Study of the in-plane magnetic structure of neutron polarizing multilayer mirrors

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Neutron polarizing supermirror is one of the most important optical devices for spin-polarization of a neutron beam. Polarizing supermirror needs to display high polarization efficiency at low external fields to meet a variety of research demands. The magnetic properties of these multilayers with a polycrystalline grain size less than the ferromagnetic exchange length can be explained by the random anisotropy model, i.e. competition between the exchange interaction between neighboring spins and the local magnetocrystalline anisotropy [1]. This study is aimed to verify whether this model is valid in our system by observing the in-plane magnetic structure in the magnetization process. Off-specular scattering (OSS) and grazing-incidence small-angle scattering (GISAS) measurements with polarized neutrons are unique and powerful techniques to observe correlations of small magnetic objects in a layered system. The polarized neutron OSS and GISAS give access to the in-plane magnetic structure because the lateral correlation length obtained by the measurements corresponds to the size of an area with a uniform orientation of the magnetization. These complementary measurements, each of them covering different length scales, together with the data analysis based on the distorted wave Born approximation, revealed lateral correlation in the fluctuating orientation of the magnetization in the layer on a sub-μm length scale [2]. The obtained in-plane magnetic structure was consistent with the random anisotropy model.

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