Electronic States in Electron-Doped High-T_c cuprate $Nd_{2-x}Ce_xCuO_4$ investigated by Angle-Resolved and Inverse Photoemission Spectroscopies

H. Yamaguchi[a], Y. Tsubota[a], Y. Miyai[a], M. Arita[b], H. Sato[a,b], D. Song[f], K. Tanaka[e], K. Shimada[a,b,c,d], S. Ideta[a,b]

[a]Graduate School of Advanced Science and Engineering, Hiroshima Univ., Higashi-Hiroshima 739-0046, Japan
[b]Research Institute for Synchrotron Radiation Science, Hiroshima Univ., Higashi-Hiroshima 739-0046, Japan
[c]Research Institute for Semiconductor Engineering, (RISE), Hiroshima Univ., Higashi-Hiroshima 739-8527, Japan
[d]International Institute for Sustainability with Knotted Chiral Meta Matter (WPI-SKCM[2]), Higashi-Hiroshima 739-8526, Japan
[e]UVSOR-III Synchrotron, Institute for Molecular Science., Okazaki, Aichi 444-8585, Japan
[f]University of British Columbia,Vancouver, BCV 6T1Z4, Canada

Keywords: cuprate superconductors, charge fluctuation, electronic structure, ARPES, IPES

The mechanism of superconductivity in conventional superconductors is understood to involve the formation of Cooper pairs via phonons, which is explained by BCS theory. In contrast with “low-temperature” superconductors, cuprate “high-temperature” superconductors were discovered in 1986, which show the highest superconducting transition temperatures (T_c), however, as for elucidations of their pairing mechanism, both experimental and theoretical studies have not been achieved yet. One of the most urgent issues in clarifying the mechanism of high-T_c cuprate superconductivity is to understand the origin, namely, boson that mediates Cooper pairing. While electron-boson interactions and strong electron correlations are believed to contribute to the origin of high-T_c cuprate superconductivity [1–3], there is less research into the origin of the boson and the pairing mechanism in electron-doped cuprates than in hole-doped ones. Therefore, to deepen the understanding of the microscopic mechanism of superconductivity through observations of the electronic states in electron-doped cuprates, we have investigated the electronic structure of $Nd_{2-x}Ce_xCuO_4$ (NCCO), one of the electron-doped high-T_c cuprate superconductors, using angle-resolved photoemission spectroscopy (ARPES) and angle-resolved inverse photoemission spectroscopy (AR-IPES).

In this study, we experimentally performed ARPES and AR-IPES studies to investigate the presence of an emergent band structure arising from the coupling between quantum charge fluctuations and quasiparticles in high-T_c cuprate superconductors. Furthermore, by comparing our experimental results of the electronic structure and calculations obtained from density functional theory (DFT) and dynamical mean-field theory (DMFT) calculations [6].

In addition, to study an insight of the ground state of NCCO, we have studied temperature dependent ARPES study for the spectral weight (Z_k) of the quasiparticle band along the nodal direction in ARPES spectra. A previous theoretical study suggested that if resonating-valence-bond-like electron correlations are involved, Z_k changes markedly across T_c in the ground state in strongly correlated electron systems such as cuprate superconductors [5]. This prediction has been verified by the temperature dependence of Z_k reported for hole-doped cuprates [4], and it could offer a new way of understanding the ground state of electron-doped cuprate superconductors.

In the poster presentation, based on experimentally obtained spectra of the electronic structure of NCCO, we discuss the verification of quantum charge fluctuations, including theoretical calculations (DFT+DMFT) and the temperature dependence of the Z_k spectrum.

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