



	Experiment title: 1D grating of silicon nanostripes on Ag(110): structure determination by GIXD and Co nanolines growth on this template followed by GISAXS	Experiment number: SI2091
Beamline:	Date of experiment: from: 30/06/2010 to: 06/07/2010	Date of report: 16-08-2010
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Report:

There is a great technological interest in the controlled preparation of nanopatterned metal- or semiconductor substrates as potential templates for the growth of periodic nanostructures. It has been shown that spontaneously patterned surfaces could be used for such a growth. Examples of such surfaces are vicinal surfaces, reconstructed surfaces or self-organized surfaces obtained by chemisorption of atoms at partial coverage. Under specific conditions of flux and temperature, the deposition of atoms on these surfaces can lead to the formation of well-ordered nanostructures reproducing the initial patterning of the surface. In this bottom-up approach, substrates can be nanopatterned on a large scale (cm²) through a one-step process.

In a recent work, we have shown that upon deposition of silicon onto the anisotropic Ag(110) surface at 473 K, it is possible to build a highly perfect array of one-dimensional (1D) Si nanostripes, with a pitch of 2 nm, covering uniformly the entire surface (see Fig. 1). This 1D grating can find applications in various fields such as gas- or biosensors or molecular electronics as it appears to be an original molecular-scale template for the oriented deposition of a wide variety of species. Since adsorption is expected to be highly structure sensitive, investigations of structural properties of these nanostructures down to the atomic scale are suitable.

Recently, we have proposed an original atomic arrangement for the self-assembled Si nanostripes deduced from the atomically resolved structure obtained by scanning tunneling microscopy and the 5×2 superstructure observed by low energy electron diffraction, in conjunction with a theoretical work concerning the structure of individual Si nanostripes. However, a different atomic model has been also built by another group in order to explain the same STM results. By using Grazing Incidence X-ray Diffraction (GIXD), we

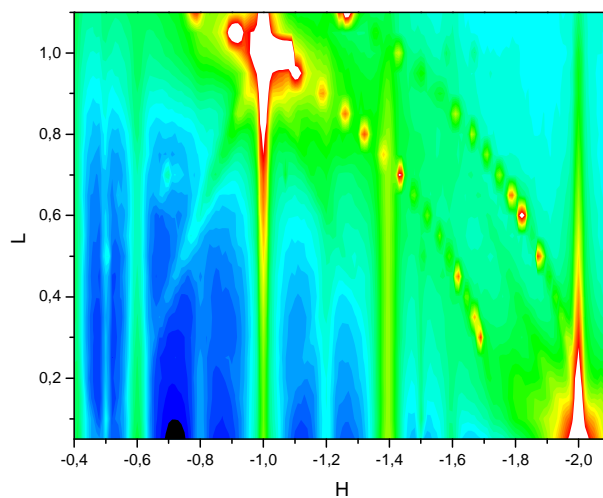
first wanted to validate our model, and to precisely determine the Si and Ag atomic positions in the unit cell. Such determination would be of great importance for the computation of the electronic properties of the Si layer.

We have first worked on a new Ag(110) crystal. On this crystal, we have spent few shifts in order to prepare the surface without great success. It appears that the sample quality was much below our requirements. We have thus changed the crystal and used an older one. On this sample, we have been able to easily observe the nanostructuration of the surface (see figure), but few tries were needed in order to optimise the quality of the surface (for example, on the figure, undesirable rods at half-order positions are observed).

The completion of the monolayer was obtained by following the intensity associated with a superstructure rod and stopping the evaporation at the saturation of the corresponding intensity.

On a well-ordered Si/Ag(110) nanopatterned surface, we have made extensive measurements of the diffracted intensity. 32 non-equivalent in-plane structure factors were acquired, up to $H=3.8$. Moreover, the intensity has been measured along 11 non-equivalent rods, including crystal truncation rods (at integer values of H). We have, of course, measured equivalent reflections in order to check the symmetry of the measurements. We are now undertaking the precise analysis of our quantitative set of data.

On this sample, we have also undertaken Co evaporation on the one-dimensional array of Si nanostripes. However, during the beginning of evaporation, the filament of the evaporator broke. Only few Co has been deposited on the surface but visible modifications of the structure factors were clearly visible: some structure factors increase whereas other decrease. It was not possible to precisely determine the Co evaporated due to difficulties with the Auger Electron Spectrometer (trouble with the electron multiplier generating a too high noise level). Due to the uncertainties on the Co quantity evaporated, we do not have performed any GISAXS measurements. However, we have shown that the growth and GIXD analysis of a Co/Si/Ag 1D grating was possible at the ESRF. New shifts are highly needed in order to continue this successful experiment and determine the structure of Co atoms adsorbed on Si/Ag nanostripes.



HL Map for $K=0$. Two Bragg spots at $(H=-1, L=1)$ and $(H=-2, L=0)$ are visible together with crystal truncation rods and satellite rods associated with the (5×2) periodicity. Additional rods with lower intensity can be seen at half-order positions.