# *Electronic Supporting Information (ESI)*

## Size dependent dipolar interactions in iron oxide nanoparticle monolayer and multilayer Langmuir-Blodgett films

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### *Nanoparticle synthesis and purification*

Iron oxide NPs were synthesized by thermal decomposition[1] of an iron stearate complex in presence of oleic acid in a high boiling solvent.[2] 1.38 g (2.22 mmol) of Fe(stearate)$_2$ and 1.24 g (4.44 mmol) of oleic acid were added to 20 mL of the solvent. The solvents used are hexadecene (b.p. 274°C) for NP5 and octylether (b.p. 284°C) for NP10. The mixture was heated and kept at 100°C under stirring for 15 min in order to dissolve the reactants. The solution was then heated to the boiling point with a heating rate of 5°C/min without stirring and was refluxed for 120 min at this temperature under air. NP16 nanoparticles have been obtained by dissolving the reactants in eicosene (b.p. 330°C), by maintaining the solution at 250°C for 1 h, and then heating quickly the solution to reflux for 120 min.

The resultant black suspensions were cooled down to room temperature and the nanocrystals were washed 4 times by centrifugation in order to collect them and to remove the solvent and reaction byproducts. For the first washing step, ethanol is added to the particles dispersed in the synthesis solvent and the mixture is centrifuged. The precipitate is collected in 0.5 mL of chloroform and a second washing step with pure ethanol is applied. The same procedure is then applied two times with a 5:1 chloroform:ethanol mixture. In order to reduce the size dispersion, Size Selective Precipitation (SSP) was applied: the spherically-shaped NPs were suspended in hexane at a concentration of 1 mg/mL and precipitated using approximately the same volume of acetone. This suspension was centrifuged and the precipitate was redispersed in chloroform. All the centrifugation steps are conducted at 8000 rpm for 10 min. The particles were then dialyzed in THF for 24 h in a 25 kDa regenerated cellulose membrane. The nanocrystals could be easily suspended in various organic solvents (chloroform, toluene, hexane, dichloromethane …).

### *Structural characterization*

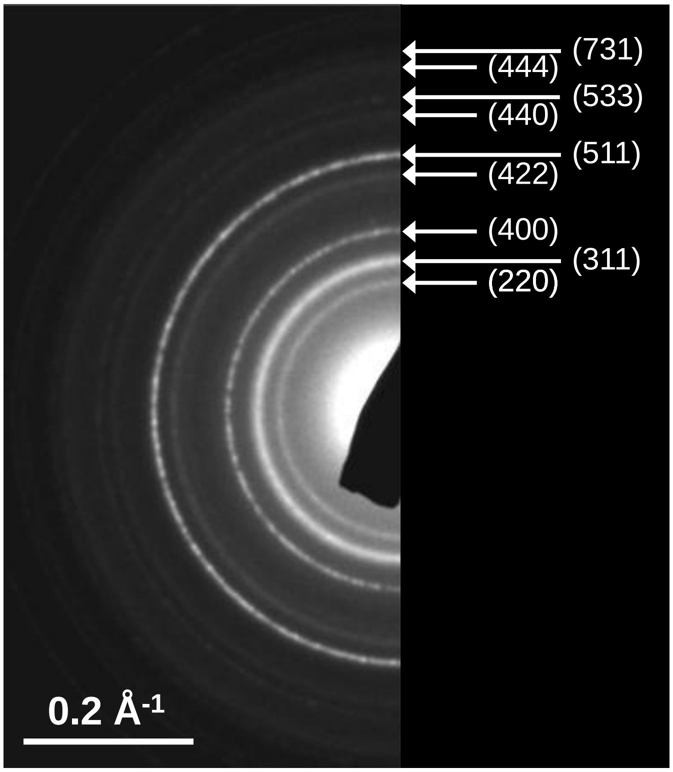

**Fig. S1** Electronic diffraction pattern of NP16, with the Miller indexes of each diffraction ring.

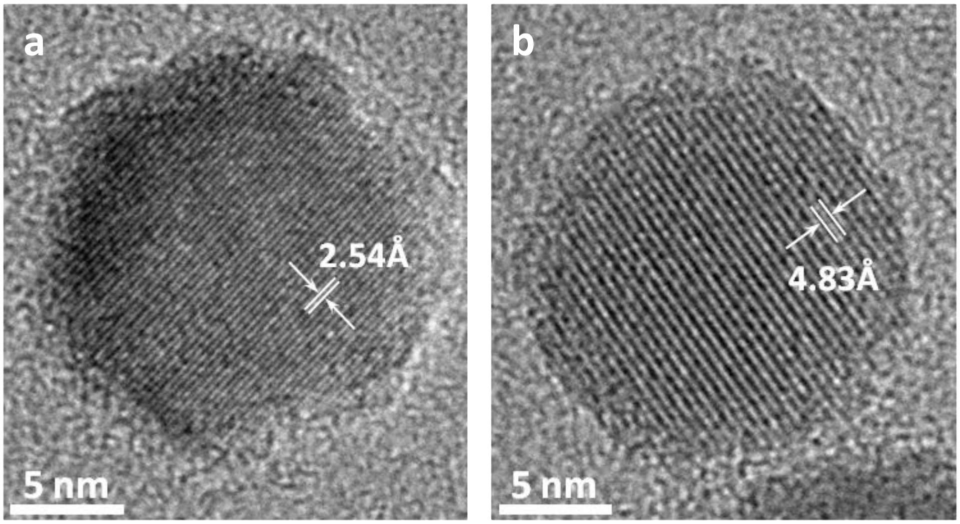

**Fig. S2** High resolution transmission electron microscopy images of two NP16 nanoparticles, showing two different lattice planes: a) (311) planes, separated by 2.54 Å, and b) (111) planes, separated by 4.83 Å.

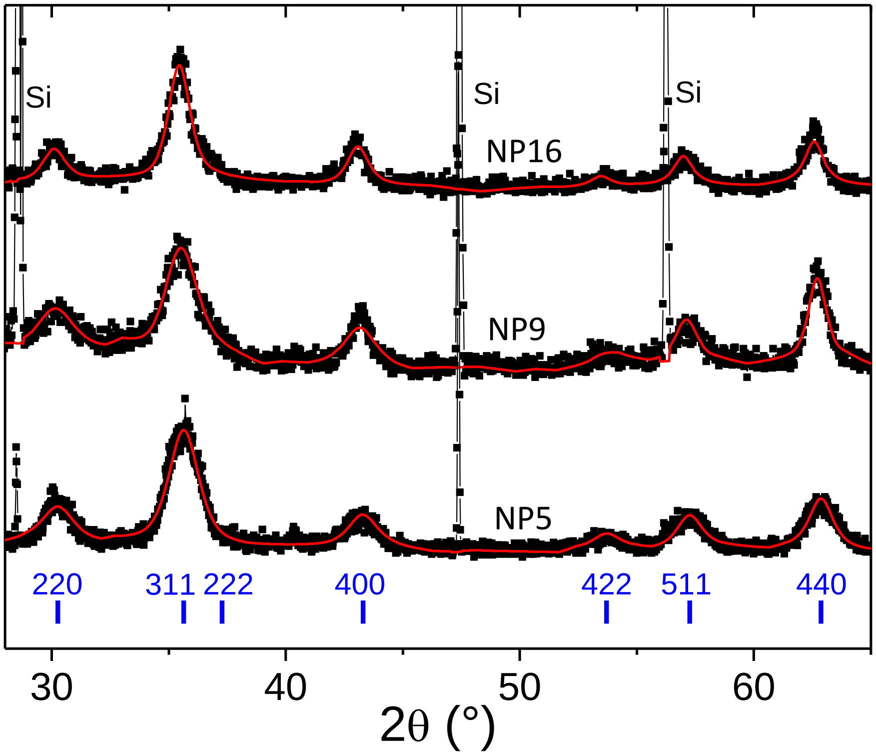

**Fig. S3** X-Ray diffraction patterns of NP5, NP9 and NP16. Black dots represent the measured intensity, the red curve is the refinement obtained using Fullprof software,[3] and blue dashes show the theoretical position of diffraction peaks for magnetite.

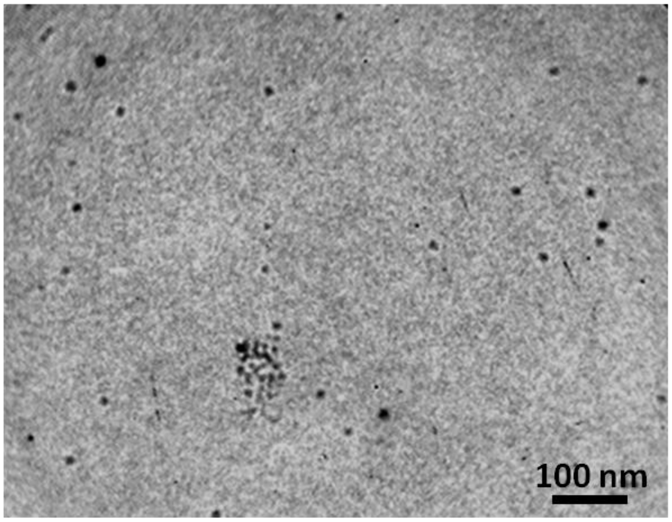

**Fig. S4** TEM pictures of a thin slice cut in the NP9 polymer dispersion, showing isolated and agglomerated nanoparticles.

## *Magnetic characterization*

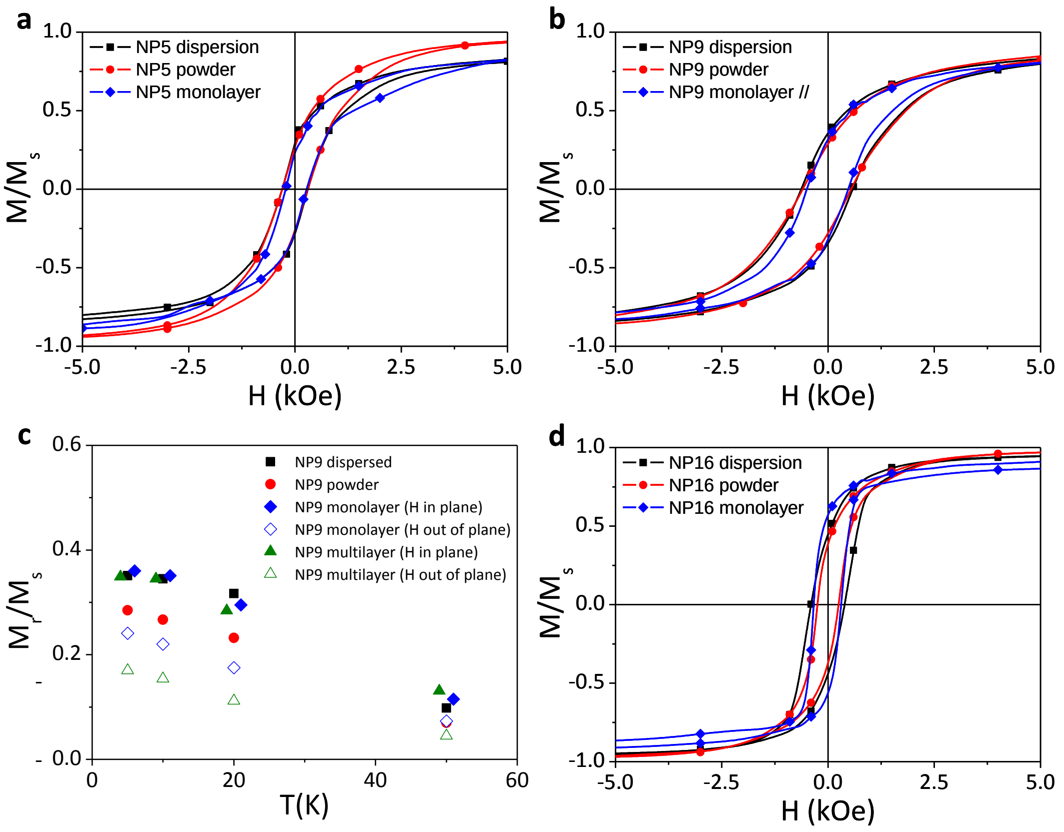

**Fig. S5** Magnetization as function of applied field at 5 K for NP5, NP9 and NP16 as function of their assembling: a) b) and d) curves compare the hysteresis loops of nanoparticles dispersed in the polymer matrix, as a powder and assembled in a monolayer with the field applied in-plane for respectively NP5, NP9 and NP16. c) $M_r/M_s$ values for NP9 as function of temperature.

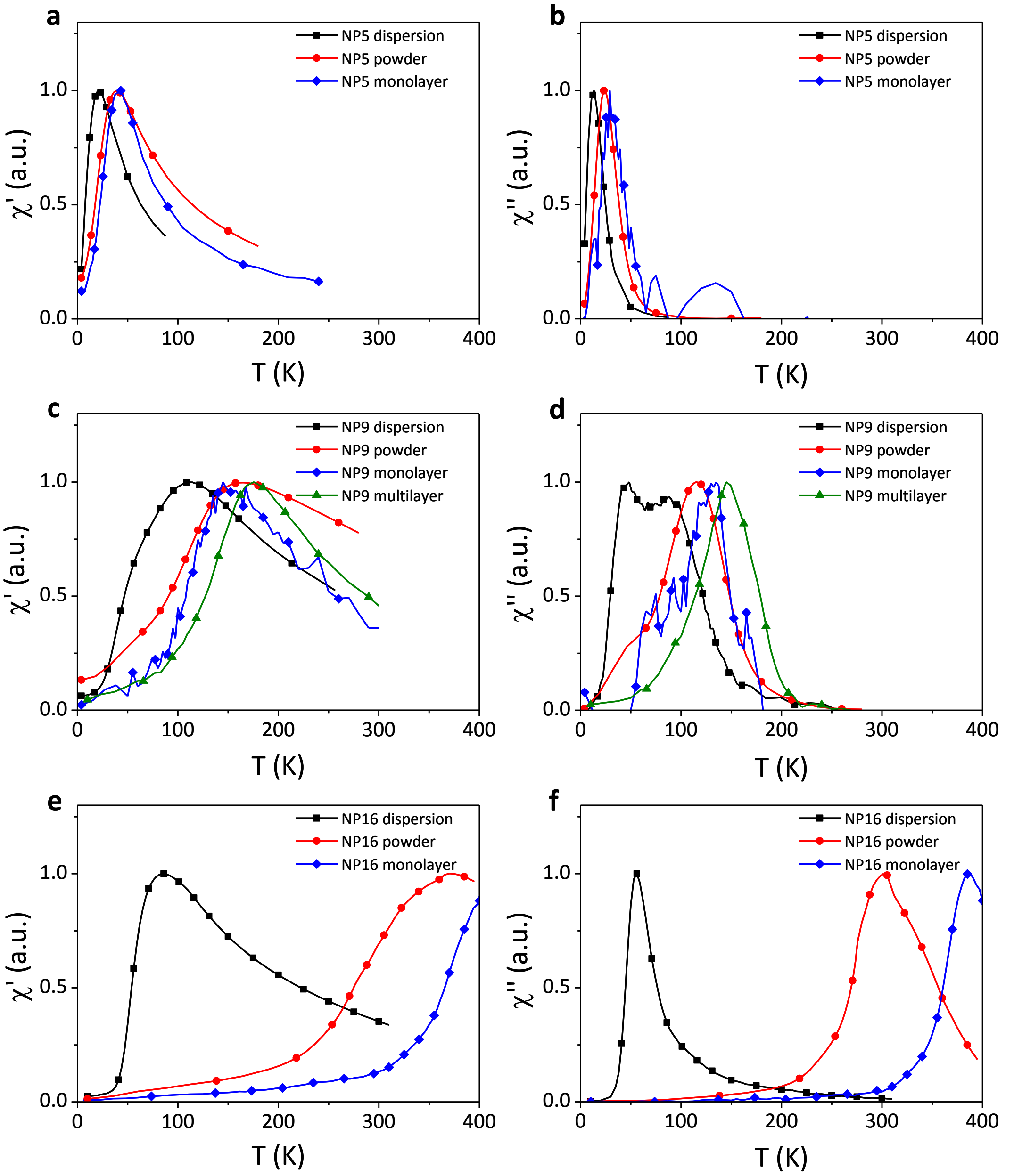

**Fig. S6** Real part χ’ (a, c and e) and imaginary part χ’’ (b, d and f) of the magnetic susceptibility for NP5 (a and b), NP9 (c and d) and NP16 (e and f) dispersed in a polymer matrix, as a powder and assembled in a monolayer with the AC field applied in-plane.

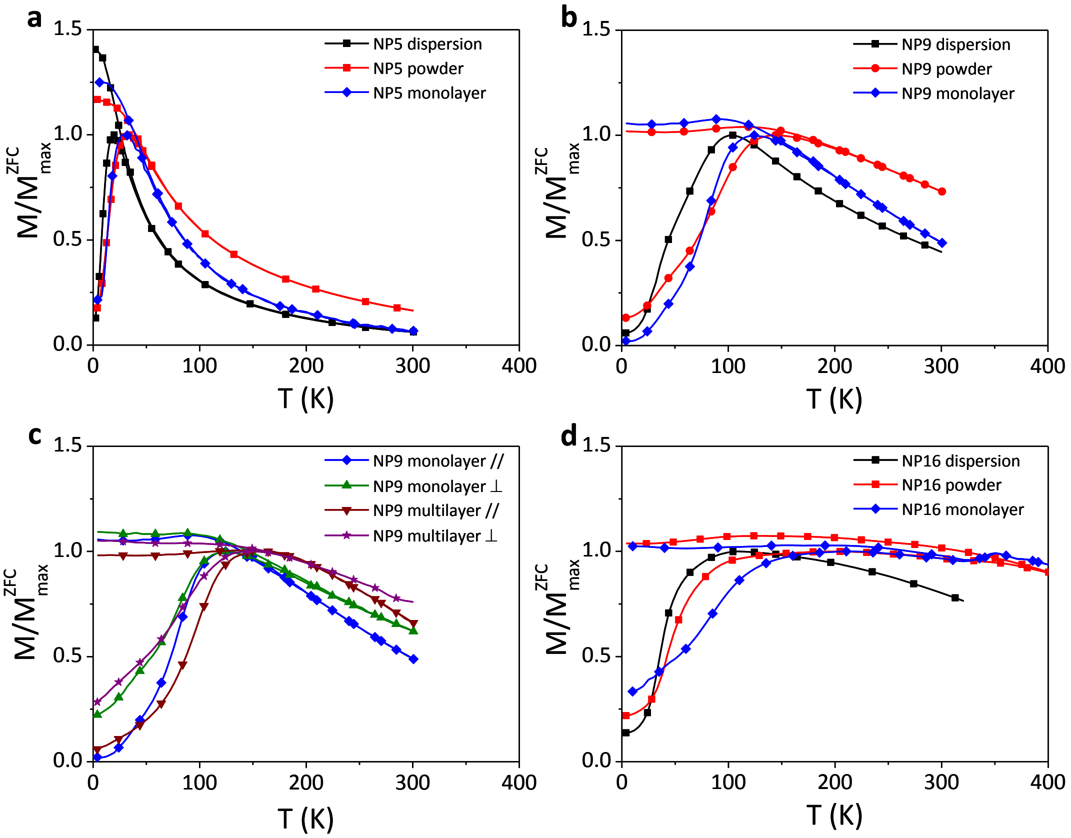

**Fig. S7** Magnetization as function of temperature (ZFC/FC curves) for NP5, NP9 and NP16 as function of their assembling: a) b) and d) curves compare the ZFC/FC curves of nanoparticles dispersed in the polymer matrix, as a powder and assembled in a monolayer with the field applied in-plane for respectively NP5, NP9 and NP16. c) compares the ZFC/FC curves of NP9 assembled in a monolayer and multilayer with the magnetic field applied in-plane (noted //) and out-of-plane (noted ⊥).

## *References*

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2. Pauly, M.; Pichon, B. P.; Albouy, P.-A.; Fleutot, S.; Leuvrey, C.; Trassin, M.; Gallani, J.-L.; Begin-Colin, S., Monolayer and multilayer assemblies of spherically and cubic-shaped iron oxide nanoparticles. *J. Mater. Chem.* **2011,** *21* (40), 16018-16027.
3. Rodríguez-Carvajal, J., Recent advances in magnetic structure determination by neutron powder diffraction. *Phys. B: Cond. Mat.* **1993,** *192* (1-2), 55-69.