Supporting Information for

Bio-templated Hybrid Microrobots for Enhanced Photocatalytic Water Remediation under Continuous Magnetic Propulsion

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Figure S1: SEM images of helical *Spirulina platensis* bio-template. (a) SEM image showing many overlapping, helical bio-templates. (b-d) SEM images showing a magnified view of the bio-template, clearly depicting the presence of many circular ridges and a rough morphology. Scale bars: (a) 150 µm, (b) 3 µm, (c) 10 µm and (d) 5 µm.
Figure S2: SEM images of Fe$_3$O$_4$ NP coated helical bio-templates (a) after 6 hours of coating showing a rough morphology as seen in the bare bio-template. (b-f) SEM images of bio-templates coated for 48 h showing a smooth morphology and even coating of NPs on the helical bio-template. Scale bars: (a) 3 µm, (b)-(c) 40 µm, (d) 4 µm, (e) 10 µm and (f) 1 µm.

Figure S3: (a,b) SEM images of Fe$_3$O$_4$@TiO$_2$ helical bio-templates before annealing showing a uniform coating of the templates with TiO$_2$. Scale bars: (a) 30 µm and (b) 10 µm.
Figure S4: SEM images of annealed hybrid Fe$_3$O$_4$@TiO$_2$ helical bio-templates showing (a, b) that they still retained their helical shape, even after removal of the bio-template. (c, d) SEM images showing a dramatic change in their smooth morphology post-annealing, which is replaced by a very rough surface and (e, f) SEM and TEM images showing development of hollow micro-structures post-annealing. Scale bars: (a) 5 µm, (b) 5 µm, (c) 2 µm, (d) 1 µm, (e) and (f) 5 µm.
Figure S5: (a) XRD analysis of bio-templates coated with Fe$_3$O$_4$ NPs, with TiO$_2$ and annealed and the hybrid micro-structures after annealing. (b) XRD patterns of hybrid sample and its comparison with the JCPDS patterns of Fe$_3$O$_4$ (75-0449) and anatase TiO$_2$ (73-1764).
Figure S6: EDX spectrum obtained from hybrid micro-structures after annealing clearly show the presence of peaks arising from Ti, O and Fe.
<table>
<thead>
<tr>
<th>Architecture/Composition</th>
<th>Light source</th>
<th>[Pollutant]/[photocatalyst] (g/g)</th>
<th>k-value (min⁻¹)</th>
<th>Ref</th>
</tr>
</thead>
<tbody>
<tr>
<td>TiO₂-Fe₃O₄ microhelices</td>
<td>450 W, 300 nm &lt; λ &lt; 600</td>
<td>0.01 Rhodamine B</td>
<td>0.047</td>
<td>This work</td>
</tr>
<tr>
<td>Ni/PtPd/TiO₂ coaxial nanotubes</td>
<td>450 W, λ &gt; 420 nm</td>
<td>0.006 Rhodamine B, Methyl Orange Methylene blue</td>
<td>0.0074 (TiO₂ NTs) 0.071 (TiO₂-PtPd NTs)</td>
<td>¹</td>
</tr>
<tr>
<td>BiOCl-Bi₂O₃ micropillars</td>
<td>400 W, λ &gt; 400 nm</td>
<td>0.004 Rhodamine B</td>
<td>0.009</td>
<td>²</td>
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<td>TiO₂-Fe₃O₄ particles</td>
<td>36 W, λ &lt; 400 nm</td>
<td>0.04 Phenol</td>
<td>0.025</td>
<td>³</td>
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<tr>
<td>TiO₂-Fe₃O₄ particles</td>
<td>Xenon lamp, 400 W, λ &gt; 420 nm</td>
<td>0.02 RhB</td>
<td>0.001 (P25) 0.014 (TiO₂-Fe₃O₄)</td>
<td>⁴</td>
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<tr>
<td>Ag₂WO₄-Fe₃O₄</td>
<td>300 W Xe lamp, λ &gt; 400 nm</td>
<td>Fast Green</td>
<td>0.0016 (Fe₃O₄-Ag₂WO₄)</td>
<td>⁵</td>
</tr>
<tr>
<td>Ag₃PO₄/NiFe₂O₄</td>
<td>300 W Xe lamp, λ &gt; 420 nm</td>
<td>0.04 Methyl Orange</td>
<td>0.03 (Ag₃PO₄) 0.06 (Ag₃PO₄-NiFe₂O₄)</td>
<td>⁶</td>
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<tr>
<td>Fe₃O₄/ZnO/BiOI/PANI</td>
<td>50 W LED lamp, λ &gt; 420 nm</td>
<td>- RhB</td>
<td>0.022 (Fe₃O₄/ZnO/BiOI/PANI) 0.0003 (Fe₃O₄/ZnO)</td>
<td>⁷</td>
</tr>
</tbody>
</table>

Table S1. Comparison of organic pollutant degradation performance of other magnetic photocatalysts' with our work.
Figure S7: Plot showing results obtained under 10 consecutive cleaning runs using hybrid helices and UV-visible light. From here we can observe that the hybrids displayed a good stability and reusability over multiple runs.
**Figure S8:** Magnetic hysteresis loop obtained for hybrid microhelices.

**Figure S9:** Time-lapse image obtained for a swarm of hybrid microhelices showing their precise propulsion and steering under 10 mT and 12 Hz rotating magnetic fields.
Figure S10. Plot showing results obtained under 5 consecutive cleaning runs using hybrid helices and UV-visible light, under continuous magnetic propulsion.
Figure S11: Time-lapse images obtained from COMSOL simulations showing the degradation of organic pollutant obtained under different swimming speeds over 1000 s. The color scale represents the pollutant degradation rates ($C/C_0$), where maroon color represents $C/C_0=1$ i.e. 100% organic pollutant concentration and dark blue represents complete degradation of organic pollutant.


