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Resolving the complex spin structure in Fe-based soft magnetic nanocrystalline material by magnetic small-angle neutron scattering

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The present work focuses on the unique ability of magnetic small-angle neutron scattering (SANS) to quantitatively analyze the magnetic interactions, namely the exchange-stiffness constant and the strength and spatial structure of the magnetic anisotropy and magnetostatic fields in (Fe_{0.7}Ni_{0.3})₈₆B₁₄ alloy [1]. This particular compound is a promising HiB-NANOPERM-type soft magnetic nanocrystalline material, which exhibits an ultrafine-grained microstructure with an average particle size as small as 4 nm and an extremely small coercive field of ~ 4.9 μT. The neutron data analysis based on the micromagnetic SANS theory yields an exchange-stiffness constant of A_{ex} = (10 ± 1) × 10⁻¹² J/m, a value that is 2-3 times larger than those reported previously for similar alloys [2]. The large value of A_{ex} together with the small grain size and low anisotropy is believed to be responsible for the extreme magnetic softness of this alloy. Furthermore, the magnitude of the extracted anisotropy-field and longitudinal magnetization scattering functions allow us to conclude that the magnetization jumps at internal particle-matrix interfaces, and the ensuing dipolar stray fields, are the main source of the spin disorder in this material.

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References:

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[2] D. Honecker *et al.*, Phys. Rev. B **88**, 094428 (2013).

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