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Size-dependent spatial magnetization profile of Manganese-Zinc ferrite nanoparticles

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In the present work, we report the results of an unpolarized small-angle neutron scattering (SANS) study on MZFO nanoparticles with the aim to elucidate the interplay between their particle size and the magnetization profile. Here, Mn0.2Zn0.2Fe2.6O4 nanoparticles covered with a thin layer of oleic acid (capping agent) were synthesized by co-precipitation or thermal decomposition. The chemical composition of the nanoparticles was determined using X-Ray Fluorescence (XRF). The studied MZFO nanoparticle samples have average diameters ranging from 8 to 80 nm according to TEM; XRD confirms in each case their single crystallinity. By taking advantage of the SANS technique, we demonstrate that the smallest nanoparticle are homogeneously magnetized. However, with increasing particle size we observe the transition from uniform to nonuniform magnetization states. Field-dependent results for the pair-distance distribution function p(r) on a 38-nm-sized specimen reveal that the internal spin disorder can be suppressed by an increasing field. The experimental SANS data are supported by the results of micromagnetic simulations, which confirm an increasing inhomogeneity of the magnetization profile of the particle with increasing size. The results presented demonstrate the unique ability of SANS to detect even very small deviations of the magnetization state from the homogeneous one.

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