EXPERIMENTAL REPORT
RAPPORT D'EXPERIENCE

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32-3-0.15
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PROJECT TITLE : *TITRE DU PROJET :*

Etude de la croissance sous champ magnétique de Co/NiO(111)
Growth of Co/NiO(111) in an external magnetic field

LIGNE : **D2AM** **IF**

INSTRUMENT :	PETITS ANGLES	☐	EXAFS	☐
	7 CERCLES	☐	G M	☐
	BIO-CRISTALLOGRAPHIE	☐	S U V	☒

NUMBER OF RUNS USED **18**
NOMBRE DE SESSIONS EFFECTUEES :

STARTING DATE **May, 15th 1997**
DATE DE DEMARRAGE :

AUTHORS : *AUTEURS :* **A.Barbier and G.Renaud**

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In this first series of experiments we have investigated the growth and the in-situ magnetisation of Co on unreconstructed NiO(111) surfaces by Grazing Incidence X-ray Scattering (GIXS). This interface is of great technological interest but was never investigated in-situ up to now. For these first experiments we aimed at demonstrating that GIXS is a good tool to investigate this insulating system. The aim was thus first to analyse the growth, epitaxial or not, on surfaces which are similar to those used when sputtered spin-valves are prepared. We wished also to demonstrate that magnetic coupling can be achieved on single crystal substrates.

The NiO(111) single crystals, with a crystalline quality compatible with GIXS, were ex-situ annealed in conditions established in previous experiments [1,2]. Two experiments, both successful, were performed. The growth was first done on an as introduced sample after a gentle outgassing at 100°C (sample #1), at room temperature, and then on an out-gassed sample (sample #2), at 300°C. In both cases, In and out of plane scans were recorded during the growth for fractional deposits, ranging from the submonolayer regime up to 200Å, allowing to follow the stacking in the Co film during its formation. Quantitative in-plane measurements were performed on both samples.

On the as-introduced sample the growth is mediocre up to several tens of Å whereas it is nicely epitaxial on sample #2 (figure 1) from the very early stages. Annealing of sample #1 leads to an

improvement of the crystalline quality of the film but some poly-crystalline Co remains. The major features are two fcc stacking (twins) in equal proportions and some residual hcp stacking (figure 2). The reciprocal space of this sample was carefully investigated in order to characterise the residual stacking faults in the film. For sample #2, 99% of the film is made of only one fcc stacking and the amount of residual hcp stacking is similar to the one of sample #1 (figure 2).

After the growth the magnetic coupling was realised for both samples. Ex-situ magnetic measurements show that both films are coupled. Sample #2 exhibits a square hysteresis loop with a very large coercive field (800oe) whereas sample #1 shows a less square loop and a smaller coercive field (500oe). The behaviour of sample #1 is typical for small, slightly disoriented magnetic domains.

In conclusion, the present experiments allowed us to show that the growth of Co on NiO(111) is strongly dependent upon the preparation conditions of the substrate, that GIXS is a very good tool to investigate this interesting system, that the growth of Co is possible up to elevated temperatures, that the magnetic coupling takes place on single crystals and that in the present case we have a strong correlation between structural and magnetic properties.

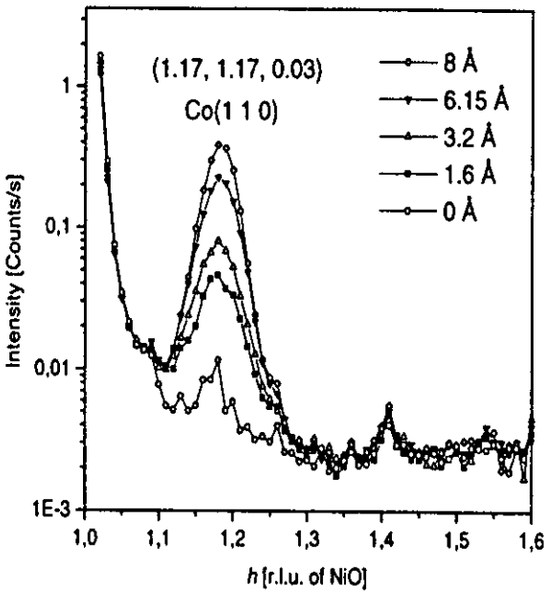

Figure 1 : In-plane scans, for sample #2, along the $(h,h,0)$ direction. Co grows epitaxially in the initial stages.

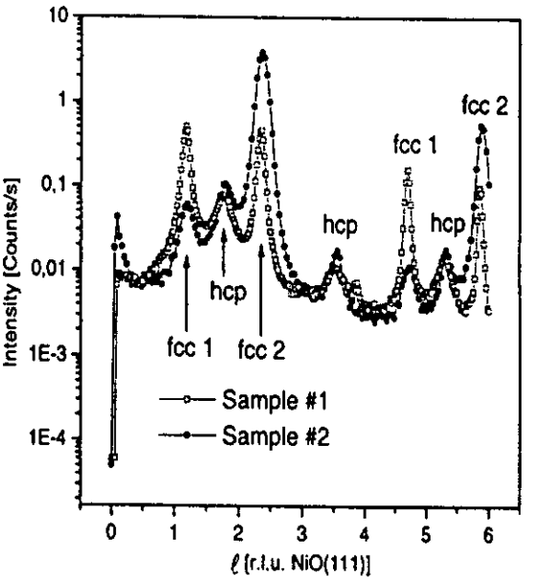

Figure 2 : Comparison of the out of plane scans (01ℓ) [in Co units] performed on sample #1 after annealing and sample #2 as-grown for 200Å Co on NiO(111).

[1] A.Barbier and G.Renaud, Surface Science Letters 1997 (In press)

[2] A.Barbier and G.Renaud, ESRF Highlights 1997 (In press)