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Evidence of a nodeless superconducting gap in PrCeCuO from magnetic penetration depth measurements

THOMAS LEMBERGER[1], Ohio State University

We have measured the inverse-squared magnetic penetration depth, λ^{-2}(T), at 50 kHz of films of the electron-doped cuprate superconductor $Pr_{2-x}Ce_xCuO_{4-\delta}$ over a range of Ce dopings, $0.124 \leq x \leq 0.144$, that extends from underdoped to overdoped. The maximum T_C was 24 K at x = 0.131. The films were grown by mbe on $SrTiO_3$ substrates that had been buffered with a thin layer of the insulating parent compound, $Pr_2CuO_{4-\delta}$, to obtain the cleanest possible films. Resistivity decreased smoothly and monotonically with doping. We used a two-coil mutual inductance technique to determine the film conductivity σ down to about 0.5 K, and we obtained λ^{-2} from σ_2 in the usual fashion. We found that λ^{-2}(T) was flat at low temperatures. That is, $\lambda^{-2}(T)/\lambda^{-2}(0)$ changed by less than the experimental noise of 0.15% over a factor of 3 or more change in T. Fits to the low-T data yield minimum a gap value, $\Delta_{min}(0)/k_BT_C$, that is unity near optimal doping and decreases with over- and underdoping. This talk will compare our results with other penetration depth measurements that find quadratic behavior at low T, consistent with a d-wave gap and with phase sensitive measurements.

[1]Work done in collaboration with M.-S. Kim, J.A. Skinta at OSU and A. Tsukada and M. Naito at NTT Labs in Japan