Sonderforschungsbereich 689
Spinphänomene in reduzierten Dimensionen

Seminarankündigung
(gem. mit Festkörpertheorie-Seminar)

Sprecher: Prof. Mairbek Cshiev
SPINETEC, Univ. Grenoble Alpes

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Thema: Theoretical insights into spintronic and spinorbitronic phenomena in magnetic nanostructures using first-principles and tight-binding approaches

Abstract
This talk will be devoted to an overview of spintronic phenomena in layered structures based on interfaces between ferromagnetic (FM) and non-magnetic (NM) materials with attention paid to demonstrating how theory helps advancing device applications.

The first part of the talk is devoted to theory of spin transfer torques (STT) in magnetic tunnel junctions (MTJs) which in particular allows prediction of STT voltage dependences and provides solutions for magnetic random access memory (STT-MRAM) applications [1, 2]. STT properties in case of various cases of asymmetric MTJs will be discussed [2, 3]. Also the properties of interlayer exchange coupling (IEC) in MTJs under different growth and interfacial oxidation conditions as well as IEC oscillations as a function of ferromagnetic electrode thickness are discussed [4].

The second part of the presentation addresses spinorbit coupling based phenomena such as perpendicular magnetic anisotropy (PMA) [5, 6, 7, 8, 9] and Dzyaloshinskii-Moriya interaction (DMI) [10, 11, 12, 13] at interfaces between FM metal and NM insulator or metal. First, the nature of PMA control at Fe|MgO interfaces is unveiled by evaluating the orbital and layer resolved contributions to magnetic anisotropy in Fe|MgO interfaces and MTJs with different interfacial conditions [6]. Mechanisms of the optimization of the effective anisotropy as well as of its electric field control are discussed [7, 8, 9]. Next, the main features and microscopic mechanisms of DMI behavior are elucidated in CoPt and other Co/NM bilayers [11]. Furthermore, several approaches for DMI enhancement and manipulation will be presented including, in particular, physical mechanisms of DMI behavior in Pt/Co/MgO structures [11, 12] allowing observation of room temperature skyrmions [12]. A possibility of electric field control of DMI in such structures is also discussed [11].

In the last part of the talk the behavior of PMA and DMI will be addressed for nanostructures comprising Co/graphene interfaces [8, 13] which may be of strong interest for graphene spintronics [14]. Finally, the mechanisms inducing the magnetism in graphene via magnetic insulators (MI) proximity effect will be discussed including four cases of different magnetic insulators were studied: europium oxide (EuO), europium sulfide (EuS), cobalt ferrite CoFeO(Oi) (CFO) as well as yttrium iron garnet Y(FeO3)(YIG) [13].