THE UPPER CRITICAL MAGNETIC FIELD OF ZrB_{12} SINGLE CRYSTAL

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Introduction

Superconductivity in the cluster compound ZrB_{12} was discovered a while ago [1]. However there has been little and controversial effort devoted to study of the basic superconducting and electron transport properties of this boride. In our recent study of the electron transport and superconducting properties of polycrystalline [2] and single crystal samples [3] of ZrB_{12}, we observed two step temperature dependence of superfluid density, $[\lambda(0)/\lambda(T)]^2$, which could be evidence of two-gap superconductivity in this compound. Furthermore, contrary to conventional theories, we found a linear temperature dependence of $H_{c2}(T)$ in polycrystalline as well as single crystal samples above 1.4 K. In order to shed light on the origin of this linear dependence, we have studied the $H_{c2}(T)$ dependence in single crystal samples of ZrB_{12}.

Experimental

Under ambient conditions, the dodecaboride ZrB_{12} crystallizes in the *fcc* structure of the UB_{12} type. In this structure, the Zr atoms are located at interstitial openings among the close-packed B_{12} clusters. We used the spark erosion method to cut the single crystal ingots into rectangular <100> oriented bars of about $0.5\times0.5\times8$ mm^3. The well-defined geometry of the samples provided for the precise resistivity, $\rho(T,B)$, measurements using a standard DC technique .

Results and Discussion

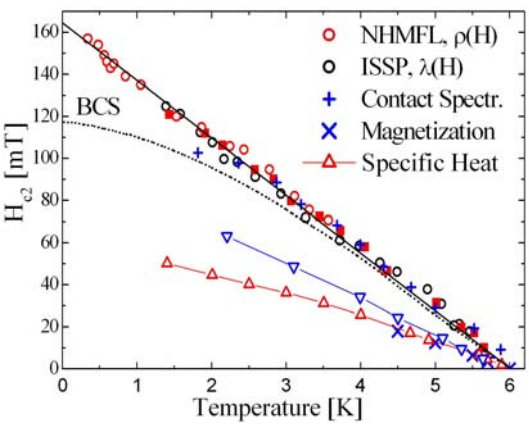
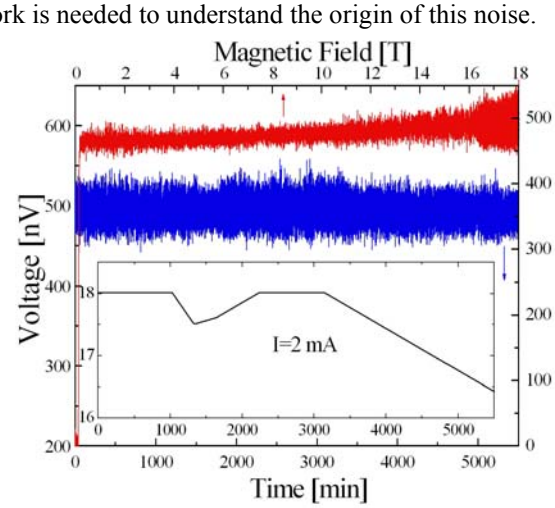


Fig. 1 (left) presents the $H_{c2}(T)$ dependence obtained using the onset criteria in transport measurements together with other data (see references in [3]). In contrast to the BCS theory, the $H_{c2}(T)$ dependence is linear over an extended temperature range down to 0.35 K. From the $\lambda(T)$ data, we found that the diffusivities in the p- and d- bands are equal to D_p=57 cm^2/sec and D_d=10 cm^2/sec, respectively [3]. According to [4], the large ratio $D_p/D_d \approx 6$ leads to enhancement of the zero-temperature $H_{c2}(0)$ value. Thus the limiting value of $H_{c2}(0)$ is dominated by the *d*-band with the lower diffusivity, while the derivative dH_{c2}/dT in the vicinity of T_c is governed by the *p*-band. **Fig.2** (below) shows the resistance of a ZrB_{12} sample as a function of magnetic field and time. Definitely, the features observed are not due to quantum oscillation of resistivity. While the abrupt increase of the noise with magnetic field is clear, more work is needed to understand the origin of this noise.



Conclusions

We have found an unconventional linear temperature dependence of $H_{c2}(T)$ of ZrB_{12} single crystal in a wide temperature range above 0.35 K. We explain this dependence in the frame of the two band model [3]. Meanwhile large, magnetic field dependent, resistance noise was observed. A detailed explanation of this phenomenon presents a puzzle.

Acknowledgements

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References

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