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Critical field anisotropy in inhomogeneous superconducting films

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Abstract

Transition metal superconducting films are characterized, unlike the films of simple superconductors, by a number of anomalies. Among them is the pronounced sensitivity of the critical parameters of the film to their structure. For example the critical temperature, T_c, deviates from T_c of the bulk metal at thicknesses $d \lesssim 10^3$ Å; the magnitude of the Josephson current is much smaller than theoretically predicted, etc..Critical magnetic field measurements reveal an additional maximum in the angular dependence at the angle $\Theta = \pi/2$ (corresponding to the direction perpendicular to the film surface) in parallel with the usual $\Theta = 0^\circ$ maximum (magnetic field along the surface of the film) /1/. Fig. 1a shows the dependence $H_c(\Theta)$ for vanadium films having thickness d = 1100 Å, deposited onto a warm substrate. The direction of the vapour beam was perpendicular to the substrate. As the temperature decreases, the relative magnitude of the anomalous ($\Theta = \pi/2$) maximum increases. Electron micrographs show polycrystalline structure of the film with the crystallites oriented normal to the substrate, the average grain size being 200 to 300 Å (so-called columnar structure, see /1/).