MAR15-2014-020085

Abstract for an Invited Paper
for the MAR15 Meeting of
the American Physical Society

Co1.5Fe1.5Ge and Co2MnSi Half-Metal Magnetic behavior tested by spin-resolved photoemission and ferromagnetic resonance

STÉPHANE ANDRIEU, Institut Jean Lamour - Universite de Lorraine

In a magnetic spin-valve or tunnel junction, a crucial parameter to get both large magnetoresistance (MR) and a good Spin Transfer Torque (STT) efficiency is the spin-polarization of the magnetic electrodes. So-called "Half-Metallic" Magnetic (HMM) materials are of interest for such devices due to the existence of a spin-gap at the Fermi level for minority spins [1]. Recently, MR enhancements have been observed by different groups on Co2-xFe1+xGe [1] and Co2MnSi [2] Heusler materials, suggesting HMM behavior. A second consequence of that minority spin gap is that very low magnetic damping is expected. Combining both properties in a device is a challenge for decreasing the critical current necessary to switch the magnetization using STT. Up to now, many Heusler alloys are claimed to get this HMM property [3], but direct demonstration using spin-resolved photoemission is often missing. Here we focus on 2 systems, (i) Co1.5Fe1.5Ge for which a significant increase of the GMR was observed in spin valves [1], and (ii) Co2MnSi for which very large TMR values were observed in MgO-based MTJs [2]. The Co1.5Fe1.5Ge and Co2MnSi(001) films (noted CFG and CMS) were prepared by Molecular Beam Epitaxy coupled to the Spin-Resolved PhotoEmission (SR-PES) set-up on CASSIOPEE beamline at SOLEIL synchrotron. The L21 chemical ordering was confirmed in CFG films by using anomalous diffraction on SIXS beamline at SOLEIL. However, SR-PES experiments did not show any HMM behavior on our CFG films [4]. Similar PES experiments performed on CMS showed that the minority spin density of states (DOS) drops down to zero at -0.4eV below EF, leading to a 100% spin polarization. However, we also observed an increase of the minority spin DOS at EF, not predicted by ab initio calculations on the bulk structure. The spin-gap is thus decreased due to the surface symmetry breaking. We will show however that this spin-gap can be enlarged when finishing the surface by 1 Mn atomic plane, or when covering with the MgO barrier. Extremely low damping (<10-3) are observed, making CMS a very good candidate for spintronics devices.

[1] S. Maat et al, Appl. Phys. Lett. 93, 143505 (2008)
[2] Hong-xi Liu et al, App. Phys. Lett., 101, 132418 (2012)
[3] T. Graf, C. Felser, S. S. P. Parkin, Progress in Solid State Chemistry 39, 1 (2011)
[4] A. Neggache et al, Appl. Phys. Lett. 104, 252412 (2014)