Options for Polarized Time-of-flight Neutron Reflectometry at AMOR

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Polarized time-of-flight neutron reflectometry is a powerful tool to investigate magnetic structure and behaviour in magnetic thin films. Using remanent supermirrors the neutron reflectometer AMOR now offers the option to perform full polarization analysis of magnetic thin films with an incident polarisation up to 97 % in time of flight mode. Specular as well as off-specular reflectivities can be recorded in this mode. At the sample position external magnetic fields of up to 1 T can be applied.

To investigate magnetic structure in thin magnetic films by neutron reflectometry investigations with polarized neutrons are a powerful tool. For this kind of studies the reflectometer AMOR has been equipped with remanent supermirrors of FeCoV:TiN type for polarization of the incoming neutron beam and for analysing the reflected polarized beam [1]. The current performance of this set-up gives a polarization of the incoming white neutron beam for the wavelength range of 2-9 Å of 85-97 % (Fig. 1).

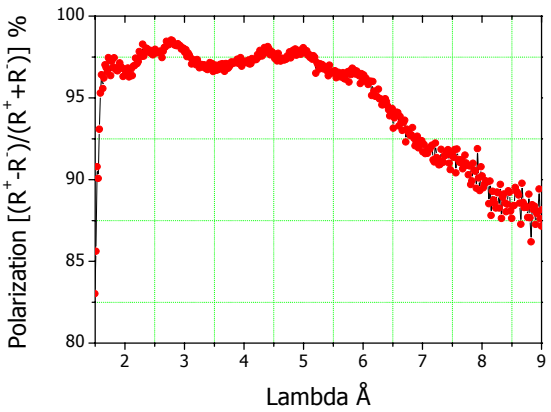

Figure 1: Polarization of incoming white neutron beam in the wavelength range of 2-9 Å.

This polarization allows full polarization analysis in all accessible spin states (R^{++}, R^{+-}, R^{-+}, R^{--}) in time-of-flight mode. High magnetic saturation fields can be applied at the sample position by installation of a 1.8 T electromagnet. Sample sizes of up to 10x5 cm^2 can be placed between the poles of the electromagnet for horizontal magnetic fields of up to 1 T at room temperature during the measurements. In addition a 2 T cryomagnet to investigate samples not only at high magnetic fields but also at low temperatures (down to 1.3 K) can be used at the reflectometer. Here the sample size is restricted to an area of 18x18 mm^2. Specular as well as off-specular reflectivities off all accessible spin states can be recorded at the instrument. As an example Fig.2 shows the reflectivities measured at saturation and remanence in a Fe/Cr multilayer and Fig.3 displays the spin up (++) off-specular reflectivity of a single Co-layer.

The current options for polarized time-of-flight neutron reflectometry at AMOR will be further improved by exchange of the current reflecting supermirror for the analysis of the reflected polarised beam by a remanent transmission supermirror (FeCoV type) in the future. This will allow collection of both spin states at different position of the 2D detector system available at AMOR at the same time, reducing measurement times by a factor of 2.

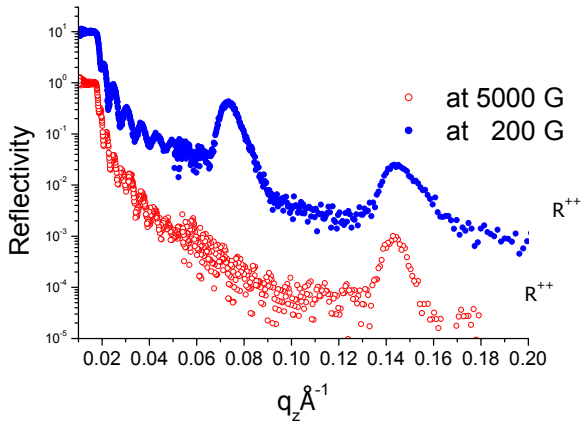

Figure 2: Polarized neutron reflectivity of a Fe/Cr multi-layer at saturation field of 5000 G and remanence field of 200 G. At remanence the peak due to the AF coupling is clearly visible at the double periodicity at q_z=0.073 $Å^{-1}$.

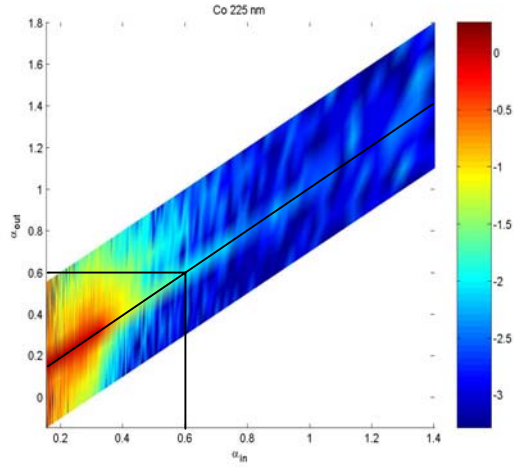

Figure 3: Off-specular polarized neutron reflectivity of a 225 nm thick Co film. (Sample by F. Radu, RUB, Bochum).

[1] D. Clemens, M. Gupta, J. Stahn, M. Koennecke, R. Steitz, T. Gutberlet, PSI Scientific Report, Vol III, 62 (2003).

Instruments: AMOR, TOPSI
Work fully performed at SINQ