Co-Ir alloying upon intercalation of Cobalt ultrathin films under Graphene

A study on Gr/Co/Ir(111) systems

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Abstract

One of the new possible generations of hard-disks is based on ultra-high density data storage.
Cobalt (Co) thin films below 10MLs show promising magnetic properties such as small magnetic domains and intense magnetization which are perfect to develop this kind of technology. The former allows one to obtain small magnetic bits and the latter guarantees, at the same time, an easy and fast data reading/writing.
Nevertheless, due to their intrinsic fragility, such thin films oxidize immediately under ambient pressure. For this reason, the use of a Graphene (Gr) capping layer is fundamental: once it is included in the system, the oxidation problem is overcome and a chemical stabilization of the Co film is easily achieved.

Gr/Co/Ir systems are made up using a rather straightforward approach: Gr is grown by Chemical Vapor Deposition (CVD) on Iridium(111) substrates, then Co is deposited on Gr. A final annealing triggers an *intercalation* process in which the Co atoms goes through the Gr and migrate on the Ir surface.
Beside the chemical stability, such systems were proven to have enhanced magnetic properties, compared to uncapped Co/Ir. The origin of this enhancement was searched in the Co-C coupling [1] and was related to the Gr presence [2]. However, due to the low dimensionality of the system, even small morphology variations have to be taken into account as they could contribute on the total magnetic anisotropy with a deep impact on the magnetic response of the whole system.

For this reason, we used Synchrotron Radiation techniques such as X-Ray Diffraction (XRD), X-Ray Reflectivity (XRR) and X-ray Absorption Spectroscopy (XAS) to investigate the chemical evolution of the Co film and the structural modifications at the Co-Ir interface induced by the intercalation procedure.

We found that the Co intercalation can give rise to a Co-Ir interface alloy layer, under some intercalation conditions [3]. By acting on macroscopic parameters such as annealing time and temperature, one is able to control the alloy thickness down to the ML scale, and the Co amount in the alloy. Furthermore, we found that the alloy formation occurs also without any Gr. However, when Gr is present the process is facilitated (fig. 1).

Once the magnetic analysis complements the structural investigations, we will be able to set the growth and intercalation conditions in order to obtain devices with optimized magnetic response, tailored on the final device. A fine control on the local scale will then be achieved simply acting on macroscopic parameters.

References

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Figures

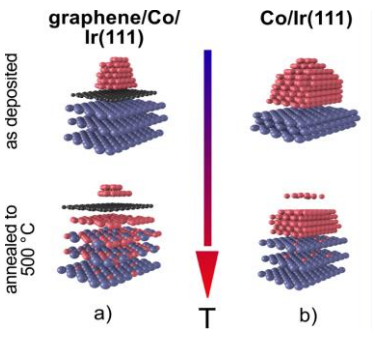

Fig. 1: XRR data: representation of the best fit models for Gr/Co/Ir (left) and Co/Ir (right) systems before (top) and after (bottom) the thermal treatment.
Little alloy is found for a 4MLs-thick Co film deposited on bare Ir, whereas 2-3 MLs of alloy are formed if the same quantity of Co is deposited on Gr.