

Exotic phenomena in spintronic nanostructures: from giant spin dependent tunneling to unconventional ferromagnetism

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Spintronic nanodevices using ultra thin oxide layers have found important applications over the past decade as components of magnetic field sensor and memory elements. Our understanding of spin dependent tunneling from magnetic electrodes through ultra thin oxide tunnel barriers has made major progress in recent years. In particular, magnesium oxide tunnel barriers give rise to highly spin polarized current of 80-90%, enabling tunneling magnetoresistance values at room temperature of several hundred percent [1]. These values are, however, highly dependent on the detailed structure of the tunnel barrier and its interfaces with the magnetic electrodes. Defects in the oxide layers and at their interfaces can significantly affect the magnetic and transport properties of these devices.

In particular we show that significant concentrations of nitrogen can be incorporated in thin films of MgO by thermal evaporation of Mg in the presence of atomic nitrogen and atomic oxygen. After activation of the N dopants by annealing (at ~500-900 C) in vacuum, the MgO layers exhibit magnetic moments. We show a correlation between holes formed on nitrogen and oxygen in the MgO layers and the magnetic moments observed.

Finally, we discuss the possibility of using spintronic devices to build a novel memory device with synaptic functionality.

[1] S. S. P. Parkin et al., *Nature Mater.* 3, 862 (2004).