HIGH FIELD TRANSPORT AS A FUNCTION OF DISORDER IN PCCO

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Introduction

We have previously reported that the electron doped high T_c superconductor $Pr_{2-x}Ce_xCuO_{4-\delta}$ exhibits quantum critical behavior near optimum doping [1] with the control parameter being the chemical doping. Magnetoresistance originating from spin scattering processes was shown to vanish around that critical doping [2]. This experiment was intended to measure the magnetoresistance of additional doping levels x=0.14 and x=0.12 to complete measurements taken during previous visits in the NHMFL. In addition, the spin related magnetoresistance was checked as a function of disorder put into the samples by means of irradiation by He ions and as a function of oxygen doping.

Experimental

PCCO samples of various doping levels were grown using pulsed laser deposition. Samples with cerium doping of x=0.17 were exposed to various doses of 2MeV He^+ : 0, 1, 2.5, 8, 32 x 10^{15} ions/cm^2 . The samples were cooled down to 1.5K. Two successive measurements were performed: measurement of resistance as a function of field applied parallel to the *c* axis, and as a function of angle between the *c* axis and the magnetic field in its maximum amplitude (32.4T). The resistance values for similar *c* axis field components were then compared in order to separate out the orbital magnetoresistance and the spin related one. The later being the focus of this experiment (for more details see reference [2]). The hall resistance R_{xy} was measured for the irradiated and oxygenated samples up to 32.4T.

Results and Discussion

The x=0.14 and x=0.12 followed the behavior of the previously measured doping levels. The irradiation and oxygenation didn't seem to induce any isotropic (spin related) MR (see figure 1). R_{xy} maintained a linear in field behavior up to 33T at low temperatures for both irradiated and oxygenated samples.

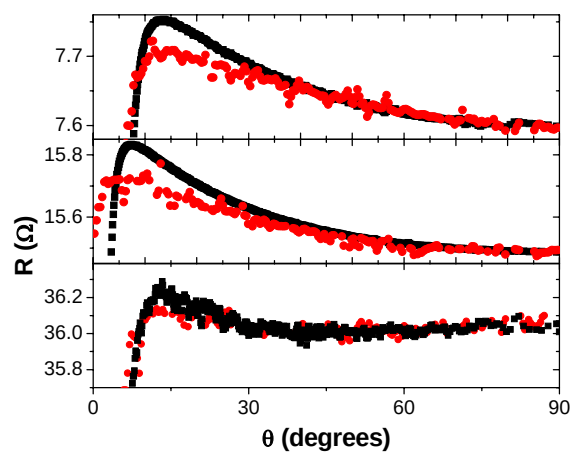

Figure 1. Comparison between field sweep (squares) and rotation in a field of 32.4T for x=0.17 samples. The field sweep was transformed into angles to reflect similar *c* axis field component using θ=arcsin(H/32.4T). Samples with no irradiation (top panel), irradiated with ΔT_c=7.2K (mid panel), and oxygenated (bottom) are shown.

Conclusions

Irradiation does not induce spin related magnetoresistance. If the spin MR originates from precursor of antiferromagnetism then irradiation induced disorder should have no effect on the spin scattering for non-antiferromagnetic samples as observed. In that case oxygenation should decrease the doping level and induced spin MR. This effect was not observed due to the fact that the corresponding doping level of the oxygenated sample is x=0.16 as determined by the Hall coefficient at low temperatures. It is therefore possible that the isotropic magnetoresistance is related to the antiferromagnetic phase persisting well into the superconducting region in the electron doped cuprate superconductors.

References

[1] Dagan, Y., *et al.*, Phys. Rev. Lett., **92**, 167001 (1-4) (2004).
[2] Dagan, Y., *et al.*, Phys. Rev. Lett., **94**, 057005 (2005).