Properties of magnetic tunnel junctions with a spin-filtering layer

General Scope:

Spin based electronics take advantage of both the electron charge and spin in solid-state systems. A crucial component in applications is the magnetic tunnel junction (MTJ), where two magnetic layers sandwich a non-magnetic one. Its conductance depend on the relative spin orientation of the two electrodes. An alternative way for generating spin-polarized currents is based on MTJ with magnetic barrier materials, which results in spin dependent tunneling probabilities (Fig. 1). Efficient spin-filtering has been demonstrated for ferromagnetic insulators such as EuS and EuO, which show low transition temperatures. Spinel ferrites like CoFe₂O₄ are promising candidates for room-temperature spin filtering.

Research topic and facilities available:

We have recently grown Fe₂O₃/MgO/CoFe₂O₄ multilayers on Ag(100) using reactive molecular beam epitaxy (MBE). In this system the magnetite layer constitutes the magnetic electrode, while the cobalt ferrite acts as a spin-filter. The properties of this system depend on the epitaxial relationship with the Ag substrate. It is known that a compressive strain induce an in plane magnetization in cobalt ferrite. In our system, this effect need to be investigated in details and systematically as function of the film thickness.

Fig. 1 Schema of spin filtering (J S Moodera et al., J. Phys.: Condens. Matter 19 (2007) 165202

Fig. 2 LEED pattern recorded at different stages of Fe₂O₃/MgO/CoFe₂O₄/Ag(100) growth, showing a good epitaxy with the substrate and between each layer (a: Ag; b,c,d: Fe₂O₃, MgO, and CoFe₂O₄ surfaces).

During the internship we will growth CoFe₂O₄ layers of different thickness and we will measure their magnetic properties by SQUID magnetometry. Once optimized the properties of the cobalt ferrite barrier, a complete Fe₂O₃/MgO/CoFe₂O₄/Ag(100) device will be elaborated and its magnetoresistance will be measured by conductive AFM.

Possible collaboration and networking: Technological groups at Néel Institut.

Possible extension as a PhD: Yes

Required skills: A good background in condensed matter physics

Starting date: March, 2019

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