Jeudi 12 Décembre 2013 à 10h00

Salle de seminaire, IJL-Vandoeuvre 4eme etage
(Faculté des Sciences et Technologies - 2ème cycle)

Theoretical insights into spintronic phenomena in magnetic tunnel junctions and graphene

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Séminaire de la priorité thématique:
Matériaux **A**rtificiels **N**anostructurés

This talk will be devoted to an overview of spintronic phenomena in magnetic tunnel junctions (MTJ) with particular attention paid to demonstrating how theory helps advancing device applications. I will start from recent progress in theory of spin transfer torques (STT) in MTJs which in particular allowed prediction of STT voltage dependences and provided solutions for STT-MRAM [1,2]. This part will also include our latest results on voltage dependences of both STT and tunnel magnetoresistance (TMR) in MTJs with asymmetric barriers [3,4].

Next part of the talk will be devoted to studies of interlayer exchange coupling (IEC) using ab-initio and tight-binding approaches. In particular, we will address the impact of structural relaxation and interfacial oxidation conditions on amplitude of IEC in MTJs [5] as well as the importance of occupation numbers (Fermi level) on period of IEC oscillations as a function of ferromagnetic electrode thickness [6].

I will continue with ab-initio investigations of perpendicular magnetic anisotropy (PMA) at Fe(001)|MgO(001) and Co(001)|MgO(001) interfaces [7]. It will be demonstrated that the oxidation conditions strongly affect the PMA and it strongly correlates with tunnel magnetoresistance (TMR) in agreement with experiments [7,8]. Finally, we unveil and elucidate microscopic mechanisms of PMA by evaluating the orbital and layer resolved contributions to magnetic anisotropy in Fe/MgO interfaces and MTJs with different interfacial conditions [9].

The talk will be concluded by first-principles investigations of magnetic properties of graphene-based structures in a view of graphene spintronics including Co|graphene interfaces [10] and shape (as well as substrate) induced magnetism in graphene [11]. In particular, using the optimized structure of graphene on EuO, we found that the interaction with the magnetic substrate remarkably affects the magnetic properties of graphene [12].

[1] I. Theodonis et al, Phys. Rev. Lett. 97, 237205 (2006); M. Chshiev et al. IEEE Trans. Mag. 44 (11) (2008); A. Manchon et al, J. Phys. Cond. Mat. 20, 145208 (2008); A. Kalitsov et al, Phys. Rev. B 79, 174416 (2009); [2] S.-C. Oh et al, Nature Physics 5, 898 (2009).[3] A. Kalitsov et al, Phys. Rev. B 88, 104430 (2013) (2013).[4] A. Kalitsov et al, ***J. Phys.: Condens. Matter*** *25, 496005 (2013).[5] H. X. Yang et al, Appl. Phys. Lett. 96, 262509 (2010). [6] L. E. Nistor et al, Phys. Rev. B 81, 220407 (2010).[7] H. X. Yang et al, Phys. Rev. B 84, 054401 (2011). [8] L. E. Nistor et al, IEEE Trans. Magn. 46, 1412 (2010). [9] A. Hallal et al, Phys. Rev. B 88, 184423 (2013). [10] Chi Vo-Van et al, New J. Phys. 12, 103040 (2010); J. Coraux et al, J. Phys. Chem. Lett. 3, 2059 (2012).[11] H. X. Yang et al, Phys. Rev. B 84, 214404 (2011). [12] H. X. Yang et al, Phys. Rev. Lett. 110, 046603 (2013).*