Supporting Information

Liquid crystalline phases from polymer functionalized ferri-magnetic Fe$_3$O$_4$ nanorods

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Figure S1: $^1$H-NMR of reactive ester block copolymer P(MMA-b-PFPMA). The ratio between the PMMA block and the PFPMA block was determined to be 9.1:1 by using ref. 1.
Figure S2: $^{19}$F-NMR of reactive ester block copolymer P(MMA-b-PFPMA).
Figure S3: $^1$H-NMR of anchor block copolymer P(MMA-b-DOPA). The ratio between the PMMA block and the DOPA-block was determined to be about 10:1 by using ref. 1, however this value is uncertain due to the overlap of the signal at 3.56 ppm with the residual water signal at 3.33 ppm.
Figure S4: $^{19}$F-NMR of anchor block copolymer P(MMA-b-DOPA) before purification (signals of pentafluorophenol are visible, but no signals for the reactive ester bonded pentafluorophenol, as showed in S2). After purification, no signals are visible anymore.
Figure S5: UV-vis-spectroscopy of block copolymer P(MMA-b-DAAM) showing an absorption band around 283 nm corresponding to the absorption of dopamine.
Figure S6: IR spectra of reactive block copolymer P(MMA-b-PFPMA) (red) and after polymer analogous reaction block copolymer (PMMA-b-DOPA). The successful attachment of the dopamine anchor group can be proven due to complete disappearance of the C=O band of the ester at 1779 cm\(^{-1}\) and the appearance of the C=O band of the corresponding amide at a wavenumber of 1650 cm\(^{-1}\).

![IR spectra](image)

Figure S7: X-ray powder diffraction of precursor particles (black) and reflex position of reduced particles (blue). B: Diffraction pattern of reduced particles. Reflexes were assigned to hematite\(^3\), magnetite\(^3\) and iron (0)\(^4\).

![X-ray diffraction](image)

Figure S8: TEM images of the as prepared Fe\(_2\)O\(_3\)-particles (left) and the reduced particles (labeled Fe\(_3\)O\(_4\)) with a higher magnification image to show the cavities formed by the Kirkendall-effect on the right.

![TEM images](image)
Table S1: Size and magnetic properties of Fe$_3$O$_4$ nanorods.

<table>
<thead>
<tr>
<th>compound</th>
<th>L$_{long}$/nm</th>
<th>L$_{short}$/nm</th>
<th>ratio</th>
<th>$T_c$/K</th>
<th>$M_{sat}$/emu/g at 5 K (5 T)</th>
<th>$M_{sat}$/emu/g at 300 K (5 T)</th>
<th>Remanence/emu/g at 5 K</th>
<th>Remanence/emu/g at 300 K</th>
<th>Coercitivity/Oe at 5 K</th>
<th>Coercitivity/Oe at 300 K</th>
</tr>
</thead>
<tbody>
<tr>
<td>$\alpha$-Fe$_2$O$_3$</td>
<td>428 (27%)</td>
<td>87 (16%)</td>
<td>~4,9</td>
<td>&gt;300</td>
<td>2,0</td>
<td>0,8</td>
<td>0,09</td>
<td>0,07</td>
<td>950</td>
<td>450</td>
</tr>
<tr>
<td>Fe$_3$O$_4$</td>
<td>340 (30%)</td>
<td>77 (27%)</td>
<td>~4,4</td>
<td>&gt;300</td>
<td>53,8</td>
<td>48,8</td>
<td>12</td>
<td>8</td>
<td>150</td>
<td>150</td>
</tr>
</tbody>
</table>

Figure S9: A shows the temperature-dependent magnetic moment of the particles. $\alpha$-Fe$_2$O$_3$ precursor particles (red) exhibit a very small magnetic moment compared to the reduced particles (blue). B shows the magnetic moment against the applied field (Oe). Precursor particles (red) show weak ferromagnetic behaviour while the reduced particles are strongly magnetic but show no significant hysteresis.
Figure S10: Size distribution of short and long axis of Fe$_2$O$_3$ precursor particles (red) and reduced particles (blue).

References

4 Fe-5Al-20Ni(5to)0.1 ;COD (Crystallography Open Database); 11001087