| ROBL-CRG | **Experiment title:**<br>**Influence of interface structure on GMR and magnetic behaviour of Fe/Cr multilayers** | **Experiment number**:<br>**20_02_059** |
|---|---|---|
| **Beamline**:<br>BM 20 | **Date of experiment**:<br>from: 04.06.02 to: 08.06.02 and<br>from: 29.08.02 to: 01.09.02 | **Date of report**:<br>13.11.2002 |
| **Shifts:**<br>12 + 9 | **Local contact(s):**<br>Dr. Norbert Schell | *Received at ROBL:*<br>*14.11.02* |

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**Report:**

The ***interface structure of Fe/Cr multilayers*** (MLs) was studied by x-ray reflectometry (XRR) and diffuse scattering using the contrast enhancement between Fe and Cr for measurements at energies in vicinity of the K-edges of these elements. The Fe/Cr MLs, UU9_3, UU9_1 and UU9_4, having the double layer structure ***8 x [$^{57}$Fe(2 nm)/Cr(1 nm)]***, were prepared by MBE on sapphire with a Cr buffer layer (7 nm) at different substrate temperatures of 60°C, 140°C and 240°C, respectively.

The data were received in the first run at energies ***below*** (5.95 keV) and ***above*** (6.05 keV) the ***Cr K-edge*** and in the second run ***below*** (7.10 keV) and ***above*** (7.15 keV) the ***Fe K-edge***. Besides the measurements of the specular scattering also the diffuse scattering was studied by rocking and offset scans. Fig. 1 shows the plotted intensity of such scans taken at 7.10 keV.

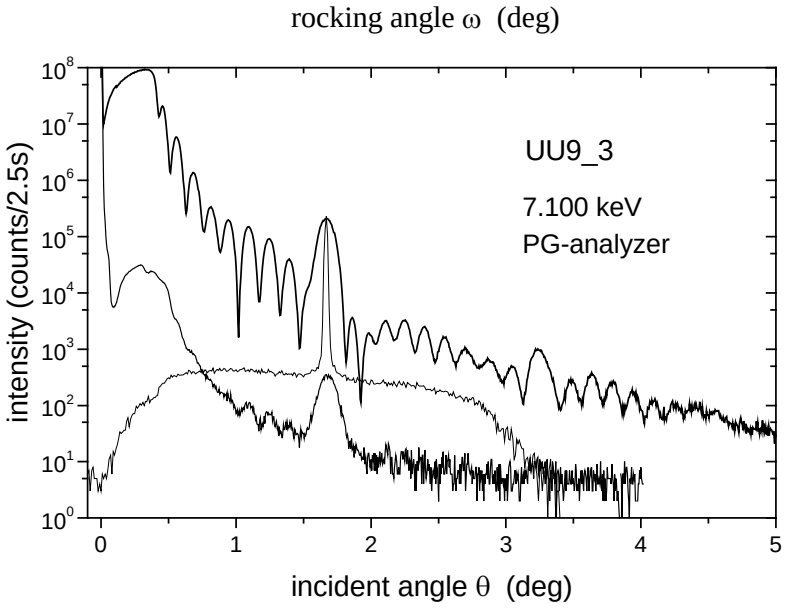


**Fig. 1:** Specular, longitudinal and transverse scans from the Fe/Cr ML UU9_3 measured below the Fe K-edge at 7.10 keV. The intensity of the transverse scan is plotted versus the rocking angle.

This study is a part of measurements on a series of this type of MLs. The MLs were grown on (1 0 -1 2) $Al_2O_3$ substrates, covered by 7 nm–Cr buffer layer, at different substrate temperatures in the range 20–480°C. Preceding investigations [1] have shown that the interface rms-roughness in these Fe/Cr-MLs strongly depends on the substrate temperature.

At present the evaluation of the measurements is not completed. Simulations using the REFS code (Bede Scientific software package) [2] are done only for the sample UU9_1. However, ***first results*** concerning the specular reflectivity have shown:

- The interface ***rms-roughness***, $\sigma_{\mathrm{rms}}$, of Fe-on-Cr ($\sigma^{Cr}_{\mathrm{rms}}$) and Cr-on-Fe ($\sigma^{Fe}_{\mathrm{rms}}$) are significantly different. The ***interface width*** $\sigma^{Cr}_{\mathrm{rms}}$ is smaller compared to interface width $\sigma^{Fe}_{\mathrm{ms}}$.

From the distribution of the diffuse scattering of this ML follows :

- The part of the vertically ***correlated interface rms-roughness***, $C_v$ does not exceed an amount of $C_v \approx (30 \pm 15)\%$.
- The MBE-grown Fe/Cr MLs of this type have an interface morphology with a short ***lateral roughness correlation length*** $\xi \approx 8 \pm 3$ nm.
- The ***Hurst parameter***, $h$, indicates with values of $h \approx 0.35 \pm 0.5$ a relatively high jaggedness of the interfaces. Based on the model of a self-affine interface morphology [3], this gives a ***fractal dimension*** $D=3-h$ of appr. 2.65.

## References

[1] V.V. Ustinov *et al*., J. of Magnetism and Magnetic Materials **240** (2002) 511
[2] B.K. Tanner *et al*., Surface Invest. **12** (1997) 259
[3] S.K. Sinha *et al*., Phys. Rev. B **38** (1988) 2297