Electronic Supplementary Material (ESI) for Physical Chemistry Chemical Physics

Supporting Information to Surface Decoration of Catanionic Vesicles by Superparamagnetic Iron Oxide Nanoparticles: a Model System for Triggered Release with Moderate Temperature Conditions

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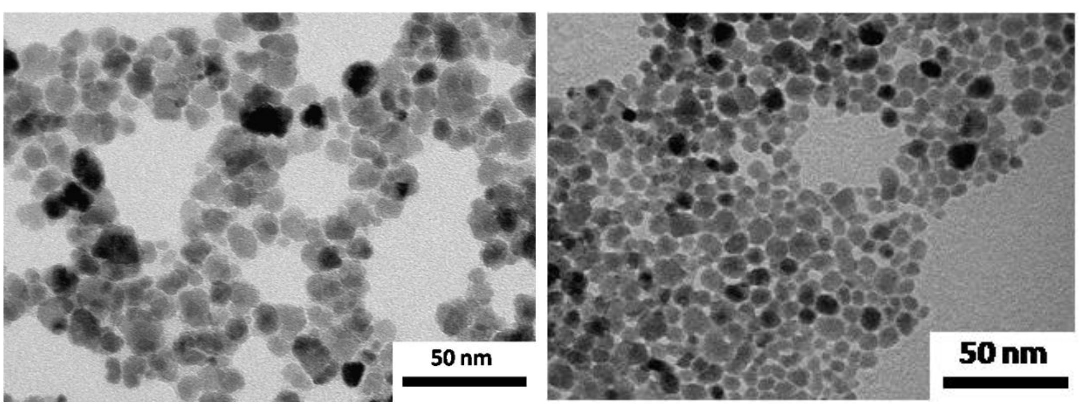

Fig. SI1. TEM micrographs of 9 nm superparamagnetic nanoparticles (left) and 7 nm superparamagnetic nanoparticles (right).

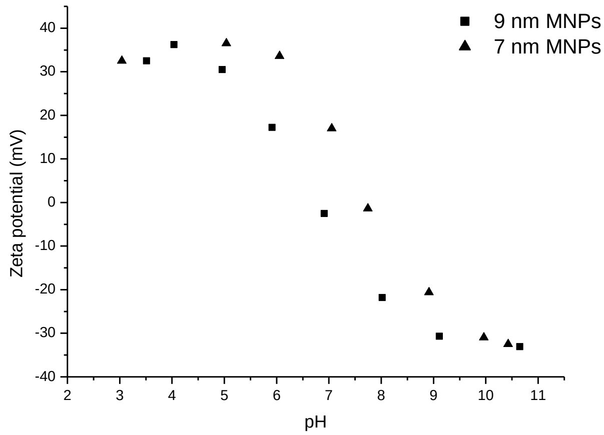

Fig. SI2. Determination of the isoelectric point of γ-Fe_2O_3 9 nm and 7 nm superparamagnetic nanoparticles.

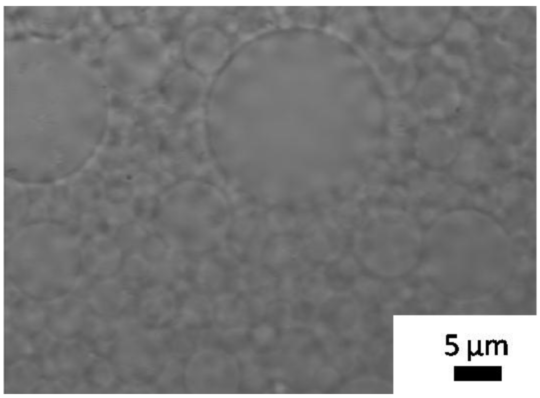

Fig. SI3. Microscopy picture in transmission mode of catanionic vesicles with their surface covered with MNPs.

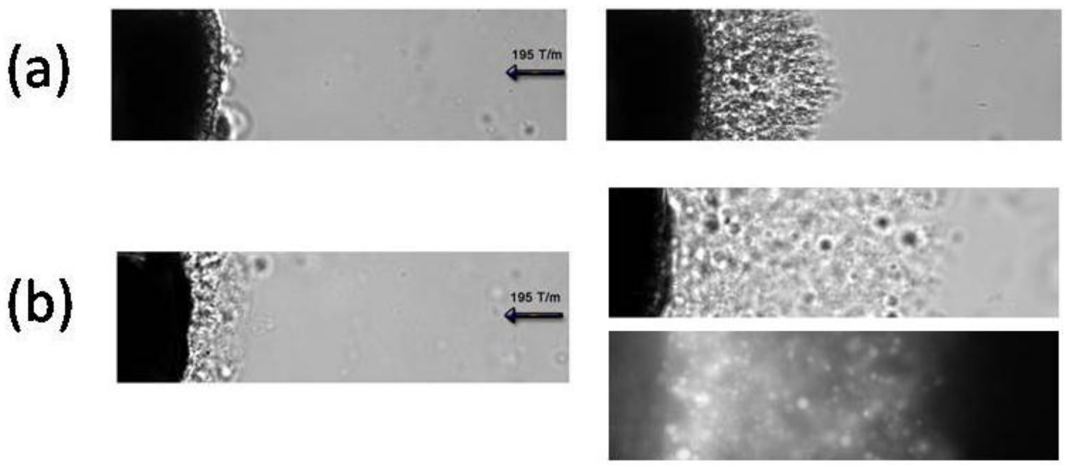

Fig. SI4. Magnetophoresis experiments under a 195 T/m magnetic field gradient on (a) decorated vesicles encapsulating 9 nm maghemite nanoparticles (optical microscopy) and (b) decorated vesicles encapsulating Rhodamine 6G (optical microscopy and fluorescence microscopy)

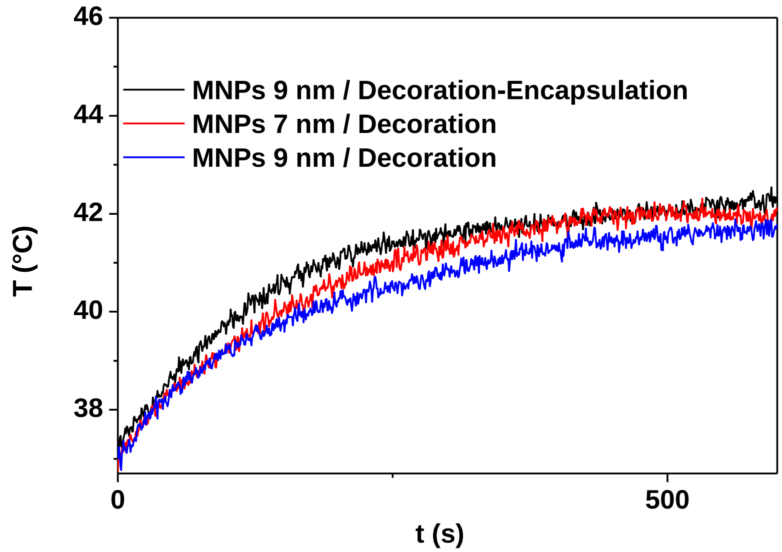

Fig. SI5. Evolution of the temperature of each sample as a function of time. For the experiment, the iron concentration was adjusted to 25mM. Temperatures were recorded every 0.7 s. Measurements were performed applying a 520 kHz oscillating magnetic field with an amplitude of 28 $kA.m^{-1}$.

Appendix SI1. Calculation of the concentration of MNPs for the surface saturation of vesicles

The concentration of surfactants C_S is given by

$$C_S = \left(\frac{m_{MA}}{M_{MA}} + \frac{m_{CTA}}{M_{CTA}}\right) \times \frac{1}{V} \qquad \text{Equation (1)}$$

where m_{MA} and m_{CTA} are the mass of myristic acid and CTACl introduced, respectively.

From this concentration, the total surface area of vesicles per volume unit of sample is given by:

$$S_{vesicles} = C_S \times N_A \times a_0 \qquad \text{Equation (2)}$$

where N_A is the Avogadro number and a_0 the surface of one surfactant in the bilayer (20 Å^2 [14])

The total surface area of MNPs per volume unit of sample is given by:

$$S_{MNPs} = C_{Fe} \times N_A \times \frac{a_{MNP}}{n_{Fe}}$$ Equation (3)

with C_{Fe} the concentration of iron, a_{MNP} the surface of a single nanoparticle and n_{Fe} the amount of iron in one nanoparticle.

n_{Fe} is given by:

$$n_{Fe} = 2 \times N_A \times \frac{d \times v_{MNP}}{M_{Fe_2O_3}}$$ Equation (4)

where d is the density of maghemite (5240 kg.m^{-3}) and v_{MNP} the volume of one nanoparticle. Substitution in Equation 3 leads to:

$$S_{MNPs} = \frac{1}{2} \times C_{Fe} \times \frac{M_{Fe_2O_3}}{d_{Fe_2O_3}} \times \frac{a_{MNP}}{v_{MNP}}$$ Equation (5)

The condition to completely cover all the vesicles with nanoparticles is that the total surface of MNPs (S_{MNPs}) is superior to the total surface of vesicles ($S_{vesicles}$). Using equations 2 and 5, this leads to:

$$C_{Fe} > C_S \times 2 \times N_A \times \frac{a_0}{a_{MNP}} \times \frac{d_{Fe_2O_3} \times v_{MNP}}{M_{Fe_2O_3}}$$ Equation (6)

Table SI 1. SAR values and ΔT of the samples.

	[Fe] mM	ΔT	SAR (W/g)
MNPs 9 nm decoration / encapsulation	25	5.6	116
MNPs 7 nm decoration	23	4.8	174
MNPs 9 nm decoration	27	4.8	154

The specific absorption rate (SAR) was calculated from the initial slope of the curve $\frac{dT}{dt}$, using Equation (7):

$$SAR = C_p \times \frac{m_{sample}}{m_{Fe}} \times \frac{dT}{dt}$$ Equation (7)

where $C_p = 4.18\, J.g^{-1}.K^{-1}$ is the heat capacity of water, m_{sample} is the mass of the sample and m_{Fe} is the mass of iron in the samples. For all samples, the SAR values found were in the range 115-180 W/g.