Preparation of Au nanostructures on Si(111) and magnetic properties of Co overlayers

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Preparing magnetic nanostructures is a prerequisite for the study of magnetism on the nanometer scale. The expected properties of nanostructures are very different from bulk magnetic properties and determine future applications for data storage. A technologically relevant substrate is Si and the possibility of electrochemically growing magnetic nanostructures on Si is very appealing.

In order to avoid silicide formation when magnetic metals are electrodeposited directly on Si, we chose to electrodeposit a Au buffer layer on which the magnetic layer is selectively grown. As we will show in this contribution, this approach allowed us to vary the morphology of the magnetic nanostructures from 2D film like to organized islands deposits.

Flat 2D Au films were grown on Si(111) at high overpotential in $AuCl_4$ containing solution at pH=4. AFM observations showed a rather flat deposit, although the top surface appeared slightly rough. The surface flatness increases with the deposit thickness yielding a very flat Au layer at ~60 ML (Fig. 1a). Au islands were also grown at high overpotential in $Au(CN)_2$ containing solutions at pH=14. AFM observations revealed an island morphology with a preferential nucleation at the Si(111) steps (Fig. 1b). The regularity and straightness of the Si steps on the macroscopic scale allowed a long-range organization of the Au islands along lines. Moreover, they have a narrow island size distribution and have a flat top surface. The two types of Au growth on Si(111) will be briefly discussed in terms of H segregation during Au deposition.

Co layers deposited on top of the flat Au layer on Si(111) present a layer by layer growth identical to that on Au(111) as observed by STM [1]. Ex-situ MOKE properties of the Co deposit covered by a Au protection layer are similar to those on Au(111), i.e., a large perpendicular magnetic anisotropy for small Co thickness and an in-plane magnetization for large Co thickness (Fig. 2). Magnetic properties of Co deposited on Au islands as a function of the Co thickness and island separation will be also presented.

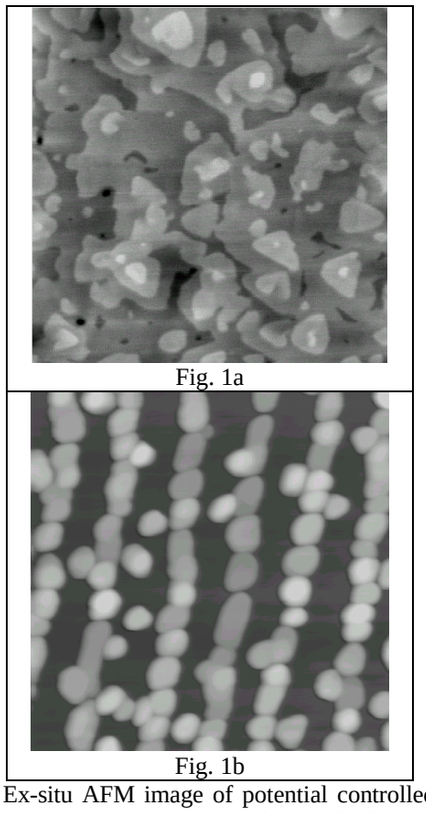

Fig. 1a

Fig. 1b

Figure 1. Ex-situ AFM image of potential controlled Au flat (a) and island (b) deposition on Si(111)-H. Image size is 0.5x0.5µm.

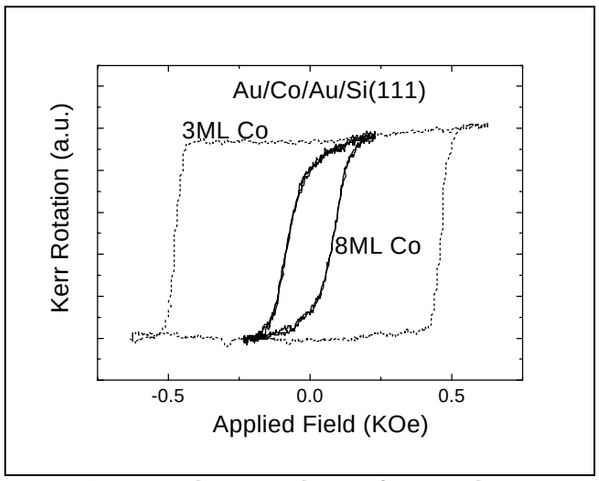

Figure 2. MOKE hysteresis loops of Au/Co deposits on flat Au layers on Si(111). The applied magnetic field and the measured Co magnetization are perpendicular (respectively parallel) to the substrate for the 3ML (respectively 8ML) Co layer.

[1] L. Cagnon, T. Devolder, R. Cortes, A. Morrone, J. E. Schmidt, C. Chappert, P. Allongue, Phys. Rev. B (2001), 63, 104419/1.