Structure and magnetic anisotropy of ultrathin Co films on Au(111) vicinal substrates

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Nanostructured systems with magnetization along the surface normal are of technological interest for magnetic storing devices. We have studied ferromagnetic films of Co as it they exhibit a strongly enhanced magnetic anisotropy with an easy axis perpendicular to the surface plane [1]. Vicinal surfaces are a system model to control the roughness of the ferromagnetic films. We have employed different vicinal substrates of Au(111) to study the relation of the structure with magnetic properties.

We have studied the structure from the low coverage regime where organised growth begins until ultrathin Co films are obtained (coverage between 0 and 20 ML). Scanning Tunnelling Microscopy and Grazing Incidence X-ray Diffraction studies have been performed to determine the surface structure (See Fig. 1A). X-ray diffraction shows that the vicinality of the substrate strongly modifies the Co film structure. While Co/Au(111) presents hcp structure, fcc Co is found in films on Au(233). Growth on an intermediate surface as Au(788) originates a structure with stacking faults. Complementary measurements of the surface morphology have been performed by STM (See Fig 1B), which has allowed to determine the critical coverage for percolation and the surface roughness.

Magnetism in these systems has been studied by Magneto-Optical Kerr Effect (MOKE), both *in-situ* and *ex-situ*. Magnetic properties in vicinal surfaces exhibit a strongly modified behaviour as compared to the reference system Co/Au(111). *In-situ* polar hysteresis loops allow to observe a transition of the magnetisation from out-of-plane to in-plane orientation as a function of Co coverage, lead by the magnetic shape anisotropy (See Fig. 1C). In vicinal surfaces, the reorientation transition appears in a more progressive way and at lower coverages than in Co/Au(111). *Ex-situ* measurements on samples passivated with a gold layer show an helicoidal reorientation transition. The easy axis of the magnetization changes from out-of-plane to in-plane, step parallel orientation as confirmed by longitudinal MOKE experiments. These experiments allow to quantify the different terms of the magnetic anisotropy. The relation between the surface structure and the magnetic properties will be discussed.

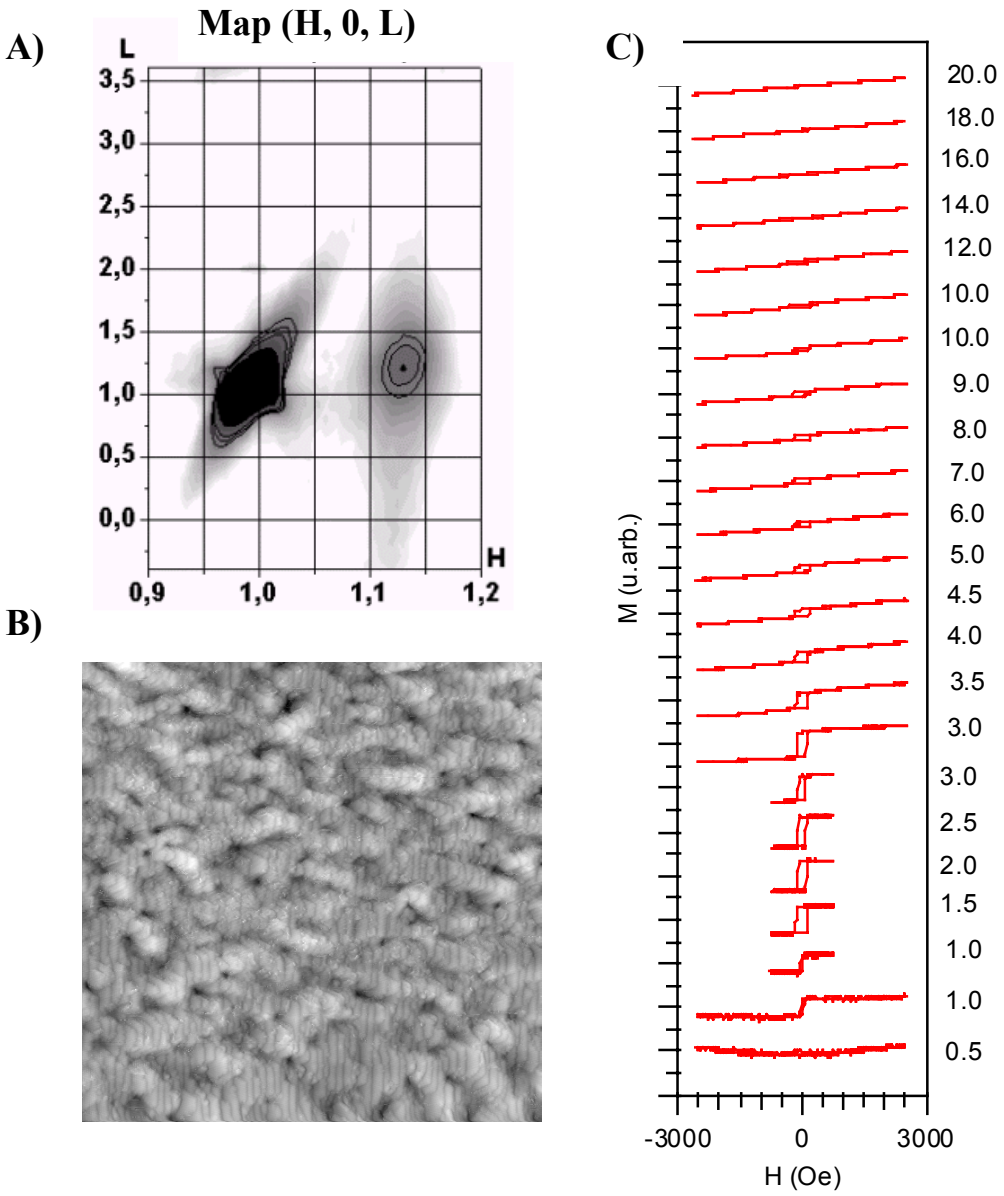

Fig. 1 : Co on Au(233). (A) Reciprocal space map of a 10 ML film. The position of the diffraction peaks shows that Co has the same crystalline structure as gold (fcc) (B) STM image (80 nm x 80 nm) of a 10 ML film. The image shows the surface roughness. (C) *In-situ* polar hysteresis loops of Co/Au(233) films, where the magnetic reorientation transition is observed as a fonction of Co coverage.

[1] R. Allenspach, J. Magn. Magn. Mater. **129**, 160 (1994), and references therein.