# Modeling multifunctional oxides devices from first principles

Stefano Sanvito
*School of Physics and Center for Research on Adaptive Nanostructures and Nanodevices, Trinity College, Dublin 2, Ireland*

In standard spintronics devices, such as magnetic tunnel junctions, the tunneling barrier constitutes a passive element, whose only function is that of separating, both electronically and magnetically, the two magnetic electrodes. One, however, can construct tunnel junctions where the insulator (most commonly MgO) is replaced by an insulating material presenting a macroscopic order of some kind. Here we explore, theoretically, the possibility of using either ferrimagnetic insulators or ferroelectric compounds. In the first case we show that ferrimagnetic spinel ferrites $CoFe_2O_4$ and $NiFe_2O_4$ can act as spin filtering barriers in magnetic tunnel junctions[1]. The spin-polarization of the current, however, depends sensibly on the precise alignment between the Fermi level of the electrodes and the ferrites valence band, so that magnetoresistance with different sign can be obtained with the same tunnel barrier. In contrast, when one uses a ferroelectric material, it is possible for magnetoresistance and electroresistance to coexist. This is demonstrated for the case of an all-oxides spin-valve in which the barrier is a complex $SrTiO_3/BaTiO_3$ layer, while the electrodes are made of $SrRuO_3$[2]. Intriguingly the magnitude of both the magnetoresistance and the electroresistance can be tuned by the thickness of the $SrTiO_3$ layer.

## REFERENCES

[1] *Spin-filtering efficiency of ferrimagnetic spinels $CoFe_2O_4$ and $NiFe_2O_4$*, Nuala M. Caffrey, Daniel Fritsch, Thomas Archer, Stefano Sanvito and Claude Ederer, Phys. Rev. B. **87**, 024419 (2013).

[2] *Coexistance of Giant Tunneling Electroresistance and Magnetoresistance in an All-Oxide Composite Magnetic Tunnel Junction*, Nuala M. Caffrey, Thomas Archer, Ivan Rungger and Stefano Sanvito, Phys. Rev. Lett. **109**, 226803 (2012).