POINT CONTACT SPECTROSCOPY MEASUREMENTS ON THE ELECTRON-DOPED CUPRATE $Pr_{2-X}Ce_XCuO_4$ IN FIELDS OF UP TO 32 TESLA

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Introduction

This report describes our progress towards the development of a complete, user friendly setup for point contact spectroscopy (PCS) measurements at NHMFL, Tallahassee as part of an in-house research program. PCS is similar to scanning tunneling spectroscopy, in the sense that the current injection occurs between a sharp tip and the sample. However, in PCS the tip is actually in physical contact with the sample. PCS is extremely useful especially for gap spectroscopy of superconductors and spin polarization measurements in ferromagnets.

Experimental

We have fabricated a point contact spectroscopy (PCS) probe for operation in fields of up to 33 tesla at temperatures down to 0.4 K. We used a screw and cantilever mechanism to make the point contact between a Platinum-Rhodium (Pt-Rh) wire and $Pr_{2-x}Ce_xCuO_4$ (PCCO), with the wire attached to the top part of the cantilever and the PCCO attached to a sample holder below it [1]. The cantilever was seated at the bottom of a probe 6 ft. in length and a worm gear at the top of the probe allows us to press the cantilever (and thus vary the barrier strength) from outside the dewar while the sample remained at low temperature (see Fig. 1). Since the magnetic field of the 33 T magnet is along the axis of our probe, we needed to orient the cantilever so that the PCCO film would have its a-b plane perpendicular to the magnetic field (Fig. 1). We have designed the electronics and software needed to measure the point contact spectra including a lock-in amplifier based *ac* technique to measure the dI/dV directly rather than measuring I vs. V and then taking numerical derivatives.

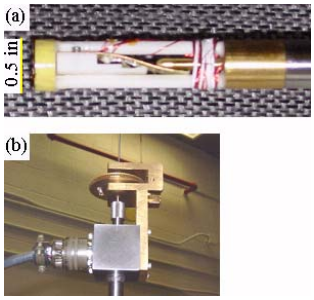

Figure 1. (a) The screw and cantilever setup. (b) The worm gear is accessible from outside the dewar.

Results and Discussion

During the week of August 2, 2004 we obtained the first point contact data on PCCO showing the evolution of the pseudogap in fields of up to 32 tesla (in cell 9, T=1.5 K), as shown in Fig. 2.

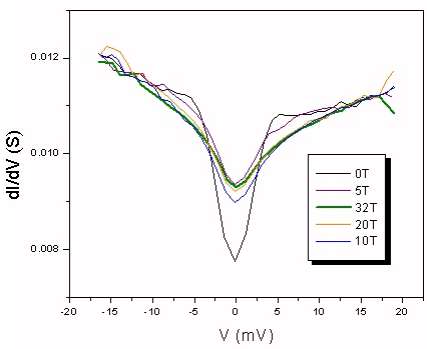

Figure 2. Point contact spectra of PCCO showing the evolution of the pseudogap in magnetic fields up to 32 tesla.

Conclusions

We are now working on developing this probe into a user facility at Tallahassee. We will also improve our point contact probe by introducing piezoelectric drives to control the tip-sample pressure. This will eventually lead to an initial design of a scanning tunneling microscope (STM) for operation in fields of up to 33 tesla.

Acknowledgements

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References

[1] Biswas, A., *et al.*, Phys. Rev. B **64**, 104519 (2001)