

Overdoping effect on the in-plane charge dynamics in $(Y,Ca)Ba_2Cu_3O_{7-\delta}$

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In order to clarify the carrier overdoping effect on the in-plane charge dynamics, we have carried out a systematic study on the optical spectra of detwinned $(Y,Ca)Ba_2Cu_3O_{7-\delta}$ crystals for various Ca- and oxygen contents. Ca-substitution introduces not only carriers but also disorders into the CuO_2 planes. The previous studies with the same interest were on the c -axis spectra¹ without paying attention to the Ca-disorder effect².

In the present study, it was clearly demonstrated that the carrier overdoping induces a huge amount of residual conductivity below the gap energy, which can be distinguished from the disorder-induced pair-breaking effect by Ca-substitution. The latter effect was also confirmed by comparison of the spectra for Ca-free and Ca-doped samples with a fixed doping level. As a result of increase of unpaired carriers, the superfluid density rapidly decreases with doping, compared to the moderate change in T_c . The present results suggest that there exists some intrinsic mechanism to create inhomogeneous electronic state in the overdoped regime.

¹J. Schuetzmann, S. Tajima, S. Miyamoto and S. Tanaka, Phys. Rev. Lett. **73**, 174 (1994).

²C. Bernhard, R. Henn, A. Wittlin, M. Klaeser, Th. Wolf, G. Mueller-Vogt, C. T. Lin and M. Cardona, Phys. Rev. Lett. **80**, 1762 (1998).