Spin reorientation and structural relaxation upon adlayer coverage of Ni monolayers

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The easy axis of magnetization of Ni monolayers on W(110), can be switched from in-plane to out-of-plane upon coverage by one layer Fe. Subsequent coverage by Ni reverts the easy magnetization direction back to in-plane [1]. The adlayer-induced spin reorientation is shown in the magneto-optical Kerr-effect measurements of Figure 1. We performed combined surface X-ray diffraction (SXRD) and magneto-optical Kerr-effect (MOKE) measurements at beamline ID-03 at the E.S.R.F. to study the correlation between adlayer-induced spin-reorientation (SRT) and structural relaxation of the epitaxial layers. Experiments were performed on 5, 8, and 10 layer thin Ni(111) films, covered by one layer of Fe, and topped with one Ni layer. SXRD measurements along the reciprocal lattice rods of the Ni film before and after adlayer deposition indicate that changes of the diffraction peak positions, are smaller than 0.001 reciprocal lattice units. As an example we present in Figure 2 a measurement of the diffracted intensity along the crystal truncation rods of the 8 ML Ni film, and after coverage by one layer Fe. The diffracted intensity increases upon Fe-adlayer coverage, and the induced shift of peak position is smaller than 0.001 reciprocal lattice units. This corresponds to an adlayer-induced change in the interlayer spacing of at most 0.002A, which is at the limit of the experimental accuracy. The analysis of the diffraction peak shapes does not provide any evidence for structural inhomogeneities. The adlayer-induced SRT is discussed in terms of strain and interface contributions to the magnetic anisotropy.

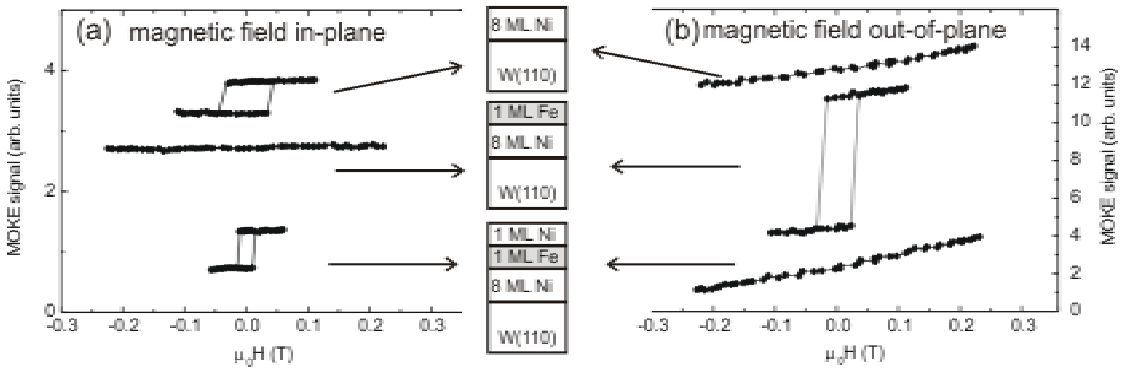

Figure 1. Magneto-optical Kerr-effect (MOKE) measurements of Ni, Fe-Ni, and Ni-Fe-Ni layers on W(110). (a) Magnetizing field in-plane along W[001], (b) out-of-plane along W[110]. The easy magnetization direction of 8 ML Ni is switched from in-plane to out-of-plane upon coverage by one Fe layer. Subsequent deposition of one Ni layer reverts the easy magnetization direction back to in-plane.

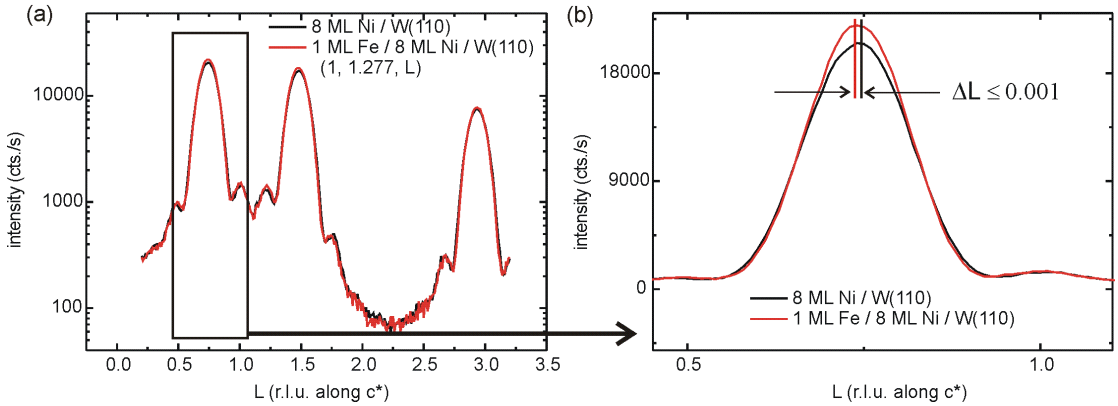

Figure 2. Scans along c* (L-scans) of the diffracted intensity of 8 ML Ni / W(110), (a) black curve, and after coverage with 1 ML Fe, (a) red curve. Same sample as in Figure 1. Deposition of Fe induces a small shift of the peak positions towards smaller L-values, which indicates a slight expansion of the Ni lattice. The effect is very small and becomes obvious only after zooming into the peak regions, as in (b). An increase of the diffracted intensity at the peak positions L=0.74, 1.47, 2.93 is observed, and the FWHM is slightly reduced. The peak positions are shifted by the Fe coverage to smaller L values by not more than 0.001 reciprocal lattice units (r.l.u.), as indicated by the arrows in (b).

[1] Sander, Enders, Schmidthals, Johnston, Arnold, Venus, Kirschner, J. Appl. Phys. **81** (1997) 4702.