## Enhanced superconducting gap in the Hg-based trilayer cuprate superconductor revealed by micro-spot ARPES

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The record of the highest superconducting transition temperature ( $T_c$ ) at ambient pressure has been held by the Hg-based trilayer cuprate HgBa<sub>2</sub>Ca<sub>2</sub>Cu<sub>3</sub>O<sub>8+δ</sub> (Hg1223) [1] for more than 30 years. Even though its electronic-structure investigation is of primary importance, angle-resolved photoemission spectroscopy (ARPES) studies have been hampered by the limited availability of high-quality single crystals as well as by the difficulty in exposing a flat surface with large area by cleaving. Unlike the well-studied Bi-based counterpart Bi<sub>2</sub>Sr<sub>2</sub>Ca<sub>2</sub>Cu<sub>3</sub>O<sub>10+δ</sub> (Bi2223) with a lower  $T_c$ , Hg1223 lacks natural cleavage planes, and hence cleaving should yield a disordered surface. Recently, Mino *et al.* [2] have established methodology to grow single crystals of the Hg-based trilayer cuprates with high reproducibility through partial Re substitutions, and singlecrystalline (Hg,Re)Ba<sub>2</sub>Ca<sub>2</sub>Cu<sub>3</sub>O<sub>8+δ</sub> [(Hg,Re)1223] samples with  $T_c$ 's exceeding 130 K have been reproducibly synthesized. While inhomogeneity created by cleaving would be inevitable, one could purify ARPES signals by exploiting a tightly focused incident beam.

We have performed micro-spot ARPES measurements of (Hg,Re)1223 at the Bloch beamline of MAX IV [3], where the photon beam is focused down to  $10\mu$ m ×  $10\mu$ m. The quality of the ARPES spectra varied significantly over space, but Fermi surfaces and superconducting gaps were successfully captured by pinpointing an appropriate spot. The prominent feature of the trilayer cuprate is the existence of two inequivalent CuO<sub>2</sub> planes in a unit cell. Compared to the trilayer cuprate Bi2223 with a lower  $T_c$ , the superconducting gap of (Hg,Re)1223 was enhanced selectively for one of those CuO<sub>2</sub> planes, suggesting the reinforced Cooper paring on that CuO<sub>2</sub> plane as a key ingredient of the highest  $T_c$  of the Hg-based trilayer cuprate.

Keywords: high-temperature superconductors, cuprates, micro-spot ARPES.

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<sup>1</sup>A. Schilling, M. Cantoni, J. D. Guo, and H. R. Ott, "Superconductivity above 130 K in the Hg– Ba–Ca–Cu–O system", Nature 363, 56 (1993).

<sup>2</sup>Y. Mino *et al.*, "Single-Crystal Growth and Characterization of Cuprate Superconductor  $(Hg, Re)Ba_2Ca_2Cu_3O_{8+\delta}$ ", J. Phys. Soc. Jpn. 93, 044707 (2024).

<sup>3</sup>C. M. Polley *et al.*, "*The Bloch Beamline at MAX IV: Micro-Spot ARPES from a Conventional, Full-Featured Beamline*", Synchrotron Radiation News 37, 18 (2024).