Lawrence Berkeley National Laboratory

Recent Work

Title

PSEUDO-REVERSIBLE MAGNETIZATION OF Nb

Permalink

<https://escholarship.org/uc/item/8qx1x5c5>

Author

Hitchcock, Harley C.

Publication Date

1963-05-13

DISCLAIMER

This document was prepared as an account of work sponsored by the United States Government. While this document is believed to contain correct information, neither the United States Government nor any agency thereof, nor the Regents of the University of California, nor any of their employees, makes any warranty, express or implied, or assumes any legal responsibility for the accuracy, completeness, or usefulness of any information, apparatus, product, or process disclosed, or represents that its use would not infringe privately owned rights. Reference herein to any specific commercial product, process, or service by its trade name, trademark, manufacturer, or otherwise, does not necessarily constitute or imply its endorsement, recommendation, or favoring by the United States Government or any agency thereof, or the Regents of the University of California. The views and opinions of authors expressed herein do not necessarily state or reflect those of the United States Government or any agency thereof or the Regents of the University of California.

PSEUDO-REVERSIBLE MAGNETIZATION OF Nb^{*}

Harley C. Hitchcock

Lawrence Radiation Laboratory
University of California
Berkeley, California

May 13, 1963

ABSTRACT

One of the striking features of the magnetization of bulk samples of defect-saturated, second-group superconductors is a quasi-perfect diamagnetism for certain regimes of the flux penetration. This effect is seen, typically, in the magnetization of a long cylinder in a uniform, axially parallel magnetic field after "flux jumps" and on changing the sign of the field rate of rise for an already penetrated specimen. The effect is also seen when the sample is cooled in the field. In the case of zero cooling field, there is a small, reversible penetration to the point where the applied field reaches some value which we associate with the lower critical field of the Ginzburg-Landau-Abrikosov-Gor'kov (GLAG) theory; above this value the irreversible, almost quadratic penetration predicted by the Bean theory commences.

We have measured the reversible flux penetration in specimens of Nb in the above geometry as a function of the cooling field, temperature, and degree of cold work. The measurement was made by integrating dB/dt from a coil surrounding the sample, and the apparatus was sufficiently sensitive to resolve a change in penetration of 3×10^3 quanta. Designating the field for the onset of irreversibility as H_{irr} and the cooling field as H_{cool} , we have $-4\pi M = H_{irr} - H_{cool}$.

The locus of these points, when plotted in the $4\pi MH$ plane, reveals a magnetization characteristic of the negative-surface free-energy theories superposed on a symmetric (diamagnetic-paramagnetic) magnetization expected for the defect structure. The net diamagnetic area enclosed by this pseudo-reversible curve is

equal to the free energy of condensation. The upper and lower critical-field values defined by these measurements are in qualitative accord with the result anticipated for Nb, namely, a decrease in the electronic mean free path associated with an increase in the intensity of the defect structure.

This result suggests that the relation of the GLAG structure to the defect-flux structure, in terms of an "effective" free energy, is one of simple superposition, and that the two coexist in this regime of penetration.

* Work done under the auspices of the U. S. Atomic Energy Commission.