ESRF	**Experiment title:** **Surface XRD study of electrochemically deposited Co in Co/Au/Si(111)-H samples**	**Experiment number**: SI-918
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Report:

In-situ and ex-situ x-ray diffraction measurements of electrochemically deposited Co on Au/Si(111) substrates have been recorded, to understand the relationship between Co coverage and distribution, and the Co lattice parameter. These measurements will ultimately be related to magnetic measurements, to identify the relationship between the Co lattice structure and magnetic properties.

The behaviour of both 2D contiguous Au layers (Au[111] ⊥ to the Si(111) surface) and also Au islands (*mostly* Au[111] ⊥ to the Si(111) surface, but also other minority orientations) on the subsequent in-situ deposition of Co was investigated, with evidence for epitaxial Co deposits on both the 'flat' and the 'island' Au(111) surfaces of the Au templates. For the 'flat' Au samples, the Co is aligned with respect to the Au (Co[110] parallel to Au[220] in-plane, and Co[101] out-of-plane), thus with the **c** axis (the easy axis of magnetisation) perpendicular to the Si(111) surface of the substrate. The Co in-plane lattice parameter **a** shows an expansion of around 2% at the lowest coverages, and this parameter gradually approaches the bulk Co lattice parameter as the Co coverage increases. The spectra below were recorded from 'flat' Au samples.

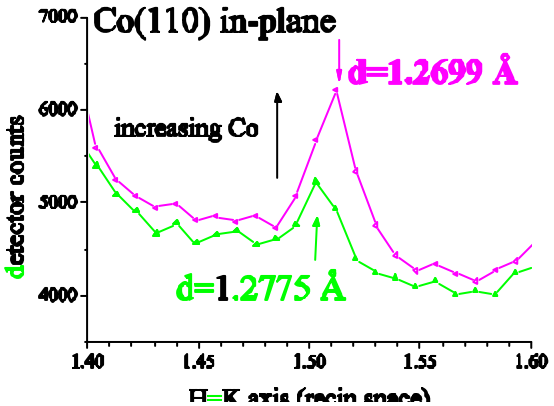

Figure 1 Co(110) peaks in-plane (indexed relative to the H=K high symmetry axis of the Si substrate). The Co(110) d-spacing approaches the bulk value (1.25 Å) as the Co layer thickness increases. Angular scans (by rotating the sample) show this peak has 6 fold symmetry, well aligned along the Au in-plane directions

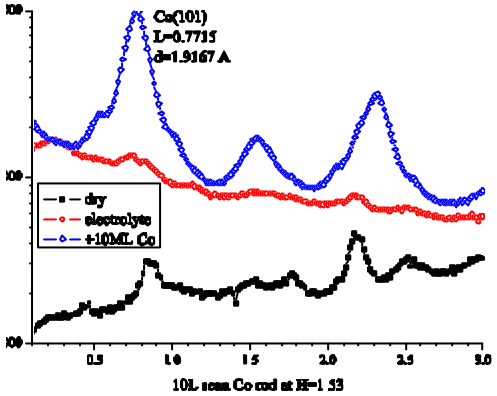

Figure 2 Co(101) peaks out-of-plane (indexed relative to the L axis of the Si substrate) after in-situ deposition of Co. The **c** lattice parameter (out-of-plane) shows a smaller % change than the **a** (in-plane) parameter.

The Au islands show similar results: even in-situ, with the technical challenge of measuring a proportionally much smaller Au(111) surface for Co deposition, and the complications of additional Au peaks from minority orientations, epitaxial hcp Co deposits have been observed.

For all in-situ samples, the effects of the beam (hole production in the Si substrate, leading to eventual Co dissolution) on the stability of the Co deposit made these measurements extremely sensitive to the correct electrochemical potential for stabilisation during in-situ XRD measurements. We found the optimum electrochemical conditions and used a meticulous data collection procedure in order to minimize the effect of the Co layer instability.

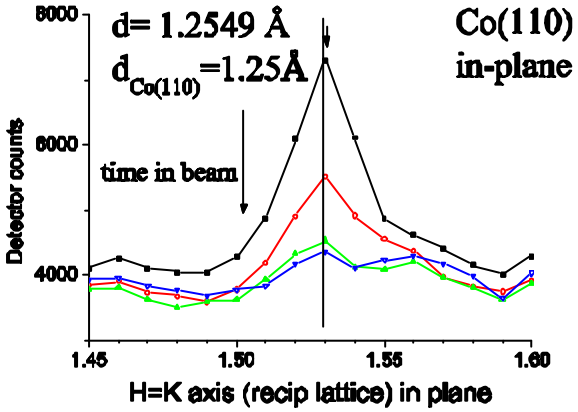

Figure 3 shows the effect of time (spectra taken at 30 minute intervals) under the beam, and 'non-optimised' electrochemical parameters, illustrating the importance of establishing the correct electrochemical conditions and measurement protocol.

Ex-situ samples have also been measured (electrochemical deposition of an Au capping layer to form Au/Co/Au(islands or 2D)/Si(111)-H layers), and a comparison of these data with the in-situ data is currently underway, as well as a full study of the morphology of the self-organised Au islands or 2D Au/Si(111) templates used for Co deposition.

In summary, in-situ XRD measurements of the electrochemical formation of Co/Au/Si(111) samples have been successfully performed, with Co coverages of only a few monolayers observed and characterised structurally. In addition to the technical challenges presented by in-situ electrochemical measurements, the sensivity of the semiconductor substrate to the beam required meticulous data collection procedures in order to eliminate the effects of time or Co deposit instability. These in-situ studies are vital for understanding the initial growth parameters of the Co layers, and their relationship to the magnetic propeties of such systems, with the ultimate aim of tuning the magnetic properties of such deposits on commercialy relevant (semiconductor) substrates.