The critical role of light in moderating microbial stress due to mixtures of engineered nanomaterials

Supporting information

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Figure S1: ENM Characterization. STEM images of (A) n-Au and (B) n-Pt. Histogram of particle size for (C) n-Au and (D) n-Pt. UV-vis extinction spectra for (E) n-Au and (F) n-Pt using a dilute citrate to and X-ray diffractogram for (G) n-Au and (H) n-Pt, showing the characteristic peaks for metals with face-centered cubic crystal structure.
<table>
<thead>
<tr>
<th>Chemical components (mM)</th>
<th>DOC (^{(a)}) (mg L(^{-1}))</th>
<th>Ca(^{2+}) (^{(b)})</th>
<th>Mg(^{2+}) (^{(b)})</th>
<th>Na(^{+}) (^{(c)})</th>
<th>K(^{+}) (^{(c)})</th>
<th>Cl(^{-}) (^{(d)})</th>
<th>SO(_4^{2-}) (^{(d)})</th>
<th>NO(_3^{-}) (^{(d)})</th>
<th>(\Sigma)PO(_4^{3-}) (^{(e)})</th>
<th>Alk (^{(f)}) meq L(^{-1})</th>
<th>IS (^{(g)})</th>
<th>pH (^{(h)})</th>
</tr>
</thead>
<tbody>
<tr>
<td>2.41 (\pm 0.08)</td>
<td>0.76 (\pm 0.07)</td>
<td>0.41 (\pm 0.04)</td>
<td>0.36 (\pm 0.02)</td>
<td>0.035 (\pm 0.001)</td>
<td>0.32 (\pm 0.05)</td>
<td>0.21 (\pm 0.06)</td>
<td>0.022 (\pm 0.009)</td>
<td>BDL (^{(i)})</td>
<td>1.92 (\pm 0.04)</td>
<td>5.4 (\pm 0.4)</td>
<td>8.1 (\pm 0.1)</td>
<td></td>
</tr>
</tbody>
</table>

\(^{(a)}\) DOC: dissolved organic carbon, measured on high-temperature combustion total organic carbon analyzer (Dohrmann Series Apollo 9000)

\(^{(b)}\) Ca\(^{2+}\), Mg\(^{2+}\) measured by flame atomic absorbance spectroscopy (Perkin Elmer PinAAcle 500)

\(^{(c)}\) Na\(^{+}\), K\(^{+}\) measured by flame atomic emission spectroscopy (GBC 932 AA)

\(^{(d)}\) Cl\(^{-}\), SO\(_4^{2-}\), NO\(_3^{-}\) measured by ion chromatography (Methrom Compact IC pro Unit #881)

\(^{(e)}\) \(\Sigma\)PO\(_4^{3-}\), or soluble reactive phosphorus, measured by colorimetry after reaction with molybdate \(^{1,2}\), detection limit \(\sim 1 \mu M\)

\(^{(f)}\) Alk: alkalinity, measured by computerized titration using a MacIntosh ME-10 unit, a Thermo\textsuperscript{TM} Scientific Orion Glass Body ROSS\textsuperscript{TM} Combination Electrode, and 0.1000(\(\pm 0.0005\)) N hydrochloric acid.

\(^{(g)}\) IS: ionic strength on the mM unit basis.

\(^{(h)}\) measured using a Thermo\textsuperscript{TM} Scientific Orion Glass Body ROSS\textsuperscript{TM} Semi Micro Combination Electrode and an Accumet Research AR20 pH meter using NIST buffer solutions for calibration.

\(^{(i)}\) BDL: Below detection limit

Table S1: Chemical characteristics of Lake Michigan Water. All measurements were done in triplicate and reported values are average \(\pm\) standard deviation.
Figure S2: Spectrum of simulated solar irradiation from Xe arc lamp (1000W).
Figure S3: Potential interferences with ENMs for the (A) ATP assay and (B) BacLight cell membrane integrity assay. There was no difference observed between nanoparticle mixtures and the control (based on $p < 0.05$).
Figure S4: Dose-response curves showing sensitivity of *E. coli* ATP levels to varying concentrations of (A) n-Au and (B) n-Pt. Dose response tests were conducted under dark conditions with one hour incubation in Lake Michigan Water.
Figure S5: Fluorescence signal due to production of hydroxyl radical for 100 µg L\(^{-1}\) metal ENMs with and without 1 mg L\(^{-1}\) P25 n-TiO\(_2\).