NUCLEAR RESONANT SCATTERING OF CIRCULARLY POLARIZED SYNCHROTRON RADIATION FOR SITE-SELECTIVE MAGNETIZATION MEASUREMENTS

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Nuclear resonant scattering of synchrotron radiation is a relatively new tool to study magnetization properties via the hyperfine interactions [1-3]. It has the advantage of being isotope-selective, which makes it extremely suitable for depth-resolved or layer-resolved magnetization measurements. With the incident synchrotron radiation being linearly polarized, the nuclear resonant scattering process is sensitive to the magnitude and the ‘absolute’ orientation of the magnetization vector. The sign of the magnetization vector, however, cannot be measured. To overcome this limitation, we introduced the use of circularly polarized x-rays in nuclear resonant scattering and demonstrated that in this case the scattering process is also sensitive to the sign of the magnetization vector [4]. Now the full magnetization information is accessible and one can record isotope-selective magnetization curves that reflect only the magnetic properties of specific parts of the sample. This approach, called nuclear resonant magnetometry, is ideally suited for the study of magnetic thin films and multilayers.

To illustrate the strength of nuclear resonant magnetometry, we applied this approach to study the interlayer coupling in Fe/Cr(100) multilayers. Despite extensive research on this system during the last two decades, several fundamental questions remain about the nature of the interlayer coupling and about the possibility to have non-collinear coupling. We prepared epitaxial Fe(50Å)/Cr(11Å)/Fe(50Å)/Cr(11Å)/Fe(50Å) quintalayers in which the central Fe-layer was enriched in the resonant isotope. We measured the magnetic response of this layer selectively using nuclear resonant magnetometry. As a result we obtained magnetization curves of the central layer which, when combined with the macroscopic data of the whole quintalayer, directly reflect the interlayer coupling. The analysis of the nuclear resonant magnetization data involves a minimum of modelling and provides very accurate quantitative values of the coupling strength and the coupling angle between the Fe layers. This example clearly shows how nuclear resonant magnetometry can supplement macroscopic magnetization measurements.

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[3] R. Röhlsberger *et al.*, Phys. Rev. **B 67** (2003) 245412.
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