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High-energy photoemission studies of oxide interfaces[1]

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The interfaces of complex oxide heterostructures can host novel quantum phases not existing in the bulk of the constituents, with the high-mobility 2D electron system (2DES) in $LaAlO_3/SrTiO_3$ (LAO/STO) representing a prominent example. Despite extensive research the origin of the 2DES and its unusual properties – including the supposed coexistence of superconductivity and ferromagnetism – are still a matter of intense debate. Photoelectron spectroscopy, recently extended into the soft (SX-ARPES) and hard (HAXPES) X-ray regime, is a powerful method to provide detailed insight into the electronic structure of these heterostructures and, in particular, of the buried interface. This includes the identification of the orbital character of the 2DES as well as the determination of vital band structure information, such as band alignment, band bending, and even k-resolved band dispersions and Fermi surface topology. Moreover, resonant photoemission at the Ti L-edge reveals the existence of two different species of Ti 3d states, localized and itinerant, which can be distinguished and identified by their different resonance behavior. The role of oxygen vacancies is studied by controlled *in-situ* oxidation, which allows us to vary the composition from fully stoichiometric to strongly O-deficient. By comparison to free STO surfaces we can thus demonstrate that the metallicity of the heteointerfaces is intrinsic, *i.e.* it persists even in the absence of O defects. I will discuss our photoemission results on LAO/STO heterostructures in both (100) and (111) orientation as well as on the related system γ-Al_2O_3/STO(100), which also hosts a 2DES with an even higher mobility. Work in collaboration with J. Mannhart (MPI-FKF, Stuttgart), N. Pryds (TU Denmark), G. Rijnders (U Twente), S. Suga (U Osaka), M. Giorgoi (BESSY, HZB), W. Drube (DESY Photon Science), V.N. Strocov (Swiss Light Source), J. Denlinger (Advanced Light Source, LBNL), and T.-L. Lee (Diamond Light Source).

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