Influence of Intermediate Layers and the Shape Function to the Interface Roughness and Magnetic Properties of Multilayers

J. Padiyath[1], P. Allenspach[1], J. Stahn[1], M. Horisberger[1], P. Böni[2]
[1] Laboratory for Neutron Scattering, ETHZ & PSI, CH-5232 Villigen PSI, Switzerland
[2] Physics Department E21, TUM, James-Framk-str., DE-85748, Garching, Germany

We sputtered multilayer monochromators with a quasi-sinusoidal scattering length density profile to reduce the higher order contributions making a filter obsolete. This was already achieved for Ni/Ti monochromators by substituting 22 layers of individual thicknesses per period for the conventional 2 layers of equal thickness. To take this idea one step further we produced a polarizing monochromator by replacing Ni with the ferromagnetic FeCoV.

We have investigated the scattering length density profile of FeCoV/Ti multilayers with neutron reflectivity. The edge in the scattering length density profile of conventional polarising multilayer is responsible for the higher order contributions. The goal is to have a quasi-sinusoidal scattering length density profile. Our approach is to substitute 22 layers of individual thicknesses for the conventional 2 layers of equal thickness per period. Some of the layers are very thin, leading to a difference for the coercive field of the multilayer. Indeed with our approach, the higher orders of non-polarising Ni/Ti multilayers have been successfully reduced in earlier experiments [1, 2]. Additionally the off-specular intensity has been reduced.
We have taken this approach one step further and replaced the Ni with the ferromagnetic FeCoV.

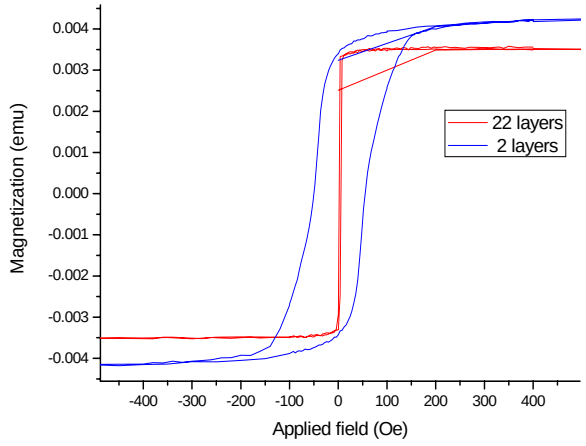

Figure 1: In-plane magnetization experiments of two multilayers with 2 and 22 layers per period.

Fig. 1 shows the magnetization experiments of multilayers with 2 and 22 layers per period. As shown the saturation field is below 250 Oe in both cases. The thickness of the layers does influence the magnetic properties of the multilayer. This behaviour is not investigated so far. We used in the neutron reflectivity measurements an applied field of 250 Oe at the sample position.
Fig. 2 shows preliminary polarized reflectivity measurements on AMOR at SINQ performed on the sample with 22 layers of different thicknesses per period. The peak in the green curve is caused by the polarizer, which is not perfect. No off-specular experiments have been performed with these multilayers yet.

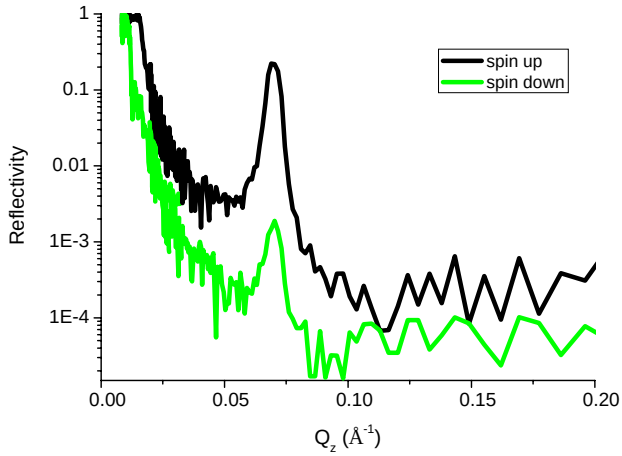

Figure 2: Polarized neutron reflectivity experiments on AMOR. The peak in the green curve in caused by a non-perfect polarizer.

Our approach with 22 sublayers per period does reduce roughness and suppresses higher order contribution in the case of Ni/Ti multilayer monochromators. By substituting Ni with the ferromagnetic FeCoV, a polarising multilayer monochromator is achieved. It follows that the interdiffusion of the materials is probably not enhanced, since this should lead to magnetic dead layers.

Financial support by the Swiss National Science Foundation is gratefully acknowledged (200021-101567).

[1] J. Padiyath et al., Physica B in print
[2] P. Böni et al., Physica B **276-278**, 142 (2000) and ref. therein

Work partially performed at SINQ
Proposal number: I/04 S-79
Instruments: AMOR