An Interface Delocalization (Wetting) Transition in a Single Crystal Tin Superconductor: An Experimental Study

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Theory [1] predicts that the phase diagram of type-I superconductors with surface enhancement of the order parameter takes an unusual shape, resembling a wetting phase diagram of adsorbed fluids. In particular, below a characteristic temperature T_w in a parallel magnetic field slightly above H_c, the superconducting/normal interface meets the sample surface under a finite contact angle. This corresponds to partial wetting. At T equal to and higher than T_w, the superconducting phase forms a continuous surface sheath, the thickness of which diverges upon approaching H_c from above. This corresponds to complete wetting. The transition between these two states is called the interface delocalization or wetting transition in type-I superconductors. For superconductors with a Ginzburg-Landau parameter κ below 0.374, the transition is expected to be discontinuous (first-order wetting). Off of two-phase coexistence it is accompanied by a first-order prewetting transition at $T > T_w$. Another predicted feature of superconductors with surface enhancements is the existence of the superconducting sheath above the bulk critical temperature T_c. We will report results of experiments targeted to verify the wetting scenario for superconductors. The magnetization of high-purity single crystal tin samples with surface enhancement [2] was measured as a function of H and T above and below the bulk critical point. Two approaches have been used to achieve the enhancement: (a) polishing with fine sand paper, and (b) implantation of a big dose (10^{17} cm^{-2}) of Xe^+ ions. In both cases, the obtained phase diagrams have similar shape, which is in accord with theoretical predictions.

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[1] J.O. Indekeu and J.M.J. van Leeuwen, *Phys. Rev. Lett.* **75**, 1618 (1995).
[2] V.F. Kozhevnikov, M.J. Van Bael, W. Vinckx, K. Temst, C. Van Haesendonck, and J.O. Indekeu, *Phys. Rev. B* **72**, 174510 (2005).