EUROPEAN SYNCHROTRON RADIATION FACILITY

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ESRF

Experiment Report Form

ESRF	**Experiment title:** **Ag-induced nanopatterning of Ni vicinal surfaces**	**Experiment number**: 32-03-620
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Report:

The self-organization of nanometric systems has been intensively studied due to their potential application for the fabrication of magnetic, optoelectronic or catalytic nano-objects among others. The faceted surfaces represent a promising way for the realization of nanostructured templates. The goal of the experiment was the study of the faceting induced by Ag deposit on Ni vicinal surfaces in the nanometric range. In the past we have studied the faceting of Cu vicinal surfaces induced by a Ag deposit in the sub-monolayer range [1], leading to the formation of periodic facets in the range of 10-100 nm, accordingly to the Ag overage of the surface. The structure and the morphology evolutions during the ordering of the system under annealing were studied by GIXD at LURE and at ESRF. Ag/Ni system presents several similarities with respect to the Ag/Cu system: Ag and Ni are immiscible; they present both the same fcc crystallographic structure and very different cohesive energies. The experiment was devoted to find the conditions of faceting, study its thermal stability and the organization of the surface for different Ag coverages.

The studied sample was a Ni(322) surface, which is constituted by (111) terraces 1 nm wide separated by {100} steps. The clean surface was prepared by repeated sputtering and annealing at 700°C cycles until no peaks of C and O were detected on the Auger electron spectroscopy (AES) analysis. The first week we prepared the Ni surface but we obtained very bad data, which gave no information about the surface evolution. In fact, at the end of the experimental session, a pollution of C was detected in the UHV chamber and, for this reason; a new week was allocated in october 2004.

During the second session, we collected very good experimental data. In order to study the system morphology, we performed a series of reciprocal space scans which are sensitive to the type of facets and/or to the superstructure period. This scans have permitted us to find the experimental conditions (thermal annealing) allowing the stabilization of the facets. In Fig.1 we report the measurements obtained before and after a Ag deposit. The data are shown by using a reciprocal space lattice basis built on the (322) substrate periodicity: in this case *H* spans the direction normal to the step edges, *K* the direction parallel to the steps and *L* the normal to the sample surface (i.e. the [322] direction in the fcc Ni unit basis). Fig.1.a shows a "*H*-scan" performed along the direction normal to the surface step and parallel to the surface plane. The two peaks correspond to the crystal truncation rods of the Ni surface after the cleaning process, which are very sharp (i.e. the surface is well prepared). After the deposit of some Ag quantity at room temperature, and a subsequent annealing, the same scan, reported in Fig.1.b, presents four peaks; in fact these peaks correspond to two couples of diffused rods from two facets, namely the Ni bare facets and the Ag-covered one. The scan allows to measure the angle orientation of the facets with respect to the (111) planes, which results 15.2° and 5.8° for the Ag-covered and the bare Ni facets respectively.

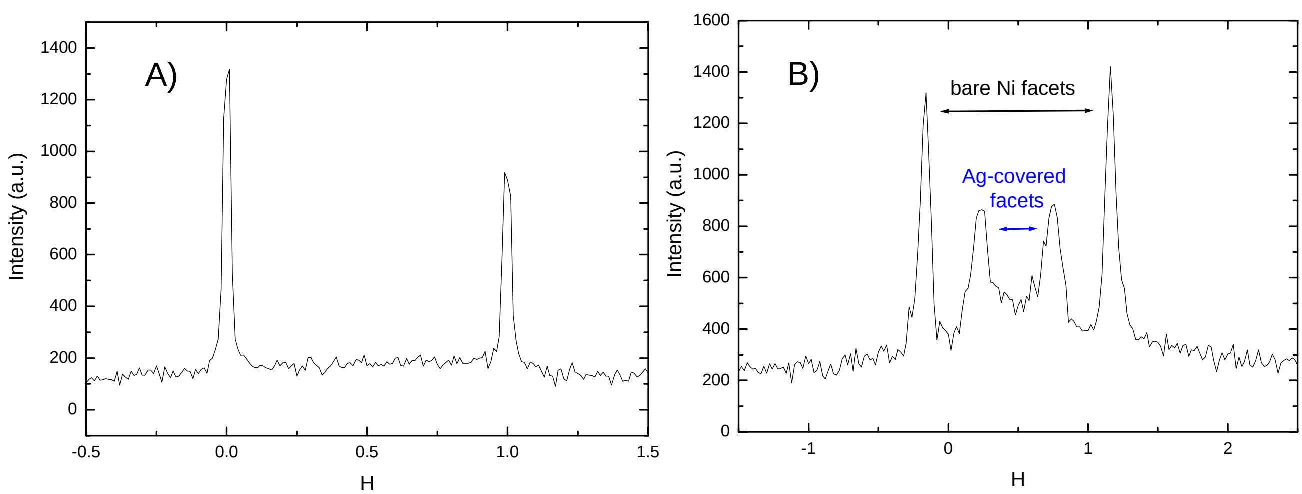

Fig.1. Reciprocal space"H- scans" in the direction normal to the surface steps. A. The clean Ni(322) surface. Two peaks are visible, due to the vicinal surface. B. Scan after Ag deposit and annealing. Four peaks are present, two for each type of facets.

We performed the same measurement for different Ag deposits. In between the sample was cleaned by Ar sputtering and annealing cycles. The result of such an exercise is reported in Fig.2. The data show a similar trend observed on the Ag/Cu case [1]. As the quantity of deposited Ag increases, the Ag-covered facets became more and more "flat", obtaining at the end a non-faceted surface covered by Ag (the angle orientation respect to the (111) planes is equal to the one measured on the starting Ni(322) surface: 11.4°. Nevertheless, some differences are visible: the bare Ni facets seem not to change their orientation in a very gentle way, but they show an abrupt transition in their orientation angles. Moreover, a "*H*-scan" performed in a region near the Bragg peak, represented in Fig.3 shows oscillations related to the period of the faceted structure. For the Ag deposit considered here, the measured period is of about 20 nm.

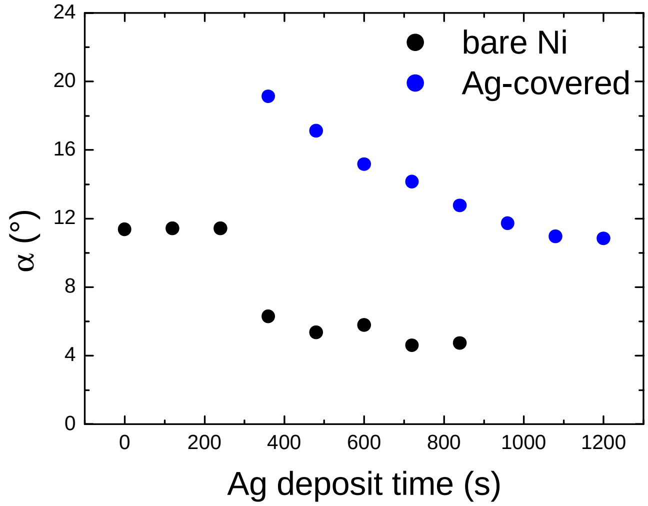

Fig.2. Evolution of the facets orientation angle with repect to Ag deposit.

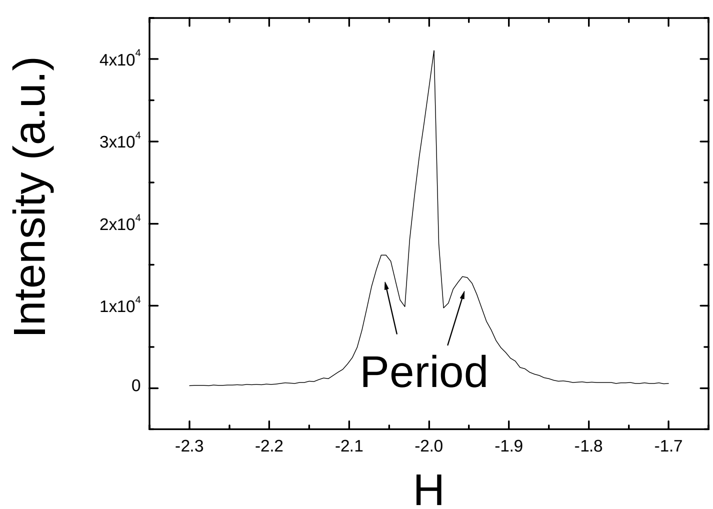

Fig.3. "H-scan" near a Bragg peak. The intensity is modulated by the surface period.

Unfortunately, some technical problems made it impossible to measure the Ag deposited quantity and the annealing temperatures (for this reason in the figures. we do not represent the angles versus the Ag coverage, but only versus the exposition time). The data are very good and they offer a qualitative description of the sample morphology evolution, but we can not conclude quantitatively. Additional experiments are needed to quantify the phenomenon.

References

[1] A. Coati, J. Creuze, and Y. Garreau, Phys. Rev. **B 72** (2005) 115424; Y. Garreau, A. Coati, A. Zobelli, and J. Creuze, Phys. Rev. Lett. **91** (2003) 116101.