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Phase Determination for Intra-unit-cell Fourier Transform STM - Picometer Registration of Zn Impurity States in $Bi_2Sr_2CaCu_2O_{8+\delta}$ INES FIRMO, MOHAMMAD HAMIDIAN, KAZUHIRO FUJITA, SOURIN MUKHOPADHYAY, Cornell University; Brookhaven National Lab, JOSEPH ORENSTEIN, University of California, Berkeley, HIROSHI EISAKI, National Institute of Advanced Industrial Science and Technology, Japan, SHIN-ICHI UCHIDA, University of Tokyo, Japan, MICHAEL LAWLER, EUN-AH KIM, Cornell University, J.C. DAVIS, Cornell University; Brookhaven National Lab; University of St. Andrews, Scotland; Kavli Institute at Cornell — By studying the real and imaginary components of the Bragg peaks in Fourier transforms of electronic structure images, distinct types of intra-unit cell (IUC) symmetry breaking can be studied using SI-STM [Lawler et al., Nature 466 347 (2010)]. However, establishing the precise r-space symmetry point of each unit cell is crucial in defining the phase for such analysis. Exemplary of this challenge is the high- T_c superconductor $Bi_2Sr_2CaCu_2O_{8+\delta}$ for which the Bi atoms in the surface BiO layer are observable, while it is the invisible Cu atoms that define the relevant CuO_2 unit-cell symmetry point. We demonstrate, by imaging with pm precision the electronic impurity states at individual Zn atoms substituted at Cu sites, that the phase established using the Bi lattice produces a $\sim 2\%(2\pi)$ error relative to the Cu lattice. In this case, IUC C_{4v} symmetry breaking in the CuO_2 plane can be determined reliably using the phase assignment from the BiO layer. Moreover, impurity atom substitution at the relevant symmetry site can be of general utility in phase determination for Bragg-peak Fourier analysis of IUC symmetry.

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