Superconducting Phase-Diagram of H_3S

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Introduction

The Bardeen–Cooper–Schrieffer (BCS) theory predicts that high temperature superconductivity is possible in metals with certain favorable parameters such as lattice vibrations with high frequencies. The recently discovered record T_c of 203 K in hydrogen sulfide[1] (H_3S) at 160 GPa confirmed this major result of BCS. Measurements of the superconducting phase-diagram under high magnetic fields provide detailed information on the underlying electron-phonon coupling. Here, we report magnetotransport studies in superconducting H_3S, under extremely high pressures and high fields.

Experimental

We measured electrical resistance as a function of temperature and magnetic field using an AC resistance bridge in two different high-field magnets at the NHMFL: 35 T resistive and at the LANL: 65 T pulsed magnets.

Results and Discussion

H_3S forms a metallic phase under pressures above millions of atmospheres and becomes superconducting at temperatures as high as 203 K at 160 GPa. The basic properties of H_3S are found to be consistent with conventional BCS theory. We tried to experimentally measure the upper critical field H_{c2} for H_3S. We measured electrical resistance as a function of temperature and magnetic field for two samples, one at 170 GPa with T_c= 198 K and the other at 150 GPa with T_c = 171 K. Our results are summarizes in **Fig #1.** Given the very high T_c of H_3S, the upper critical field in the limit of zero temperatures seems to be beyond the available magnets.

Conclusions

We found that H_{c2} for H_3S generally follow the Werthamer, Helfand and Hohenberg (WHH) formalism at low fields, while noticeable deviations from WHH appear at experimental limit of 65 T. Our experiment is the first ever experimental measurement of samples under extremely high pressures and magnetic fields.

Acknowledgements

The National High Magnetic Field Laboratory is supported by the National Science Foundation through NSF/DMR-1157490/1644779 and the State of Florida. Balicas (DoE-BES DE-SC0002613); Eremets (ERC- 267777)

References

[1] Drozdov, A. P., *et al.*, Nature **525**, 73-77 (2015).

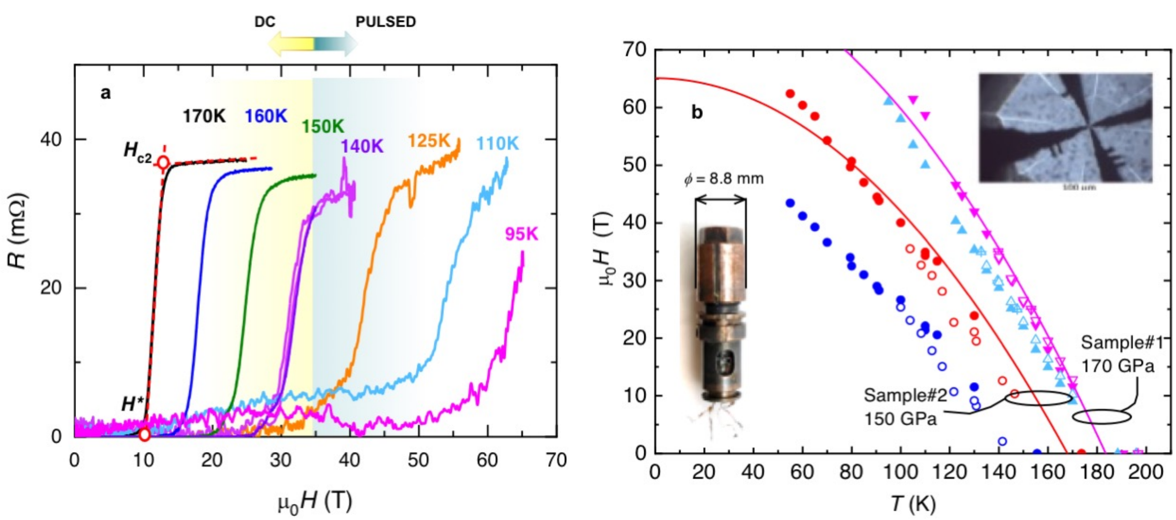

Fig.1 a, Resistance as a function of the magnetic field under several temperatures (T) for a sulfur Hydride sample under p = 170 GPa of hydrostatic pressure. Red dashed lines Indicate the definition of H_{c2} or the onset of the SC transition. **b**, Superconducting upper critical fields as a function of T for two samples under p = 150 and 170 GPa. Open markers correspond to DC field data and solid ones to pulsed field data. For each sample we have included H_{c2} (▼) and H^*(▲) data. Solid lines are fits to $H_{c2} = H_{c2}(0)[1-(T/Tc)^2]$. Insets: diamond anvil cell and sample pictures