Evauation of the normal self-energy in overdoped Bi2201

Y. Miyai[1], S. Kumar[1,2], T. Kurosawa[3], M. Oda[4], S. Ideta[1,2], K. Shimada[1,2]

[1]*Graduate School of Advanced Science and Technology, Hiroshima University*
[2]*Hiroshima Synchrotron Radiation Center, Hiroshima University*
[3] *Fuculty of Science and Engineearing, Muroran Institute of Technology*
[4] *Department of Physics, Hokkaido University*

Author Email: d220057@hiroshima-u.ac.jp

High-T_C cuprate superconductors have attracted much interest not only for their high superconducting transition temperature (T_C) but also for their intriguing physical properties derived from several competing interactions. To understand these physical properties, it is necessary to clarify the quasiparticle properties near the Fermi level (E_F). Angle-resolved photoemission spectroscopy (ARPES) is an ideal tool to investigate the quasiparticle properties (lifetime, effective mass). Based on the quantitative analyses of high-resolution ARPES lineshapes one can evaluate the self-energy (Σ) due to the many-body interactions such as the electron-electron interaction (EEI) and the electron-boson(phonon) interaction (EBI). In this study, we focus on overdoped cuprate $(Bi,Pb)_2Sr_2CuO_{6+\delta}$ (Pb-Bi2201) with T_C ~6 K to clarify details of the normal self-energy above T_C. The ground state of overdoped Pb-Bi2201 is interesting because a recent study reported re-entrant charge order [1] and ferromagnetic fluctuation [2]. The normal self-energy is also helpful to understand the anomalous self-energy in the superconducting state.

We analyzed the observed Fermi surface in the wide momentum region using a tight-binding (TB) model. Based on the TB-model band dispersion, we extracted the real part (ReΣ) and imaginary part (ImΣ) of the normal self-energy which is mainly derived from the EEI as shown in Fig. 1. Note that ReΣ has a zero point at ω ~ -0.6 eV, where |ImΣ|(=lifetime broadening) has the maximum value. It is the reason why the ARPES intensity is significantly suppressed around ω ~ -0.6 eV. The group velocity above ω ~ -0.6 eV is further reduced due to the EBI near the E_F. We analyzed the obtained self-energy due to the EEI employing a model complex function (solid line in Fig. 1). In addition, we evaluated the coupling parameter near the E_F and found the contribution from the EEI is comparable with that from the EBI.

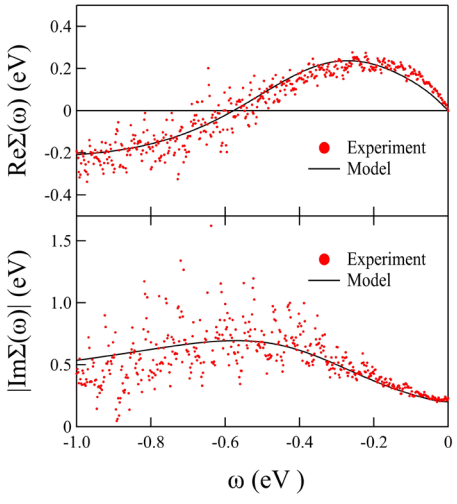

Figure 1: Experimentally evaluated real and imaginary parts of the normal self-energy of overdoped Pb-Bi2201. Solid lines show fitting to a model self-energy.

References

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