X-ray Photoelectron Spectroscopy Studies of Chemically-Etched High Temperature Superconductor Surfaces*

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Abstract

Work in this lab on the characterization of chemically-etched high temperature superconductor (11'1'S) surfaces by x-ray photoelectron spectroscopy (XPS) will be reviewed, with emphasis on surface quality, surface termination and stability, and alkaline earth core level binding energies. Surfaces of $YBa_2Cu_3O_7$ (YBCO), $Bi_2Sr_2CaCu_2O_8$, and $Tl_2Ba_2CaCu_2O_8$ etched in Br_2/ethanol, and $Nd_{1.85}Ce_{0.15}CuO_{4-\delta}$ etched in HCl/ethanol, are comparable in quality to surfaces prepared in vacuum, exhibiting negligible or greatly reduced signals from contaminants in the O 1s and alkaline earth core level regions, and clear Fermi edges in the valence band regions. In contrast to photoemission studies of cleaved crystals, the Fermi edge of chemically-etched YBCO is stable in vacuum at room temperature on a time scale of days, and the 13a core levels exhibit no surface component, as verified with angle-resolved measurements. These results are interpreted as resulting from the termination of the surface in Cu-O planes, rather than the probable Ba-O termination of cleaved crystals, so that the reactive Ba occurs only at subsurface sites in a bulk environment. Estimates of the final state relaxation energies from the Auger parameters show no correlation with the alkaline earth core level binding energies. Calculations of the Madelung energies in simple alkaline earth ionic compounds indicates that the negative binding energy shifts relative to the corresponding metals originate primarily from initial state electrostatic effects, suggesting that similar effects are responsible for the alkaline earth core level binding energies observed for }-1'1'S materials.

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