ESRF	**Experiment title:** Structure and morphology of the $Ni_{81}Fe_{19}$/NiO(111) interface during its formation by Grazing Incidence X-ray Diffraction (GIXD)	**Experiment number:** SI-337
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Names and affiliations of applicants (* indicates experimentalists):

A. Barbier[1,*], G. Renaud[1,*], C. Mocuta[1,*]

[1] . CEA-Grenoble, DRFMC/SP2M/IRS, 17 Rue des Martyrs, 38054 Grenoble Cedex, France

Report:

The aim of this experiment was to provide a structural characterization of a ferromagnetic (F) $Ni_{81}Fe_{19}$ film grown on an antiferromagnetic (AF) substrate (i.e. NiO(111) single crystal). To the best of our knowledge, this is the first in situ experiment during the formation of this interface. Further ex *situ* magnetic measurements will be performed on this sample.

The substrate was a NiO(111) single crystal surface, with a small surface mosaic spread of about 0.1° (see experimental report SI-359). It was shown in our previous experiments (see. experimental report SI-265) that the NiO(111) surface exists, is stable and p(2x2) reconstructed. The reconstruction peaks gave us a good criterion to investigate the growth, because NiO(111) is not reconstructed when covered by a metallic layer. Indeed, during the deposit, the intensity of the peaks corresponding to the NiFe film increased in intensity, while the intensity of the p(2x2) NiO reconstruction peaks vanished when the surface was covered by a continuous thick film (see figure 1).

The $Ni_{81}Fe_{19}$ film was grown by co-deposition at 350°C. In order to describe the growth of the $Ni_{81}Fe_{19}$ film on NiO(111), in-plane and out-of-plane measurements were performed for increasing quantities of NiFe deposits. At each of these thicknesses, several peaks were

quantitatively measured : (a) rocking scans of the p(2x2) NiO reconstruction peak (1.5,0,0.09) and in plane scans crossing the reconstruction peaks, (b) NiFe peaks ((1.18,1.18,0) and (1.18,0,0)) and rods ((1.18,0,L) and (1.18,1.18,L)) allowing to identify the different structures of the deposit (see figure 2) and (c) substrate crystal truncation rods ((1,1,L) and (1 ,0,L)). It is shown that the growth of $Ni_{81}Fe_{19}$/NiO(111) is epitaxial and that two structures (FCC and twined-FCC in amounts of 99% and 1% respectively) exist. Annealing of the deposit at 500°C lead to a recrystallisation of the film. Only one FCC structure of the NiFe film remained (see figure 2). At the end of the deposit (about 200Å $Ni_{81}Fe_{19}$) a 2x2 superstructure of the surface of the film was observed ; in and out of plane scans were performed. Quantitative measures of the peaks for this superstructure were also taken. These data still have to be analyzed.

Before removal, the sample was covered by a protective Ag film of 18Å thickness. Then the , coupling between the NiFe film and the substrate was realized by heating the sample above the Neel temperature of NiO (250°C) in an external magnetic field.

In summary, an epitaxial $Ni_{81}Fe_{19}$ film was obtained and characterized during the deposition process. The existence of NiFe rods shows the good quality of this film. All the necessary information to propose a detailed description of the growth mode are now available. The data will allow us to correlate this interface structure with the magnetic properties of this F/AF systems.

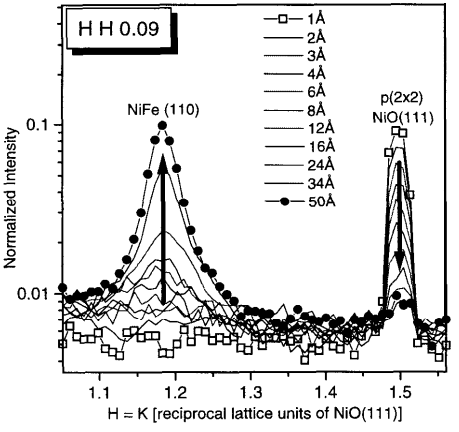

Figure 1 : In-plane scans along the (H,H,0.09) direction ; scans are taken during the deposit, at different thicknesses.

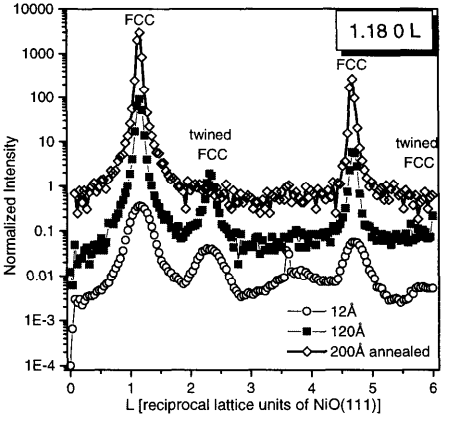

Figure 2 : Out-of-plane scans along the (1.1 8,0,L) rod of NiFe; the intensity at 200Å was shifted by a factor of 10.