Superconductivity with Extremely Large Upper Critical Fields in $Nb_2Pd_{0.81}S_5$

Q. Zhang (NHMFL), G. Li (NHMFL), D. Rhodes (NHMFL), A. Kiswandhi (NHMFL, FSU, Physics), T. Besara (NHMFL), J. Sun (NHMFL), T. Siegrist (NHMFL, FSU, Engineering), M. D. Johannes (ONR) L. Balicas (NHMFL)

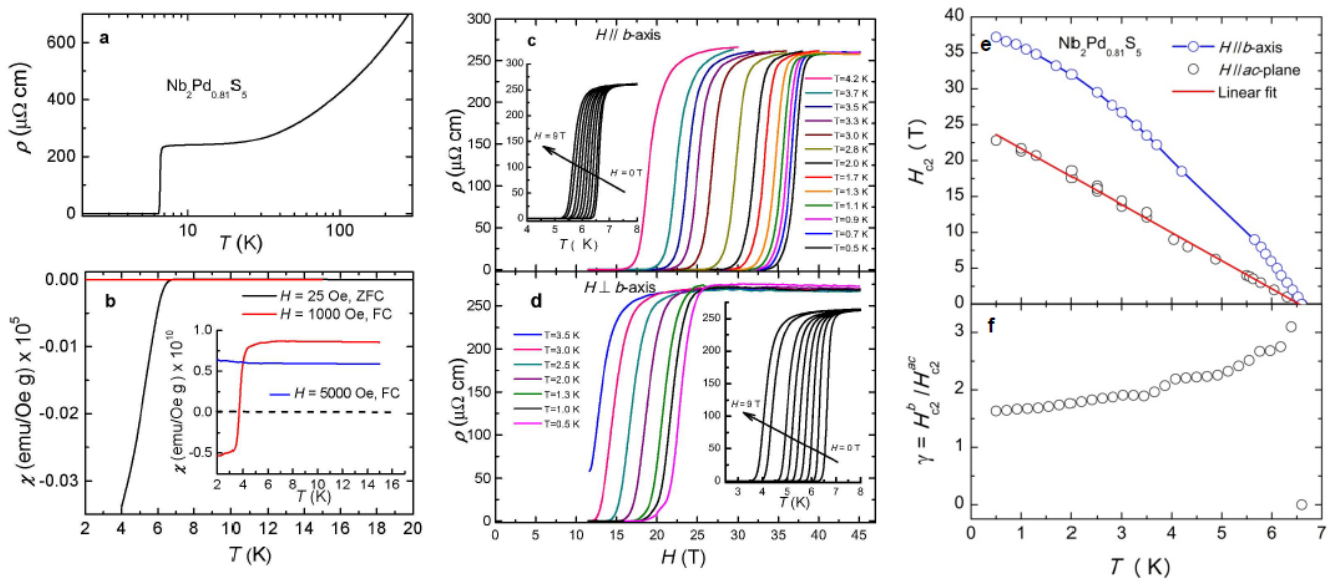
Introduction

We report the discovery of superconductivity [1] in a new transition metal-chalcogenide compound, i.e. $Nb_2Pd_{0.81}S_5$, with a transition temperature $T_c \cong 6.6$ K. Despite its relatively low T_c, it displays remarkably high and anisotropic superconducting upper critical fields, e.g. $\mu_0 H_{c2}$ ($T \rightarrow 0$ K) > 37 T for fields applied along the crystallographic *b*-axis.

Experimental

We used the hybrid magnet to draw the superconducting phase diagram of $Nb_2Pd_{0.81}S_5$ under field.

Results and Discussion



Resistivity as a function of temperature for $Nb_2Pd_{0.81}S_5$, revealing a superconducting transition whose resistive transition is located at $T_c \cong (6.5 \pm 0.2)$ K. **b** Magnetic susceptibility χ as function of T acquired either under a zero-field cooled condition for a field H = 25 Oe (black line), or under a field-cooled condition for H = 1000 Oe (red line). Inset: a detail of $\chi(T)$ at low Ts obtained under a field of 1000 Oe. The diamagnetism is completely suppressed by the application of a field of 5000 Oe (blue line). No evidence for magnetic impurities, such as Curie-Weiss behaviour is observed in the magnetic susceptibility obtained under H = 5000 Oe. **c** and **d** Resistivity as a function of magnetic field for a $Nb_2Pd_{0.81}S_5$ single-crystal for several temperatures and respectively, for fields applied along the needle or the *b*-axis of the single crystal or perpendicularly to it. Both insets: Temperature dependence of the resistive transition for several fields applied along the b-axis (in **c**) and perpendicularly to it (**d**). **e** Superconducting upper critical field as a function of T for $Nb_2Pd_{0.81}S_5$ and for both field orientations. Notice how anomalous is the behaviour of H_{c2}(T) for fields applied perpendicularly to the b-axis, i.e. it shows a linear in temperature dependence. While for fields along the needle or the b-axis of the single crystal one does not observe a clear saturation of the upper critical fields at the lowest temperatures as observed in conventional superconductors. **f** anisotropy of the upper critical fields as a function of the T. Notice that the anisotropy is temperature dependent as observed in multi-band superconductors.

For a field applied perpendicularly to the *b*-axis, $\mu_0 H_{c2}$ shows a linear dependence in temperature which coupled to a temperature-dependent anisotropy of the upper critical fields, suggests that $Nb_2Pd_{0.81}S_5$ is a multi-band superconductor. This is consistent with band structure calculations which reveal nearly cylindrical and quasi-one-dimensional Fermi surface sheets having hole and electron character, respectively.

Conclusions

A new family of superconductors based on this compound is about to emerge.

Acknowledgements

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References

[1] Q. Zhang *et al.* (under review).