ESRF	**Experiment title:** **Step induced in-plane anisotropy of FexNi1-x ultrathin films.**	**Experiment number**: HE - 759
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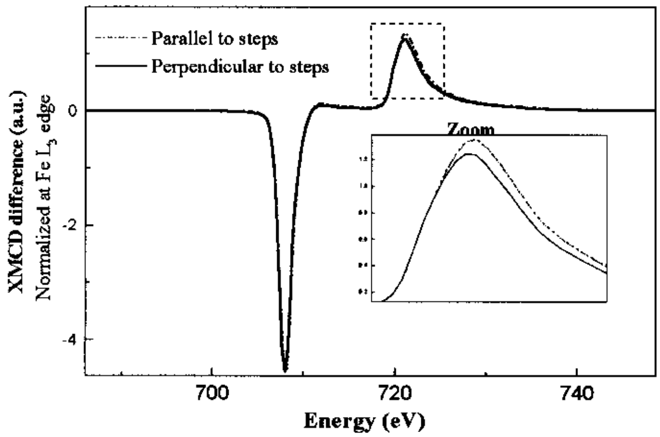
Report:

The relationship between the structure of thin magnetic films and their magnetic anisotropy has been investigated in this project. In order to separate the different contributions of the usual structural configurations to the magnetic anisotropy it was mandatory to analyse a sample with a single type of defects. In the present work we focused on the effect of steps from vicinal Cu(111) substrates on the magnetic in-plane anisotropy of ferromagnetic ultrathin Fe_xNi_{1-x} alloy films. The ultrathin films are ferromagnetic even for x=0.8 (Fe rich alloys) related to the stable fcc structure induced by the substrate over the whole thickness range analysed in this work. The aim of our experiment was to study the in-plane magnetic anisotropy induced by vicinal surfaces exhibiting atomic steps [Cu(111) single crystal with a miscut of 1.2° and 5°] and to compare them to the usual out of plane versus in-plane anisotropy. This was performed by orbital and spin magnetic moment measurements using XMCD at the $FeL_{2,3}$ edges for different azimutal angles (fig1) with respect to the step direction. Different thicknesses were investigated: Below 1.5 ML the film exhibits 1D strips along the step edges and above the 2D coalescence in-plane strain is present, leading in both cases to an in-plane magnetic anisotropy.

The work performed at the ESRF beam line ID12 B confirms the previous data and extends the thickness range towards thinner films (0.3 - 6 ML). For each of the in-situ evaporated ultrathin Fe_xNi_{1-x} films the magnetization direction could thus be continuously tuned between parallel and perpendicular to the steps at a constant incidence angle (50°). We show that the magnetic in-plane anisotropy induced by the steps is thickness dependent and the extracted orbital moments (M_L) are strongly azimutal (in-plane) dependent ($0.08 \pm 0.01\mu_B$ /at $\leq M_{L\,(3.5ML)} \leq 0.14 \pm 0.01\mu_B$ /at) if we plot M_L (μ_B/at) versus coverage (fig 2). Moreover the out-of- plane versus in plane anisotropy shows less variation in the orbital moment for the ultrathin films. We explain this result by a strongly anisotropic in-plane structures especially for 3.5ML and 1.4 ML which are respectively related to the structural in-plane strain due to the step induced in-plane lattice compression (magnetocrystalline anisotropy) and to the 1D percolation of the $Fe_{65}Ni_{35}$ stripes (shape anisotropy) That strong in-plane anisotropy (M_L) in the case of the 1D strips (1.4ML) is unexpected. The 2D coalescence of the stripes indeed (at 2.1 ML) gives rise to a strong reduced in-plane anisotropy related to structural disorder. Below 1.4 ML the spin moment of $2.48\pm 0.02\mu_B$ /at related to hight spin state is reached as compared to 3.5 ML where we measure $M_S = 2.10\pm 0.02\mu_B$ /at. This corresponds to the calculated 2D-3D transition (E. Smirnova et al. PRB 59 (1999)14417). The effective spin moments show reduced dependence with the azimuth related to the small dipolar moment T_Z for iron. Compared to Kerr measurements and to the recorded hysteresis loops - $FeL_{2,3}$ edges- (mostly spin sensitive) the azimuth dependence of the orbital moment gives a new insight to the in-plane anisotropy for magnetic ultrathin films.



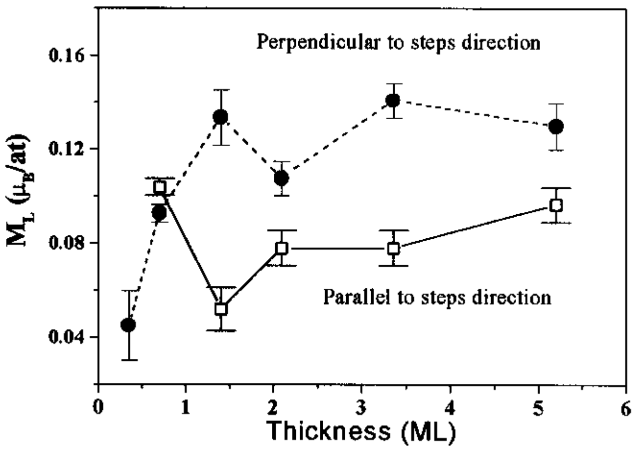


Fig 1 : XMCD differences for 3.5 ML taken at grasing incidence (50°) for 2 different azimuts (0° and 90°).
Fig 2 :Thickness dependence of the orbital magnetic moment at 0° and 90° with respect to the step direction.