Orbital reconstruction and interface magnetism in SrTiO3 based heterostructures

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The interface between $LaAlO_3$ (LAO) and $SrTiO_3$ (STO) band insulators have attracted strong interest for the interesting properties of the 2D-electron system (2DES) induced at the interface. One of the most interesting characteristics of this system is the inversion at the interface of the Ti3d bands compared to bulk $SrTiO_3$ [1,2], and the possibility of coexisting magnetic and superconducting ground states. By using a combination of X-ray Absorption Spectroscopy and Grazing Incidence x-ray diffraction we show that the orbital reconstruction takes place at the interface when a complete LAO layer covers the STO surface, i.e. before the appearance of mobile 2DES. Other titanate interfaces show a similar inversion of the Ti3d bands, independent on their eventual metallic character, like $BiMnO_3/SrTiO_3$ and $DyScO_3/SrTiO_3$ heterostructures.
Moreover we find that localized and delocalized electrons transferred to the STO interface are characterized by a negative exchange coupling with interfacial magnetic ions, being Mn3+ in the case of $BiMnO_3/SrTiO_3$ and Ti^{3+} localized spins in $LaAlO_3/SrTiO_3$. However, the magnetic dichroism signal is quenched in standard LAO/STO interfaces annealed in high oxygen pressure after the deposition and exhibiting a homogeneous superconducting ground state [3]. These data suggest a decisive role of oxygen vacancies in the magnetism of these oxide interfaces [4], in agreement with some theoretical predictions [5].

[1] M. Salluzzo, et al. Phys. Rev. Lett. 102, 166804 (2009).
[2] M. Salluzzo, et al., Adv. Mater. **25**, 2333 (2013).
[3] D. Stornaiuolo, et al., Appl. Phys. Lett. **101**, 222601 (2012).
[4] M. Salluzzo, et al., Phys. Rev. Lett. **111**, 087204 (2013).
[5] N. Pavlenko, et al., Phys. Rev. B 85, 020407(R) (2012).