Multifunctional oxides for spintronics

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The wealth of physical phenomena exhibited by transition metal oxides constitutes an exciting playground for solid-state scientists and a world of opportunities for novel devices. Their range of functionalities spans from superconductivity to ferromagnetism in the bulk and can be further broadened by considering their interfaces [1]. There, novel electronic phases may appear such as the metallic state found at the interface between a Mott insulator and a band insulator [2].

In this talk, I will try to illustrate how multifunctional oxides can bring novel degrees of freedom to spintronics [3]. After reviewing briefly the potential of half-metallic oxides for spin-based studies and devices, I will present results on the use of ferroic (ferromagnetic, ferroelectric) and multiferroic oxides as tunnel barriers and magnetic pinning layers in spintronics heterostructures. Notable results include the realization of four-resistance state memory elements through the combination of tunnel electroresistance and magnetoresistance [4], and the ferroelectric control of exchange bias [5,6].

I will also discuss recent progress on the physics of the metallic electron gas that appears in epitaxial heterostructures combining two band insulators, namely $LaAlO_3$ and $SrTiO_3$ [7]. Finally I will propose some directions to add ferroic degrees of freedom to such low-dimensional interface phases.

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