Supporting Information

Responsive Single-Chain/Colloid Composite Janus Nanoparticle

Liping Yang†§, Jingjing Xu†§, Jiawei Wang†§, Fengzheng Lang†§, Bing Liu†§,
Zhenzhong Yang*‡

† State Key Laboratory of Polymer Physics and Chemistry, Institute of Chemistry,
Chinese Academy of Sciences, Beijing 100190, China

‡ Institute of Polymer Science and Engineering, Department of Chemical Engineering,
Tsinghua University, Beijing 100084, China

§ University of Chinese Academy of Sciences, Beijing 100049, China
**Calculation of grafting number of the polymeric chain.**

Based on the VSM results as shown in Figures 1d and 3d, grafting number of a polymer chain onto the NP surface was estimated. The saturation magnetization values were measured 41.3 emu/g for the Fe$_3$O$_4$@Cl NP, 29.7 emu/g for the PMEO$_2$MA$_{94.9k}$-Fe$_3$O$_4$@Cl NP, 35.4 emu/g for the PMEO$_2$MA$_{44.1k}$-Fe$_3$O$_4$@Cl NP, 34.8 emu/g for the PMEO$_2$MA$_{9.3k}$@Fe$_3$O$_4$@Cl NP. The saturation magnetization values were measured 41.3 emu/g for the Fe$_3$O$_4$@Cl NP, 29.7 emu/g for the PMEO$_2$MA$_{94.9k}$-Fe$_3$O$_4$@Cl NP, 35.4 emu/g for the PMEO$_2$MA$_{44.1k}$-Fe$_3$O$_4$@Cl NP, 34.8 emu/g for the PMEO$_2$MA$_{9.3k}$@Fe$_3$O$_4$@Cl NP.

The weight ratio of polymer to the Fe$_3$O$_4$@Cl NP in one composite NP can be given as:

$$\frac{V_0 - V}{V} = kN$$  \hspace{1cm} \text{Equation S1}

$V_0$: saturation magnetization of the Fe$_3$O$_4$@Cl NP, $V$: saturation magnetization of the composite NP, $\bar{M}_n$: number average molecular weight of the grafting polymer chain, $N$: grafting number, $k$: a constant.

For the PMEO$_2$MA$_{94.9k}$-Fe$_3$O$_4$@Cl NP: $(41.3-29.7)/(29.7\times94900)=kN_1$; for the PMEO$_2$MA$_{44.1k}$-Fe$_3$O$_4$@Cl NP: $(41.3-35.4)/(35.4\times44100)=kN_2$.

The grafting number ratio was calculated as $N_1:N_2 = 1:0.92$ when the molecular weights are 94.9k and 44.1k, respectively.

Similarly, $N_1:N_3 = 1:4.9$ when the molecular weights are 94.9k and 9.3k, respectively.

**Calculation of Critical Micelle Concentration (CMC).**

Mass of one Fe$_3$O$_4$ NP can be approximately calculated:

$$m_{Fe_3O_4}=\rho V=\rho 4/3\pi r^3=5.18\times4/3\times3.14\times(5\times10^{-7})^3 = 2.71\times10^{-18} \text{ g}.$$  

Mass of 1 mole of Fe$_3$O$_4$ NP can be approximately calculated:

$$M_{Fe_3O_4}=m_{Fe_3O_4}/N_A=2.71\times10^{-18}\times6.02\times10^{23}=1.6\times10^6 \text{ g/mol}.$$  

0.024 mg/mL equivalent to: $0.024/(M_{Fe_3O_4}+\bar{M}_n)\times1000 \text{ mmol/L}=0.024/(1.6\times10^6+44100)\times1000 = 1.46\times10^{-5} \text{ mmol/L}$. 

**Figure S1.** XRD patterns of (1) the oleic acid capped Fe$_3$O$_4$ NP and (2) the Fe$_3$O$_4$@Cl NP.

**Figure S2.** FT-IR spectra of (1) the oleic acid capped Fe$_3$O$_4$ NP and (2) the Fe$_3$O$_4$@Cl NP.

**Figure S3.** (a) GPC traces of the three representative PMEO$_2$MA with varied molecular weight: (1) 94.9k, (2) 44.1k, (3) 9.3k; (b) DLS traces of the solutions in THF.
Figure S4. FT-IR spectra of (1) the Fe$_3$O$_4$@Cl NP and (2) the PMEO$_2$MA-Fe$_3$O$_4$@Cl Janus NP.

Figure S5. TEM image of the as-synthesized PMEO$_2$MA$_{94.9k}$-Fe$_3$O$_4$@Cl Janus NP without staining.

Figure S6. DLS traces of the three composite NPs after grafting PMEO$_2$MA with varied molecular weight: (1) 94.9k, (2) 44.1k, (3) 9.3k. The measurements were performed in THF.
**Figure S7.** DLS traces of the composite PMEO₂MA₉.₃k@NP in water at 24 °C (1) and 27 °C (2).

**Figure S8.** CLSM images of: (a) the droplets in the stable emulsion; (b) the emulsion droplets grown during the de-emulsification at 30 °C; (c) the bottom phase after a further treatment using a weak magnet (0.2 T).