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Comprehensive Studies of the Electronic Structure for the Double-layer high-T_c Superconductor $Bi_2Sr_2CaCu_2O_{8+\delta}$ - Revisit of the Phase Diagram by ARPES

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It has been known that the cuprate superconductors show a high superconducting (SC) transition temperature (T_c) and exotic physical properties. However, the SC mechanism of cuprates has been unclear yet. In order to understand the mechanism of the microscopic origin of the high-T_c cuprate, various theoretical and experimental studies have been done so far [1]. In high-T_c cuprate superconductors, superconductivity occurs by hole doping into the CuO_2 plane. The superconducting transition temperature T_c as a function of hole concentration was reported as schematically shown in Fig. 1 [2]. For the hole-doped cuprate superconductors, it has been widely believed that the phase diagram is universal, and the highest T_c occurs at the hole concentration of ~0.16. However, recent angle-resolved photoemission spectroscopy (ARPES) experiments indicated that the empirical phase diagram may not be universal and shifted toward the overdoped region [3-5].

In this study, we have performed ARPES measurements systematically to directly investigate the electronic structure of the underdoped, optimally doped, and overdoped regions with three different compositions of the double-layer cuprate, $Bi_2Sr_2CaCu_2O_{8+\delta}$ (Bi2212). We have estimated the hole concentration of each sample from the Fermi-surface area and compared them quantitatively. Fig. 1 shows the Fermi surface of the optimally doped Bi2212 with T_c = 92 K and determined the Fermi momentum (red dots in Fig. 1) from the ARPES lineshape analyses.

In this poster presentation, we will show the results of the hole concentration estimated from the Fermi surfaces in Bi2212 for each sample and are compared with the previous study to understand the relationship between the hole concentration and T_c, namely, the new phase diagram. In this study, we found that the phase diagram differs from the reported one [2]; the maximum T_c shifts toward the overdoped region. Furthermore, we have measured the electronic structure in which the pseudogap closes and verified its consistency with respect to the carrier concentration below and above T_c. Based on the present ARPES study, we will show the new phase diagram in Bi2212 and discuss the results in comparison with other studies [6,7].

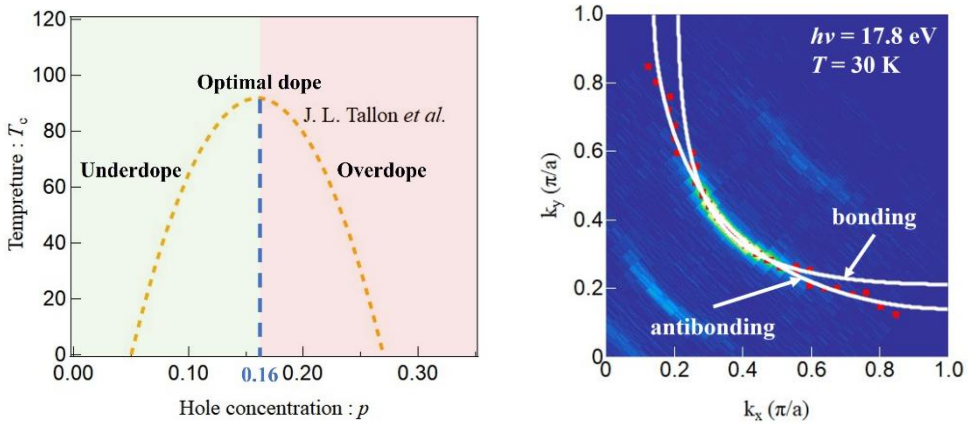

FIGURE 1. Schematic phase diagram reported from Ref. [2] (left). Fermi surfaces of Bi2212 observed by ARPES (right). Red dots indicate the Fermi momentum estimated from the momentum-distribution curves near the Fermi level. White curves are the Fermi surfaces fitted by tight-binding model. The bonding and antibonding bands are shown by the white curves, respectively.

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