

ASS/AE-01-1-K-M

Probing surface-, interface-, and bulk- properties with hard X-Ray-, standing-wave-, total reflection- and resonant- photoemission

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A primary challenge in surface and interface analysis is quantitatively determining the properties of buried layers and the interfaces between them, and of course cleanly distinguishing surface/interface properties from bulk properties. In this talk, I will discuss four interrelated methods for achieving this: going to hard x-ray energies in the multi-keV regime (HXPS or HAXPES) to probe more deeply, using soft- and hard- standing-wave (SW) excitation from multilayer heterostructures to selectively excite from buried layers and interfaces, going into total reflection to probe the surface and near-surface interfaces selectively, and tuning the photon energy through different resonances to enhance reflectivity (and thus SW strength) and also alter SW phases [1-5]. These measurements include soft x-ray- and hard x-ray- angle-resolved photoemission (SARPES, HARPES [1]) that can provide momentum-resolved electronic structure. I will illustrate these methods with applications to a variety of systems, including metal/oxide multilayer heterostructures [2,4,5], a liquid/solid interface at high ambient pressure [3], a metal oxide bilayer structure [4], and an oxide heterostructure exhibiting a 2D electron gas at its interface [5].

Acknowledgements:

This work was supported by the U.S. Department of Energy, Contracts DE-AC02-05CH11231 at LBNL and DE-SC0014697 at UC Davis, and through the LDRD Program of LBNL.

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