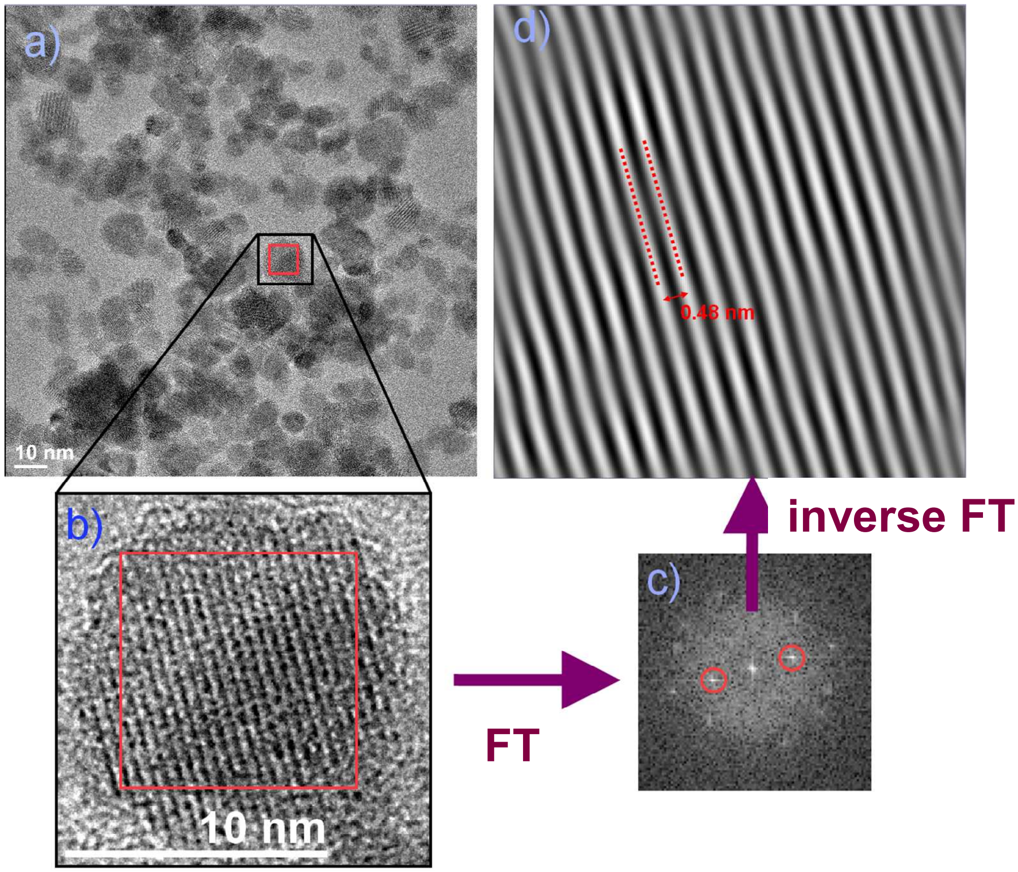
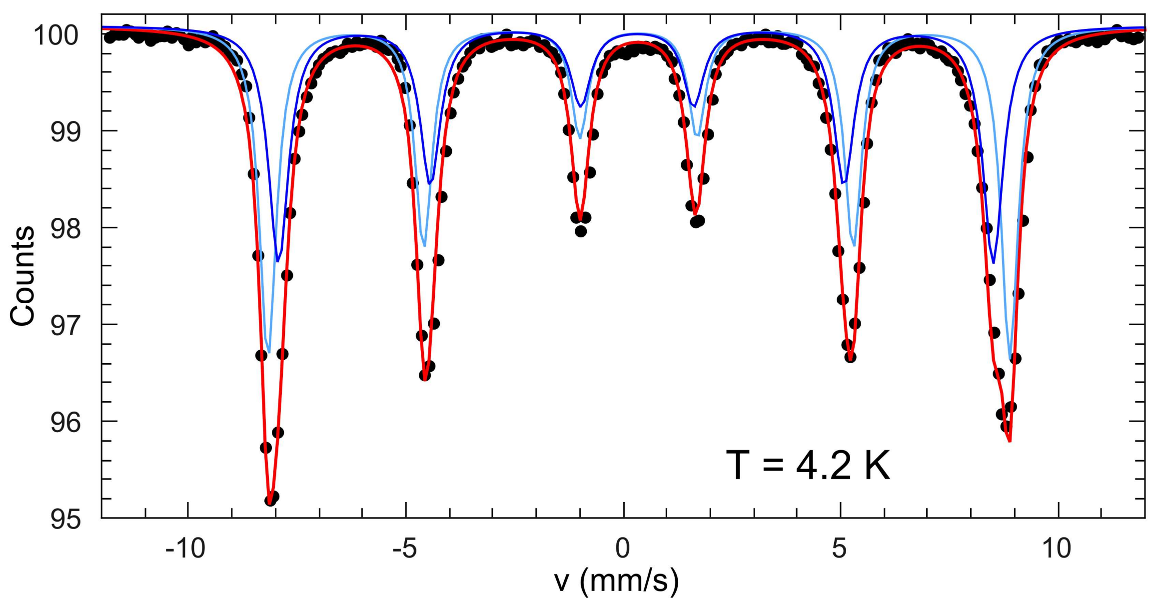
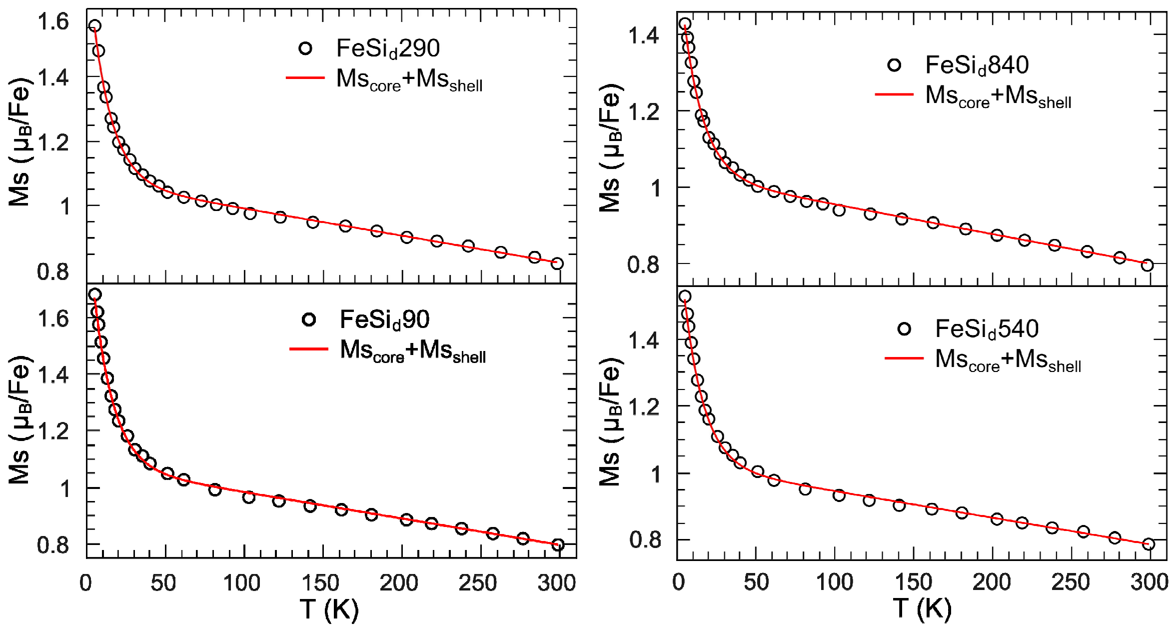
SUPPORTING INFORMATION



Crude γ-Fe_2O_3 nanoparticles (Fe90 sample) : High-resolution TEM image along the [111] zone axis of a selected particle (b) with the corresponding Fourier transform (c). Image calculation by inverse Fourier transform for the indicated spots in Fourier space.



Mössbauer absorption spectrum measured at 4.2 K for the Fe_2O_3/SiO_2 composite sample dried at 90°C (Fe/Si = 0.25). The spectrum was fitted to the sum of 2 subspectra.



Magnetization value under 5 T as a function of temperature for the Fe_2O_3/SiO_2 composite samples dried at 90°C and annealed at 290, 540 and 840°C (Fe/Si = 0.01). The solid line correspond to a fit to Eq. (3)

Description of Equation (3)

At high temperature, surface spins fluctuate along different orientations giving rise to a paramagnetic-like contribution, which is much smaller than the volume contribution. When the temperature is lowered, these spins are frozen along a radial direction, leading to a throttled structure with increased magnetization as compared to the high-temperature data. The contribution of these surface spins to saturation magnetization can be fitted to the following expression: [1,2]

$$M_{S_{shell}}(T) = M_{S_{shell}}(0).e^{-\frac{T}{T_f}}$$

where T_f is the freezing temperature of the surface spins.

In contrast, the saturation magnetization of the core part should follow a $T^{3/2}$ Bloch law.[1,3] However in nanoparticulate-based systems, as magnon energy levels are quantified due to finite size effects, the Bloch law can be simplified. Because of the energy gap between the uniform mode (E_o) and higher energy modes (E_n, n ≥ 1), the contribution of the E_o mode will be predominant. It results in a linear temperature dependence of the saturation magnetization,[4] so that the core contribution to M_s can be expressed as:

$$M_{S_{core}}(T) = M_{S_{core}}(0) + a.T$$

The sum of these two equations has been used to model the experimental M_s versus T curves for the Fe_2O_3/SiO_2 composite samples studied in the present work.

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[1] Shendruk, T. N.; Desautels, R. D.; Southern, B. W.; van Lierop, J., *Nanotechnology* **2007**, *18*, 455704
[2] Adebayo, K.; Southern, B. W., arXiv:1002.4648v2
[3] Mandal, K.; Mitra, S.; Kumar, P. A., *Europhys. Lett.* **2006**, *75*, 618.
[4] Morup, S., *Europhys. Lett.* **2007**, *77*, 27003.