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M1Po2B-07: Electronic structure and Auger electron spectroscopy (AES) measurements on cuprate oxide thin film heterostructures

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Epitaxial growth and studies on “emergent behaviors”of cuprate oxide thin film heterostructures are of the utmost importance for developing many superconductor electronic devices such as Josephson junctions, three-terminal devices, and circuit applications such as interconnects, ground planes, and multichip modules. In particular, the heterostructures made with high critical temperature (Tc) superconductor YBa2Cu3O7-x (YBCO) are interesting for device applications and basic science research, including studies of mechanisms for high-Tc superconductivity, 2D superconductivity, and measurement of the correlation energy. These heterostructures typically have the S/D/S, S/N/S, S/I/S geometries (S = superconductor, D = dielectric, N = normal metal, I = insulator), with the middle layer as the isolation layer, normal metal, or the insulator, where the intermediate layer materials must be structurally compatible and chemically stable at the processing temperature of superconducting thin films. Moreover, further complications arise concerning the surface superconductivity and the interfacial properties of the bottom and top thin film layers with the middle thin film layer. Although the mechanism of high Tc -superconductivity remains elusive, electron correlation plays an essential role in the superconductivity of high-Tc superconductors. The correlation energy, a measure of how much the presence of all other electrons influences the movement of one electron, can be directly obtained from a combination of Auger electron spectroscopy (AES) of cuprate oxide materials. It is a unique experimental tool since the Auger line-shape reflects a two-hole (or two-electron) density of states (DOS). This follows, for example, from discrepancies between various spectroscopic data and density of states curves computed by the local-density approximation (LDA).

Using the pulsed laser-based thin film deposition technique (PLD), we have fabricated “device-quality”(110)-oriented YBa2Cu3O7 (YBCO) and PrBa2(Cu0.8Ga0.2)3O7 (PBCGO) based S/I bi-layer and S/I/S tri-layer heterostructures. Here, we present the theoretical studies using a full-potential spin-polarized relativistic Korringa-Kohn-Rostoker Green's-function method (sprKKR) and experimental measurements, including X-ray reflectivity, pole figures, reciprocal space mapping, Auger electron spectroscopy, the density of states, and correlation energy on these cuprate oxide heterostructures.

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