance technique at radio frequencies, in which the coil configuration along with the temperature stabilized tunnel diode oscillator enable the measurement of λ for thin film samples. There is also a provision for studying modulation of λ in the presence of small magnetic fields generated from an inbuilt coaxial superconducting coil. We present the performance of this probe in attainment and controlled sustenance of temperatures below liquid helium temperature (4.2 K) and a signal-to-noise ratio of $\sim 10^5$, in transition temperature measurement of superconducting Indium foil .