EUROPEAN **S**YNCHROTRON **R**ADIATION **F**ACILITY
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Experiment Report Form

	Experiment title: ***X-Ray Magnetic Scattering on prototype Ni/EuS multilayers for spintronics at room temperature: magnetic moment profile of Eu and Ni***	**Experiment number**: HC-2957
Beamline: ID 12	**Date of experiment**: from: 03.05.17 to: 09.05.17	**Date of report**: 18.06.2018
Shifts: 15	**Local contact(s)**: F. Wilhelm, A. Rogalev	*Received at ESRF:*

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Report:

The aim of this project was the investigation of magnetic moment profile of Eu and Ni, as main components of prototype Ni/EuS multilayers. The investigated sample consisted of a [Ni/Co/EuS/Co]x20+Ni on a Si(111) substrate with native oxide.

One may extract interesting and innovative results which are needed for spintronics applications at room temperature[1]. In order to succeed, the multilayers have to be as smooth as possible with minimum surface roughness. To check the quality of the multilayer sample XRR measurements were performed at beam line ID12, at ESRF, and the results are shown in Fig. 1.

Five Bragg beaks are clearly visible with an additional sixth one being just visible. In between, Kiessig fringes point to a clear and smooth interface between each layer.To investigate the magnetic moment profile of Ni and EuS, XMCD and XRMS measurements were performed. An example of the Eu L2 edge XMCD signal at 150K and room temperature is shown in Fig. 2. As expected, the XMCD intensity shows a temperature dependance and is higher for lower temperature. To varify the findings of the XRR analysis, the sample interface quality was additionally analyzed by HRTEM after the beam time. Fig. 3. shows a HRTEM

picture, indicating sharp material interfaces. In addition, the XRR pattern has been fitted by derive data from HRTEM and with the help of a commercial software GenX [2] and the information extracted from the HRTEM measurements, such as structure, exact multilayer thickness and roughness. As one may see in Fig. 3, from the 11th (starting from 1 in the top right corner) until the final repetition the coherence of multilayers is not continuous and the separation of multilayers is difficult to be distinguished. This is also verified with the XRR fitting. The XRR fitting shows that the total average thicknesses of Cobalt, EuS and Ni is 0.51nm, 1.4nm 6.7nm respectively. The final Ni capping layer is 7.24nm. The total average roughness of Cobalt is 0.31nm, for EuS 0.97nm, for Nickel 2.3 nm and for the Ni capping 2.9nm. This data are in good agreement with the programmed fabrication data. The analysis on the element-specific magnetic data is in progress. A precise analysis and details will be provided in a forthcoming publication [3].

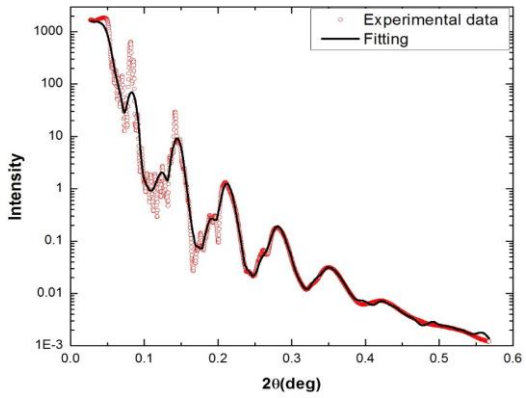

Figure 1:XRR pattern for our multilayer and the fitting are shown.

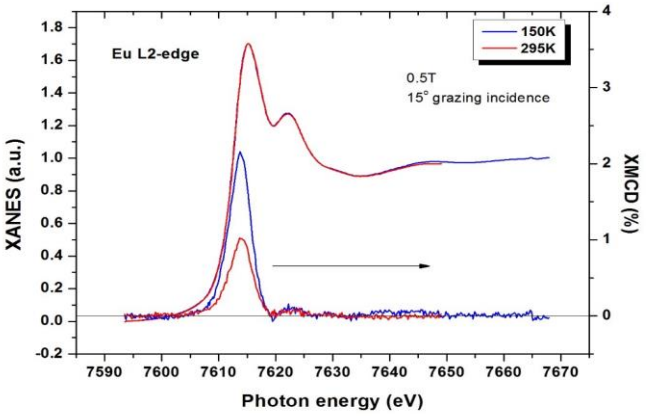

Figure 2: XMCD spectra at the Eu L_2-edge of multilayers sample.

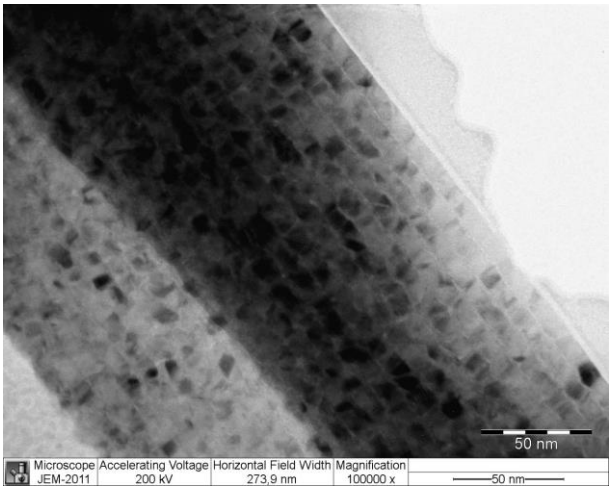

Figure 3: HRTEM picture from the multilayer. The quality and the coherence of structure can be observed. The dark and the grey spots are corresponding to Ni/Co and EuS respectively.

References

1. S.D. Pappas et al., Scien. Rep. **3**, 1333 (2013).
2. M. Björck, and G. Andersson, J. Appl. Crystallogr. 40, 1174 (2007).
3. A. Stamatelatos et al., Phys. Rev. B (to be submitted).