Thickness dependences of the electronic and magnetic properties of perovskite oxide thin films

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Transition-metal oxide thin films grown on single crystal substrates exhibit various interesting physical properties arising from the reduced spatial dimension. We have studied the electronic density of states, band dispersions, and magnetization of some perovskite-type oxide thin films by angle-integrated and angle-resolved photoemission spectroscopy (ARPES), and x-ray magnetic circular dichroism (XMCD).

According to photoemission measurements [1-3], thin films of the metallic oxides $SrRuO_3$ (SRO), $La_{1-x}Sr_xMnO_3$ (LSMO), $SrVO_3$ (SVO) all exhibit a metal-to-insulator transition (MIT) below critical thicknesses of several mono-layers. In particular, the MIT of SVO and SRO with an integer number of d electrons is considered to be a Mott transition [3], but the multi-orbital character of the t_{2g} bands should play an essential role. Indeed, ARPES studies of SVO have revealed orbital-dependent quantization of the t_{2g} bands in the SVO quantum well, which may lead an orbital-specific Mott transition below the critical thickness [4].

XMCD studies of the ferromagnetic metals LSMO and SRO have shown that the ferromagnetic moment of the d electrons decreases with decreasing thickness and that the system becomes paramagnetic below the critical thickness of MIT. For thick films, we have found no evidence for a magnetically dead layer at the interface with $SrTiO_3$ (STO) and conclude that the ferromagnetic-to-paramagnetic transition is an intrinsic property of the reduced spatial dimension and driven by the MIT.

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