Title
Ultralow temperature inductive measurements of YbBiPt

Journal
Physica B Condensed Matter, 206(C)

ISSN
0921-4526

Authors
Bremer, J
Sergatskov, DA
Xia, JS
et al.

Publication Date
1995-02-01

DOI
10.1016/0921-4526(94)00451-z

ELSEVIER

Physica B 206 & 207 (1995) 336–337

PHYSICA B

Ultralow temperature inductive measurements of YbBiPt

J. Bremer[a], D.A. Sergatskov[a], J.S. Xia[a], G.E. Granroth[a], P.J.C. Signore[a], G.G. Ihas[a], M.W. Meisel[a,*], P.C. Canfield[b], R. Movshovich[c], A. Lacerda[c], Z. Fisk[c]

[a]*Department of Physics and Center for Ultralow Temperature Research, University of Florida, 215 Williamson Hall, P.O. Box 118440, Gainesville, FL 32611-8440, USA*
[b]*Department of Physics, Ames Laboratory, Iowa State University, Ames, IA 50011, USA*
[c]*Los Alamos National Laboratory, Los Alamos, NM 87545, USA*

Abstract

Low frequency magnetic susceptibility measurements have been performed on YbBiPt from 3 to 800 mK. In addition to the known peak at 400 mK, an anomaly exists near 120 mK. The lowest temperature feature arises from a surface phase (e.g. Bi_2Pt) and is not a property of the main material. No additional features in the susceptibility are attributed to the bulk material down to the lowest temperature.

The unique properties of YbBiPt were first reported in 1991 when a low temperature linear specific heat coefficient of 8 J/K^2 (mol Yb) was measured [1]. In the same work, changes in the specific heat and the magnetic susceptibility were observed at 400 mK. Additional work [2–6] has been performed in an attempt to further clarify the ground state properties of this material. Resistivity measurements on carefully polished single crystals suggest the 400 mK anomaly arises from a spin density wave transition which gaps approximately one third of the Fermi surface [5]. The purpose of this work was to investigate the diamagnetic trend in the magnetic susceptibility which appears below 100 mK in two different measurements which achieved minimum temperatures of ~50 mK [1,2].

The sample consisted of an ensemble of single crystal flakes that were polished and scraped to remove the known BiPt surface film [4]. In spite of these efforts, a small quantity of the surface residue remained in the indentations of the surface. Measurements were performed on two different cryostats. Standard AC (41–4.1 kHz) mutual inductance measurements were performed from 50 to 800 mK on a homemade dilution refrigerator. During the testing phases of Cryostat II in the UF Microkelvin Laboratory, an RF SQUID was used as a low temperature amplifier to perform AC (16 Hz) susceptibility measurements from a minimum temperature of 3 ± 1 mK to ~225 mK. This particular experimental configuration was almost identical to one described in Ref. [7]. On the millikelvin cryostat, a calibrated Ge resistor served as the thermometer while on the microkelvin machine a ^{3}He melting curve thermometer was used. Another important difference between the two measurements was that the earth's field was present on the sample during the millikelvin experiment while a static background field of about 20 nT was present on the specimen in the microkelvin study.

The results of the 417 Hz measurements on the dilution refrigerator are shown in Fig. 1, and similar results were also obtained at 41 and 4.17 kHz. These results are also similar to those reported by other workers [1,2], especially with respect to the diamagnetic trend which appears below ~110 mK. The data from the experiment on the microkelvin cryostat are shown in Fig. 2, and a sharp change in the signal was

* Corresponding author.

SSDI 0921-4526(94)00451-X

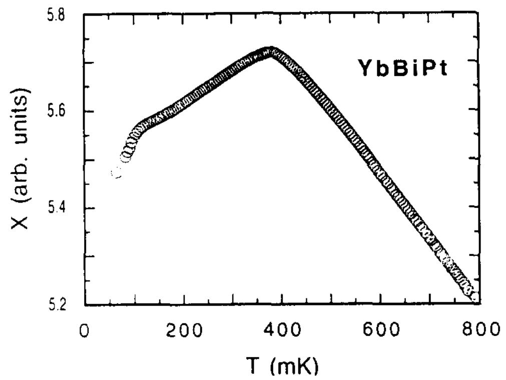

Fig. 1. The AC (417 Hz) susceptibility in arbitrary units is shown as a function of temperature. The measurement was made in the presence of the earth's field.

observed at ~120 mK. It is noteworthy that the resistivity measurements on well-polished single crystals showed no anomalies in this temperature region [5]. On the other hand, resistance measurements on single crystal flakes which still contained some surface residue did indicate the presence of anomalies at several temperatures below 200 mK [8]. It is likely that

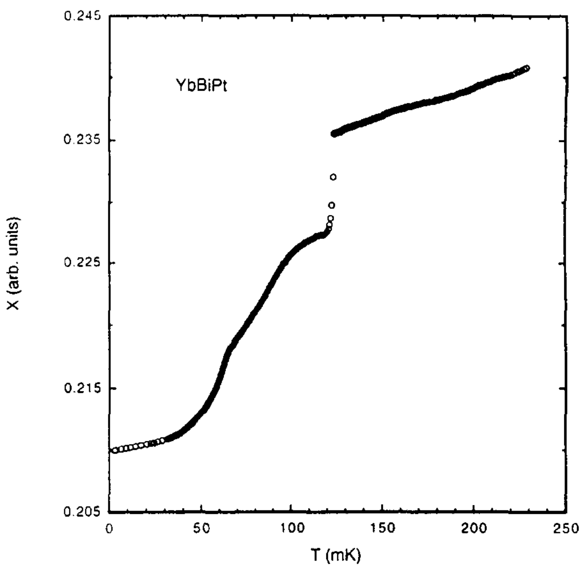

Fig. 2. The AC (16 Hz) susceptibility in arbitrary units is shown as a function of temperature. The measurement was made in a static DC field of approximately 20 nT.

the diamagnetic trends shown in Figs. 1 and 2 are related to a superconducting transition, with Bi_2Pt ($T_c \approx 150$ mK, $H_c \approx 0.95$ mT) being a possibility [9], which is shifted to lower temperature (and broadened) in the presence of a small magnetic field.

In summary, our studies of the magnetic susceptibility of YbBiPt indicated the peak at 400 mK is independent of frequency from 41 to 4.17 kHz. The presence of a diamagnetic anomaly near 120 mK is ascribed to a superconducting transition in the surface residue and is not related to the bulk properties of YbBiPt.

Acknowledgements

We gratefully acknowledge the enlightening conversations with J.D. Thompson. This work was supported, in part, by the National Science Foundation and the Department of Energy.

References

[1] Z. Fisk, P.C. Canfield, W.P. Beyermann, J.D. Thompson, M.F. Hundley, H.R. Ott, E. Felder, M.B. Maple, M.A. Lopez de la Torre, P. Visani and C.L. Seaman, Phys. Rev. Lett. 67 (1991) 3310.
[2] J.D. Thompson, P.C. Canfield, A. Lacerda, M.F. Hundley, Z. Fisk, H.R. Ott, E. Felder, M. Chernikov, M.B. Maple, P. Visani, C.L. Seaman, M.A. Lopez de la Torre and G. Aeppli, Physica B 186–188 (1993) 355.
[3] R.A. Robinson, M. Kohgi, T. Osakabe, P.C. Canfield, T. Kamiyama, T. Nakane, Z. Fisk and J.D. Thompson, Physica B 186–188 (1993) 550.
[4] P.C. Canfield, R. Movshovich, R.A. Robinson, J.D. Thompson, Z. Fisk, W.P. Beyermann, A. Lacerda, M.F. Hundley, R.H. Heffner, D.E. MacLaughlin, F. Trouw and H.R. Ott, Physica B 197 (1994) 101.
[5] R. Movshovich, A. Lacerda, P.C. Canfield, J.D. Thompson and Z. Fisk, Phys. Rev. Lett. 73 (1994) 492.
[6] A.P. Reyes, L.P. Le, R.H. Heffner, E.T. Ahrens, Z. Fisk and P.C. Canfield, Physica B 206 & 207 (1995) 332.
[7] O. Avenel, J.S. Xia, B. Andraka, C.S. Jee, M.-F. Xu, Y.J. Qian, T. Lang, P.L. Moyland, W. Ni, P.J.C. Signore, E.D. Adams, G.G. Ihas, M.W. Meisel, G.R. Stewart, N.S. Sullivan and Y. Takano, Phys. Rev. B 45 (1992) 5695.
[8] R. Movshovich, personal communication.
[9] B.W. Roberts, J. Phys. Chem. Ref. Data 5 (1976) 581.