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MAGNETO-OPTICAL RESPONSE OF ELECTRON DOPED CUPRATES Pr$_{2-x}$Ce$_x$CuO$_4$

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Introduction

The normal state of cuprates shows many anomalous properties, attributed at present to the formation of a pseudogap. In the $ab$-plane of hole-doped cuprates, the pseudogap is identified with a drop in the optically-defined scattering rate whereas for electron-doped materials it appears directly in the conductivity spectra at around 0.15 eV [1]. This high-energy pseudogap has been attributed to changes in antiferromagnetic spin correlations and spin density waves (SDW). In this paper, we present magnetic-field infrared transmission data in the large-energy pseudogap region.

Experimental

Thin Films of Pr$_{2-x}$Ce$_x$CuO$_4$ (PCCO) of several compositions were grown on LaSrGaO$_4$ (LSGO) substrates using pulsed laser deposition. The films used in this experiment included a highly underdoped ($x = 0.11$) non-superconducting sample, an optimally doped ($x = 0.15$) sample and an overdoped ($x = 0.18$) sample. The magnetic field studies were performed at the National High Magnetic Field Laboratory, using a Bruker 113v spectrometer with custom-built light-pipe optics to carry the mid-infrared radiation through the sample and on to a 4.2K helium-cooled bolometer detector [2]. We employed a 30 T resistive magnet and measured the transmittance ratio, $T(H)/T(0)$. Two different sample holders were used, one where the $ab$-plane of the sample was perpendicular to the magnetic field and one where the $ab$-plane was at an angle of $\theta=25^0$ to the magnetic field.

Results and Discussion

The magneto-transmission of the underdoped PCCO, with magnetic field perpendicular to the $ab$-plane, did not show any change within the experimental signal to noise of 1%, as shown in Fig. 1. For the optimally-doped sample (Fig 2), we measured the effect of having components of the magnetic field both along the $ab$-plane and along the $c$-axis. No magneto-optical effect exceeding 2% was observed. Finally, the overdoped sample (Fig 3) with magnetic field perpendicular to the $ab$-plane also does not show any change in transmission within experimental signal to noise resolution of 3%.

Conclusions

These experiments indicate that the high energy pseudogap is unaffected by magnetic field. This result is probably due to the fact that the Zeeman energy of the field (about 3 meV) is small compared to the energy scale of the antiferromagnetic correlation (~0.12 eV), so the $ab$-plane spins are very slightly perturbed by the applied magnetic field.

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References