Orbital Engineering of Spin-Orbit effect at Correlated Oxide Interface

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Using interlayer interaction to control functional heterostructures with atomic-scale designs has become one of the most effective interface-engineering strategies nowadays. Here, we demonstrate the effect of a crystalline $LaFeO_3$ buffer layer on amorphous and crystalline $LaAlO_3/SrTiO_3$ heterostructures. The $LaFeO_3$ buffer layer acts as an energetically favored electron acceptor in both $LaAlO_3/SrTiO_3$ systems, resulting in modulation of interfacial carrier density and hence metal-to-insulator transition. For amorphous and crystalline $LaAlO_3/SrTiO_3$ heterostructures, the metal-to-insulator transition is found when the $LaFeO_3$ layer thickness crosses 3 and 6 unit cells, respectively. Such different critical $LaFeO_3$ thicknesses are explained in terms of distinct characteristic lengths of the redox-reaction-mediated and polar-catastrophe-dominated charge transfer, controlled by the interfacial atomic contact and Thomas-Fermi screening effect, respectively. Our results not only shed light on the complex interlayer charge transfer across oxide heterostructures but also provides a new route to precisely tailor the charge-transfer process at a functional interface.

References:

[1] Omar *et al.*, Nano Letters, **20**, 2493 (2020)