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Mechanisms of perpendicular magnetic anisotropy and interlayer exchange coupling in MgO-based tunnel junctions[1]

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Magnetic tunnel junctions (MTJ) comprising ferromagnetic (FM) electrodes with MgO spacer have been an object of high interest for spintronics due to Bloch states symmetry spin filtering leading to high tunnel magnetoresistance (TMR) [1] and due to observation of antiferromagnetic (AF) coupling between FM electrodes across MgO spacer [2]. This attention have been strongly reinforced in a view of a huge interest in MTJs with perpendicularly magnetized magnetic layers (p-MTJs) originating from large values of interfacial perpendicular magnetic anisotropy (PMA) first observed at Pt|Co|MOx interfaces (M=Ta, Mg, Al, Ru…) [3,4] and later reported for Co|MgO [4,5] and CoFeB|MgO p-MTJs [6]. In this talk we will elucidate mechanisms responsible for the PMA from first-principles [7] and report the effect of interfacial oxidation conditions on the PMA in Fe(Co)|MgO p-MTJs. In particular, we found very large PMA values for MTJs with pure interfaces in agreement with recent experiments [4,6]. Furthermore, it will be demonstrated that oxidation conditions strongly affect the PMA which strongly correlates with TMR in agreement with experiments [7,8]. Finally, we will discuss the origin of AF coupling in Co|MgO p-MTJs which oscillates as a function of FM layer thickness in agreement with theories of interlayer exchange coupling in MTJ [5].

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