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Perpendicular upper critical field of a proximity-coupled superconducting film

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Abstract

The temperature dependence of the perpendicular upper critical field $B_{c2\perp}$ of a single superconducting Nb film (S) sandwiched between insulating (I) and/or normal-metal layers (N = Cu) is investigated. For the ISI configuration, $B_{c2\perp}$ exhibits the usual linear T-dependence near the transition temperature T_c in contrast to the NSI and NSN configurations where a positive curvature of $B_{c2\perp}(T)$ is observed near T_c. This demonstrates the influence of the different boundary conditions on the $B_{c2\perp}(T)$ behavior of a single S film in contact with N or I. Deviations from the linear T-dependence are thus attributed to the proximity effect due to the presence of an N–S boundary.

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1. Introduction

The upper critical magnetic field B_{c2} of an isotropic type-II superconductor generally obeys a linear temperature dependence in the vicinity of the superconducting transition temperature T_c. A deviation of $B_{c2}(T)$ from a linear T-dependence is often ascribed to inhomogeneities distributed in the sample volume which can result in a broadening of the resistive transitions $R(T)$ and $R(B)$ as considered by Zwicknagl and Wilkins [1] or by Larkin and Ovchinnikov [2].

However, in anisotropic superconductors B_{c2} may show deviations form a linear T-dependence [3,4]. In particular, artificially prepared metallic multilayers (ML) consisting of alternating superconducting (S) and normal metal (N), or of S and insulating (I) layers, or even of two different superconductors S and S′, show unusual $B_{c2}(T)$ dependences [5]. For instance, for S/N ML the *parallel* upper critical field $B_{c2\parallel}(T)$, where the magnetic field is oriented parallel to the film plane, can exhibit a dimensional crossover arising from the modulated structure perpendicular to the film plane and field. $B_{c2\parallel}(T)$ was calculated

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