In situ magnetic characterizations of electrodeposited ultrahin magnetic layers

P. Allongue, F. Maroun
Laboratoire de Physique des Liquides et Electrochimie
CNRS UPR – 15, Université P. & M. Curie,
4 Place Jussieu, Tour 22 E5, *75005 Paris (France)*

A. Gündel, A. Morrone, J. E. Schmidt
Laboratório de Magnetismo
Insituto de Física - UFRGS,
91501-970 Porto Alegre, RS (Brasil)

T. Devolder
Institut d'Electronique Fondamentale
Bat. 220, Université Paris – Sud
91145 Orsay Cedex

We recently showed that the properties of electrodeposited ultrathin magnetic layers may outperform those of MBE layers [1]. In particular it was shown that ED Cu/Co/Au(111) structures exhibit a strong *perpendicular* magnetization anisotropy (PMA) [2]. PMA is of considerable interest for high density information storage.

This work deals with *in situ* magnetic characterization using AGFM (alternating field gradient magnetometry) or PMOKE (Polar Magneto Optic Kerr Effect). It is shown that both methods are capable of sub-ML sensitivity [3] and that they yield new information regarding the factors influencing the magnetic state of layers as well as the mechanisms of deposition. To our knowledge only very few studies attempted to characterize *in situ* magnetic layers [4].

The EC-AGFM set-up developed for this study relies on Flander's principle [5]. A sample hanging at the extremity of a glass rod is placed in the center of two coils which generate the ac field gradient necessary to promote an *ac* force M x $\delta H/\delta$ on the sample. This force is converted into a voltage using a piezoelement. Two configurations are used, with the sample perpendicular or parallel to the gradient to determine the components M⊥ and M//? An EC-cell is fitted between the poles of the electromagnet with the coils rigidly fixed on its walls. The EC-PMOKE set up was an adaptation of a standard set with an EC-cell having an optical window (suprasil) to illuminate the sample with a modulated polarized HeNe laser beam. Attention was given to the mechanical stability of the ensemble and to the distance between the sample surface from the window. In both experiments the sample is immersed in the cell under potentiostatic control. within a classical three electrode configuration.

To illustrate the potential of *in situ* magnetic characterizations different experiments will be presented :

Co and Fe/Au(111) : In this case the issue was following in real time the phenomenon of PMA during the film formation. Fig. 1 is an example of result. It shows M(H) loops of 0.5 to 3 ML Co layers deposited on gold from a sulfate bath. The square loops indicate the occurrence of PMA below $t^* \sim 2$ ML. Results are similar with iron layers. Further experiments will be presented at the conference to show that the t^*-value critically depends on the surface chemistry of the film and on the plating solution. The case of iron will be also the opportunity to compare the merit of PMOKE and AGFM.

Ni/Au(111) : In this case we focused on the incorporation of hydrogen during deposition. EC-AGFM measurements reveal indeed that the magnetic moment of Ni is smaller in the initial stages of the deposition before reaching the bulk value.

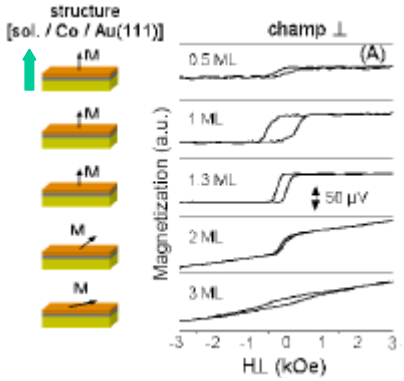

Fig. 1 : M(H) loops of Co/Au(111) layers of increasing thickness (EC-AGFM measurements)

References :

[1] L. Cagnon et al., Phys . rev. B, 63 (2001) 104419
[2] W. J. M. de Jonge et al., in *Ultrathin Magnetic Structures*, B. Heinrich and J. A. C. Bland Eds., Springer Verlag, Vol. I, Chap 1.3 (1994)
[3] A. Gündel et al., PCCP, 3 (2002) 3330
[4] W. Schindler et al., Phys. Rev. B, 55 (1997) R1989; J. Appl. Phys., 81 (1997) 3915
[5] P. J. Flanders, J. Appl. Phys., 63 (1988) 3940