

# ARPES Study of Pb Substitution at Bi Sites in Double-Layer Cuprate Bi2212

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High- $T_c$  cuprate superconductors show the highest superconducting transition temperatures ( $T_c$ ) under ambient pressure. However, the mechanism of superconductivity remains unclear. These materials are characterized by  $\text{CuO}_2$  planes in which superconductivity emerges when charge carriers are doped into the plane with an antiferromagnetic phase. The superconducting properties are typically explained using an electronic phase diagram, which illustrates the relationship between  $T_c$  and carrier concentration. It is well known that there is a typical phase diagram, which is referred to as a “universal phase diagram”[1,2]. The optimal hole concentration is around 0.16. This empirical phase diagram has been used to estimate carrier concentration from  $T_c$ . However, recent studies have reported that there is a deviation from the universal phase diagram, suggesting that the phase diagram may depend on composition and preparation conditions of the sample [3,4, 5, 6].

A bilayer hole-doped cuprate,  $\text{Bi}_2\text{Sr}_2\text{CaCu}_2\text{O}_{8+\delta}$  (Bi2212), allows a systematic control of carrier concentration through oxygen content and chemical substitution. However, the Pb substitution at the Bi site modifies the charge balance and suppresses the structural modulation, and therefore, the hole concentration shifts toward the overdoped regime. Additionally, subsequent reduction annealing is necessary to optimize the  $T_c$  of Pb-substituted Bi2212, which makes it difficult to determine carrier concentration solely from  $T_c$ . Angle-resolved photoemission spectroscopy (ARPES) provides a direct probe of the electronic structure in a solid. The Fermi surface area measured by ARPES can be used to estimate carrier concentration based on the Luttinger sum rule, offering a more quantitative approach than empirical relations.

In this study, we have performed ARPES measurements on Pb-substituted and slightly overdoped Bi2212 with  $T_c$  of  $\sim 90$  K. Our experimental results indicate that samples with similar  $T_c$  can exhibit noticeably

different carrier concentrations. In the poster presentation, we will show our ARPES data and discuss reasons for the discrepancy between the universal phase diagram and our revised version.

## REFERENCES

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