Electronic Supplementary Material

Continuous size fractionation of magnetic nanoparticles by using simulated moving bed chromatography

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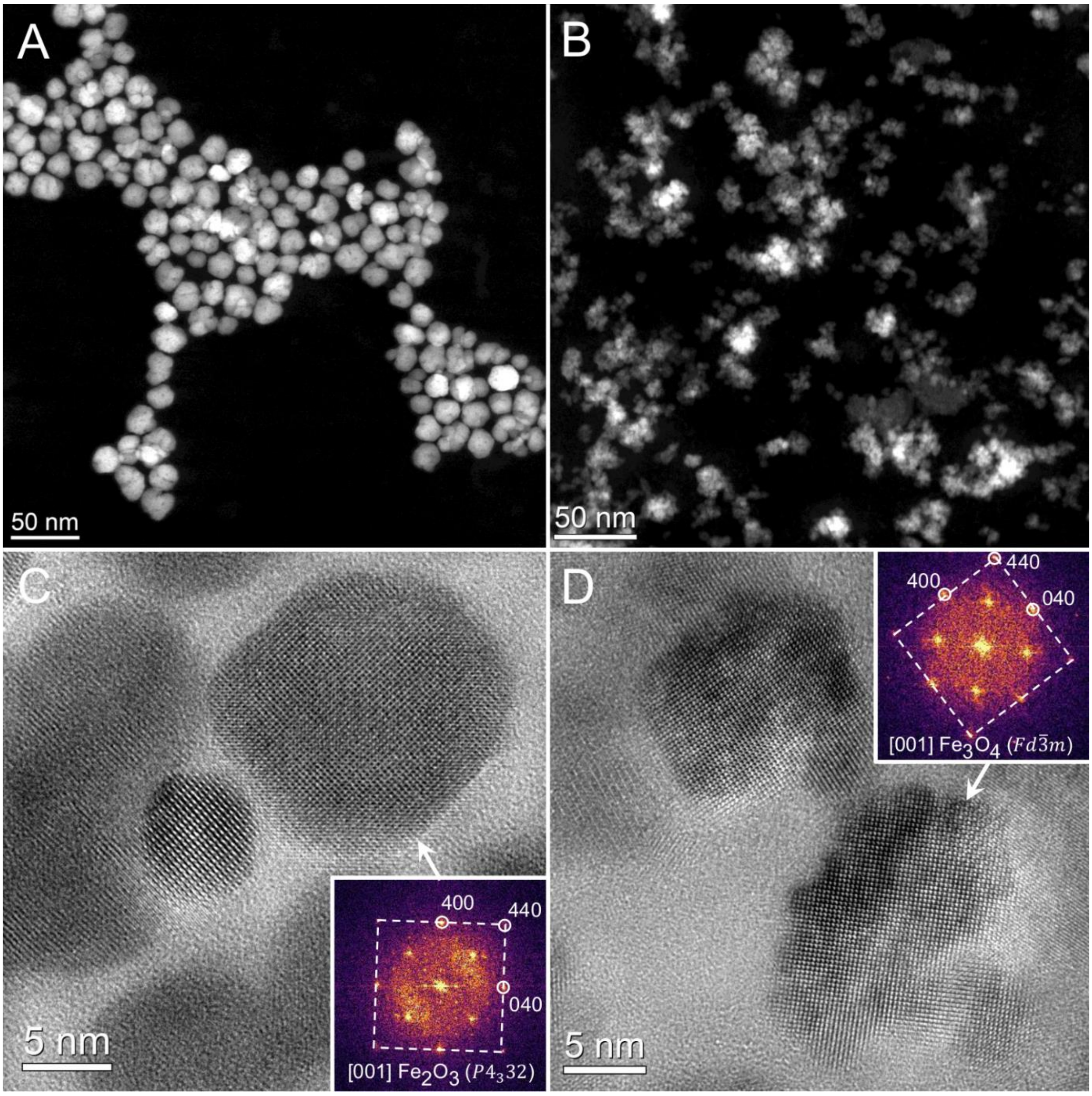

Figure S: Scanning transmission electron micrographs (panels SA + SB) and high-resolution electron micrographs (panels SC + SD) of the particle variants synomag (SA+ SC) and nanomag (SB + SD) that were used in the experiment. The fast Fourier transforms in Figures SC and SD are indexed on the basis of maghemite (space group $P4_332$) and magnetite (space group $Fd\bar{3}m$).

In Figure S, several electron micrographs of the nanoparticles used in the experiment can be observed. For the transmission electron microscope (TEM) analysis, nanoparticles suspended in water were nebulized on a standard copper TEM grid that was covered with an amorphous carbon film. The TEM experiments were carried out on a JEOL JEM 2200FS (JEOL Ltd, Tokyo Japan) transmission electron microscope, which was equipped with a field emission gun operating at 200 kV, with an ultra-high resolution objective lens (Cs = 0.5 mm), with an in-column energy filter (Ω-filter) and with a CESCOR probe aberration corrector (CEOS GmbH, Heidelberg, Germany). The transmission electron micrographs were taken both in the scanning transmission mode using a high-angle annular dark-field detector and in the standard high-resolution mode.

Due to the Z-contrast imaging with a high-angle annular dark-field detector, the iron oxide cores of the nanoparticles, which consist of iron oxide and dextran, appear bright in the micrographs in Fig. SA and SB. While the synomag nanoparticles have a nearly spherical shape (see Figure SA), the nanomag nanoparticles exhibit an agglomerate-like structure (see Fig. SB). In the high-resolution micrographs (see Figures SC and SD), it can be seen that the size of the iron oxide cores is below 20 nm for both particle types. These particle sizes agree very well with the hydrodynamic diameters determined in the DLS analysis. The single crystalline cores of such diameters represent single magnetic domains, which supports our assumption about their spontaneous magnetization. The fast Fourier transforms shown as insets in Figures SC and SD confirm the crystal structure of the nanoparticles, that is, maghemite (space group $P4_332$) and magnetite (space group $Fd\bar{3}m$) for the synomag and for the nanomag sample, respectively. Although both crystal structures possess similar lattice parameters, they can be distinguished from each other, because the lower crystallographic symmetry of maghemite produces additional diffraction spots in the fast Fourier transforms which could be seen in Fig SC, which are not visible in the corresponding picture of magnetite (see Fig SD).