Lorentz microscopy sheds light on the role of dipolar interactions in magnetic hyperthermia

M. Campanini[a]*, R. Ciprian[a], E. Bedogni[b], A. Mega[b], V. Chiesi[a], F. Casoli[a], C. de Julián Fernández[a], E. Rotunno[a], F. Rossi[a], A. Secchi[b], F. Bigi[b], G. Salviati[a], C. Magén[c], V. Grillo[a] and F. Albertini[a]

[a] Istituto Materiali per l'Elettronica ed il Magnetismo IMEM-CNR, Parco Area delle Scienze 37/A, 43124 Parma, Italy. Fax: +39 0521269206; Tel: +39 0521269250; email: marco.campanini@imem.cnr.it.
[b] Dipartimento di Chimica, Università di Parma, Parco Area delle Scienze 17/A, 43124 Parma, Italy.
[c] Instituto de Nanociencia de Aragón, Campus Río Ebro, Calle Mariano Esquillor, 50018 Zaragoza, Spain

*email: marco.campanini@imem.cnr.it

Phone: +39 0521 269212 Fax: +39 0521 269206

Supplementary Information

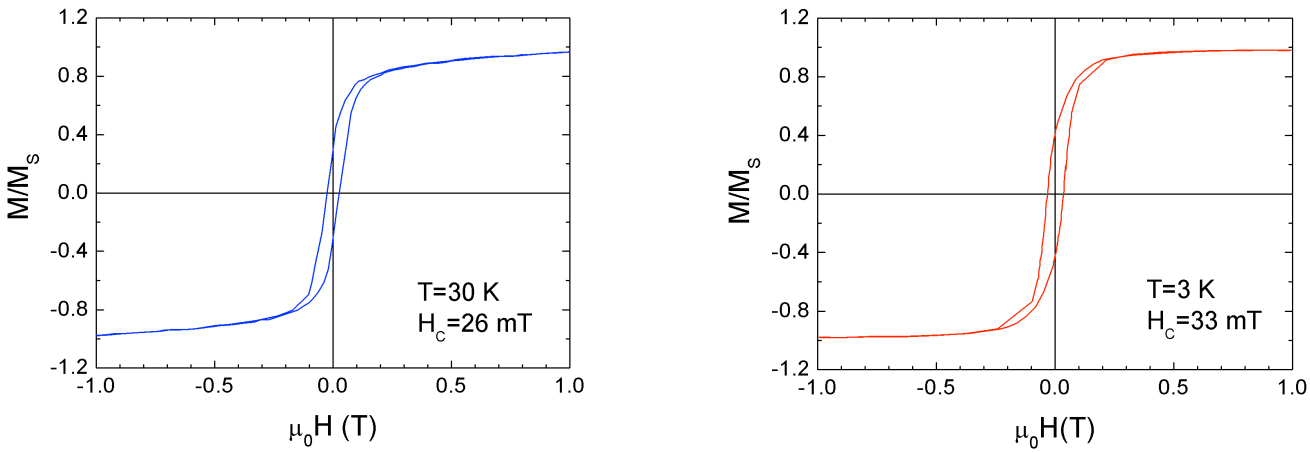

Figure SI.1

Hysteresis loops measured at low temperature (i.e., in the blocked state) on CO-NPs (left panel) and TD-NPs (right panel) samples, which do not evidence a substantial difference in magnetic anisotropy between the two samples. Coercive field values are 26 mT for CO-NPs at 30 K and 33 mT for TD-NPs at 3 K.

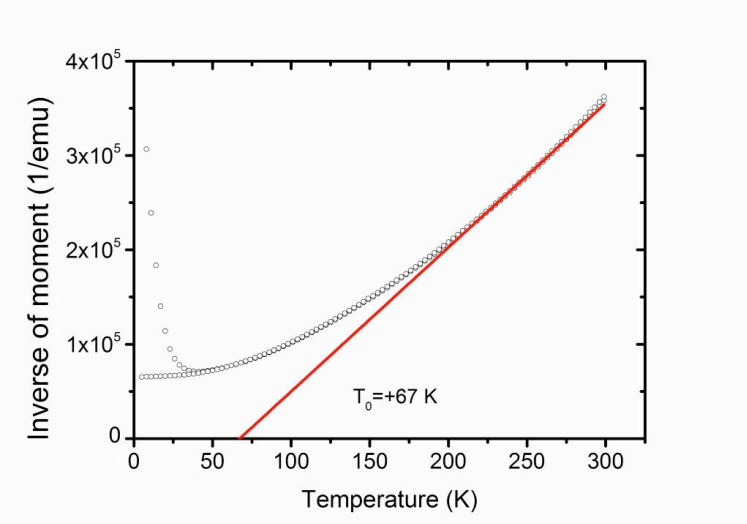

Figure SI.2

Inverse of magnetic moment as a function of temperature for TD-NPs sample, showing that inter-particle interactions in the TD-NPs sample are lower than in the CO-NPs sample, but not negligible. The ZFC and FC curves of this sample show in fact a Curie-Weiss temperature dependence $M = A(T - T_0)$ in the temperature region from 200 to 300 K, i.e., well above the blocking temperature. A T_0 value of +67 K was deduced, indicating that inter-particle interactions favour magnetic ordering.

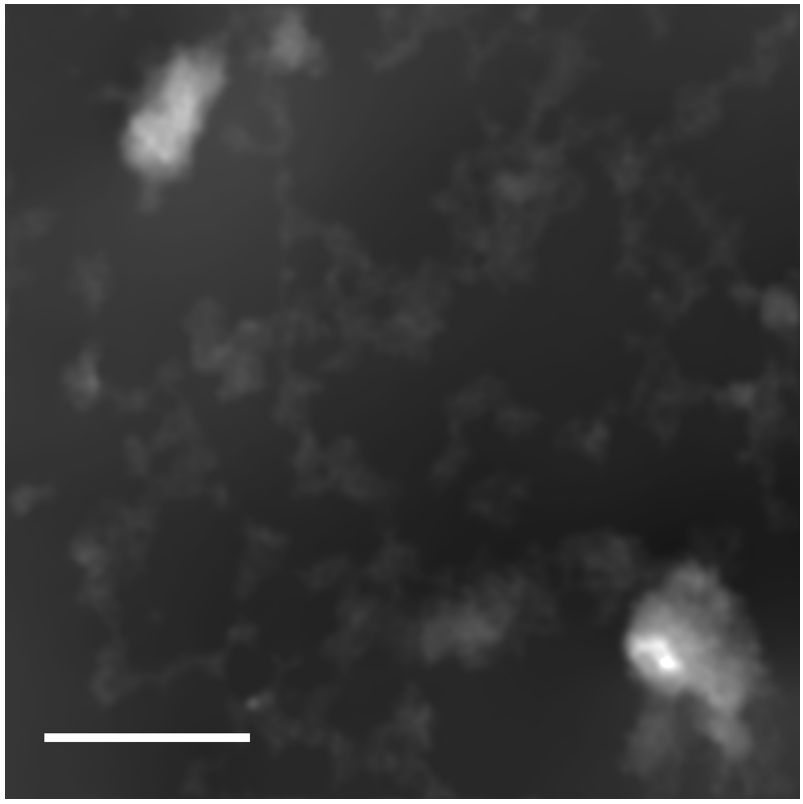

Figure SI.3

Mean inner potential (MIP) contribution as obtained by Lorentz microscopy investigation for the CO-NPs sample. The image is relative to the same area of the sample shown in Fig. 5; the image scale bar is 0.5 μm.