Photoemission Spectroscopy on Buried Complex Oxide Interfaces

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At the interface between complex oxides, unexpected electronic properties different from those of the constituent bulk materials can arise. A particularly interesting example is the appearance of 2-dimensional conductivity at the interface of the band insulators $LaAlO_3$ (LAO) and $SrTiO_3$ (STO) above a critical LAO thickness of 4 unit cells [1-4].

Photoemission spectroscopy is a powerful technique which directly probes the electronic structure of materials and can thus provide important information for a better understanding of their properties. The interfaces of LAO/STO have been investigated by soft x-ray photoelectron spectroscopy for different layer thicknesses across the insulator-to-metal interface transition. We measured clear spectroscopic signatures of Ti^{3+} signal at the Fermi level in fully oxygenated sample. Our results show that Ti^{3+}-related charge carriers are present only for conducting samples, and are confined to a few monolayers from the interface. No Fermi-edge signal could be detected for insulating samples below the critical thickness [5].

Polarization-controlled synchrotron radiation was subsequently used to map the electronic structure of conducting interfaces in a resonant angle-resolved photoemission experiment. A strong dependence on the light polarization of the Fermi surface and band dispersions is demonstrated, highlighting the distinct Ti *3d* orbitals involved in 2D conduction. Samples with different doping levels were prepared and measured by photoemission, revealing different band occupancies and Fermi-surface shapes. A direct comparison between the photoemission measurements and advanced first-principle calculations carried out for different *3d*-band fillings is presented in conjunction with the 2D carrier concentration obtained from transport measurements [6]. Moreover, some recent results on the effect of post-growth oxygen pressure on the in-gap states will be presented together with high energy resolution photoemission images.

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