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Magnetic small–angle neutron scattering of two–phase bulk ferromagnets

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Small-angle neutron scattering (SANS) is a powerful method to resolve the magnetic microstructure in the bulk and on length scales between about 1 – 100 nm. We have used this technique to study Fe-based two-phase nanocrystalline alloys. In the investigated soft magnetic heterogeneous nanocomposites, the jump of the magnetization at the phase boundary between particles and matrix gives rise to a dipolar stray field, which represents a non-negligible source of spin disorder.

With the help of a micromagnetic description of the magnetic SANS cross section, it can be shown that magnetic anisotropy and magnetostatic field in the sample decisively determine the properties of the strongly magnetic field-dependent scattering, such as the asymptotic power-law behaviour, the range of spin-misalignment correlations and angular anisotropies. In particular, the 'clover-leaf'-shaped angular anisotropy, which was observed for several nanostructured magnetic materials, can be clearly attributed to jumps of the magnetization at internal interfaces. Moreover, the micromagnetic aproach allows one to extract quantitatively essential features of the spin structure from the field behaviour of the magnetic SANS, for instance, the average exchange interaction as well as the strength of magnetic anisotropy and magnetostatic fields.

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