Supporting Information

**Antibacterial Activity of Two-Dimensional MoS\(_2\) Sheets**

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1. Superoxide radical anion production by MoS\(_2\) materials

The possibility of superoxide radical anion (O\(_2^{•−}\)) production was evaluated by monitoring the absorption of XTT (2, 3-bis (2-methoxy-4-nitro-5-sulfophenyl)-2H-tetrazolium-5-carboxanilide, Fluka). XTT can be reduced by superoxide radical anion (O\(_2^{•−}\)) to form water-soluble XTT-formazan with the maximum absorption at 470 nm.

XTT (0.4 mM) was dissolved in phosphate buffered saline (PBS) solution at pH 7.0. dispersions of MoS\(_2\) materials (80 \(\mu\)g/mL, 1 mL) in a PBS buffer (80 \(\mu\)g/mL) was mixed with 1 mL of 0.4 mM XTT. The mixtures were incubated in dark for 2 h - 6 h under shaking. Afterwards, the mixture was filtered through a 0.2 \(\mu\)m surfactant-free cellulose acetate membrane filter (Thermo Scientific Nalgene Syringe Filter) to remove the MoS\(_2\) materials. Filtered solution (250 \(\mu\)L) was then placed in a 96-well plate. The change in absorbance at 470 nm was monitored on a microplate spectrophotometer (MTP-880, Corona Electric Co. Ltd. Japan). TiO\(_2\) nanoparticle (40 \(\mu\)g/mL) dispersion was exposed to a UV light source as a positive control.

2. Glutathione (\(\gamma\)-L-glutamyl-L-cysteinyl-glycine, GSH) oxidation examination by Ellman's assay

Dispersion (225 \(\mu\)L) of MoS\(_2\) materials with concentrations of 20 \(\mu\)g/mL, 40 \(\mu\)g/mL or 80
μg/mL in 50 mM bicarbonate buffer (pH 8.6) was added into 225 μL of GSH (0.8 mM in the bicarbonate buffer) to initiate oxidation in microcentrifuge tube. The mixture of MoS₂ materials with GSH in the tube was covered with alumina foil to prevent illumination of light, and then placed in a shaker with a speed of 150 rpm at room temperature for incubation of 2 h, 4 h, or 6 h. After the incubation, 785 μL of 0.05 M Tris-HCl and 15 μL of 100 mM DNTB (Ellman’s reagent, 5,5'-dithio-bis-(2-nitrobenzoic acid) (DTNB, Invitrogen or Sigma-Aldrich) were added into the mixture. MoS₂ materials were removed from the mixture by filtration through a 0.2 μm surfactant-free cellulose acetate membrane filter (Thermo Scientific Nalgene Syringe Filter). A 250 μL aliquot of the filtered solution was then placed in a 96-well plate. Their absorbance at 412 nm was measured on a microplate spectrophotometer (MTP-880, Corona Electric Co. Ltd. Japan). GSH solution without MoS₂ materials was used as a negative control. GSH (0.4 mM) oxidation by H₂O₂ (1 mM) was used as a positive control. The experiments were performed in triplicate.

Table S1. Raman peaks of raw MoS₂ power, ce-MoS₂ sheets, and aggregated ce-MoS₂.

<table>
<thead>
<tr>
<th></th>
<th>E₁₁g</th>
<th>A₁₁g</th>
<th>2LA (MO)</th>
<th>2E₁₁g</th>
<th>2E₁₁g (O)</th>
<th>E₁₁g → 2E₁₁g</th>
<th>LA(MO)</th>
<th>2E₁₁g</th>
<th>2E₁₁g</th>
<th>E₁₁g → 2E₁₁g</th>
</tr>
</thead>
<tbody>
<tr>
<td>raw MoS₂ powder (cm⁻²)</td>
<td>148.5</td>
<td>180.0</td>
<td>285.5</td>
<td>382.0</td>
<td>407.5</td>
<td>451.5</td>
<td>567.5</td>
<td>594.5</td>
<td>751.5</td>
<td>776.5</td>
</tr>
<tr>
<td>ce-MoS₂ sheet (cm⁻²)</td>
<td>150.5</td>
<td>183.5</td>
<td>223.5</td>
<td>283.5</td>
<td>327.0</td>
<td>381.0</td>
<td>406.0</td>
<td>451.0</td>
<td>520.5</td>
<td>566.5</td>
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</tbody>
</table>
Figure S1. AFM characterization of ce-MoS$_2$ sheets. (a) A cross-sectional profile of a ce-MoS$_2$ sheet suggests that the ce-MoS$_2$ sheets are monolayers; (b) A cross-sectional profile of a ce-MoS$_2$ sheet suggests that the size of the ce-MoS$_2$ sheet is 265.63 nm; (c) A cross-sectional profile of a ce-MoS$_2$ sheet suggests that the size of the ce-MoS$_2$ sheet is 163.73 nm.
Figure S2. XPS patterns of (a) ce-MoS$_2$ sheets on Si/SiO$_2$ substrate; (b) Raw MoS$_2$ powers on Si/SiO$_2$ substrate; (c) Aggregated ce-MoS$_2$ on Si/SiO$_2$ substrate. The results suggest that the MoS$_2$ materials are highly pure.
**Figure S3.** X-ray diffraction (XRD) spectra of raw MoS$_2$ powder, ce-MoS$_2$, and aggregated ce-MoS$_2$. Compared to the XRD patterns for the raw MoS$_2$ powder, almost all the peaks disappeared for the ce-MoS$_2$ sheets and the (002) peak at $2\theta=14.4^\circ$ became very weak, which is mostly due to the crystals with nanoscale sizes and the fact that the ce-MoS$_2$ sheets lay on the substrate with preferred orientation (Hua Zhang, et al., *Angew. Chem. Int. Ed.*, 2011, 50, 11093; Manish Chhowalla, et al., *Nano Lett.*, 2011, 11, 5111). However, the (002) peak became observable for the aggregated ce-MoS$_2$, suggesting the monolayer MoS$_2$ restacking together.
**Figure S4.** Digital camera photos of live *E.coli* DH5α bacteria after they were exposed to ce-MoS$_2$ dispersions with different concentrations for 2 h.
Figure S5. Glutathione oxidation by monitoring color change. GSH was mixed with dispersions (20, 40 or 80 µg/mL) of ce-MoS$_2$ sheets or raw MoS$_2$ powders for 2 h - 6 h. GSH solution without MoS$_2$ materials was used as a negative control. GSH (0.4 mM) oxidation by H$_2$O$_2$ (1 mM) was used as a positive control.
Figure S6. Keynece microscope image of the *E.coli* DH5α cells after exposure to (a) raw MoS\(_2\) powder and (b) ce-MoS\(_2\) sheet for 2 h. We can see after exposed to the ce-MoS\(_2\) sheets, most the cells did not show a normal cell shape as observed on the cells exposed to the raw MoS\(_2\) powders.

Figure S7. Concentration dependent viability of the cells after exposure of 2 h.