# Fundamentals of MR– RA scaling : TMR vs. GMR

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At reduced sensor dimensions required for high density magnetic recording, scaling of magneto-resistance (MR) and resistance area product (RA) with sensor thickness is one of a critical materials specific properties. We consider fundamental aspects of RA scaling problem by investigating two classes of planar FM/NM/FM hetero-structures : (i) Fe/MgO/Fe tunneling junctions and (ii) CPP-GMR based on full Heusler alloy ferromagnets. In both cases we focus on the electronic structure contributions to RA(MR).

The FeCoB/MgO/FeCoB magnetic tunneling junctions have been a subject of intensive research [1]. In this work we focus on the electronic structure calculations for (001) Fe/MgO/Fe using the state-of-the-art QSGW method [2] . The GW correction is found to be important for a number of key electronic structure features. In particular, we find that minority spin channel interface states which usually found in LDA right at the Fermi level are shifted by about 0.15 eV to higher energies. We argue that these findings help to explain low energy pick found in the tunneling spectroscopy experiments [3] and reconcile theory and experiment on the zero-bias anomaly issue. The complex band structure responsible for scaling of RA and interlayer exchange coupling (IEC) with thickness of tunneling barrier. The latter property contribute to $H_1$ or field sensitivity. We discuss comparison of calculated and measured IEC for Fe/MgO/Fe. We find that metal/insulator interface imperfections are likely responsible for observed trends.

Ambrose and Mryasov [4] proposed to used Heusler alloys both for NM and FM. Recently, this idea was experimentally realized and tested both on the level of tri-layer and read head structures [5]. These experiments confirmed original suggestion that combination of NM and FM Heusler alloys may help to improve interface spin scattering asymmetry [4,5]. In this presentation we focus on the fundamentals of spin dependent interface scattering for ordered Heusler alloy and also investigate how it is affected by substitution disorder. Ab-initio electronic structure calculations are employed to account for band structure of these materials and its effect on the spin dependent transport properties. We present direct transport simulation results comparing All Heusler alloy (110) and Heusler/Ag/Heusler (100) designs.

References:

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