Supporting Information

Fast and All-Weather Cleanup of Viscous Crude-Oil Spills with Ti$_3$C$_2$T$_X$ MXene Wrapped Sponge

Cheng Gong, Junchao Lao*, Bingyv Wang, Xiaoyan Li, Guojie Li, Jun Gao, Yizao Wan, Xiaohong Sun, Ruisong Guo*, Jiayan Luo*

C. Gong, X. Sun, Y. Wan, R. Guo
School of Materials Science and Engineering, Key Laboratory of Advanced Ceramics and Machining Technology of Ministry of Education, Tianjin University, Tianjin 300072, China
Email: rsguo@tju.edu.cn
J. Lao, B. Wang, X. Li, G. Li, Prof. J. Luo
Key Laboratory for Green Chemical Technology of Ministry of Education, State Key Laboratory of Chemical Engineering, School of Chemical Engineering and Technology, Tianjin University, Tianjin 300072, China
Email: junchaolao@tju.edu.cn, jluo@tju.edu.cn
G. Li
Key Laboratory of Materials Processing and Mold (Zhengzhou University), Ministry of Education, Zhengzhou 450002, China
Y. Wan
Jiangxi Key Laboratory of Nanobiomaterials, Institute of Advanced Materials, East China Jiaotong University, Nanchang 330013, China
J. Gao
Physics of complex fluids, University of Twente, Enschede, 7500AE, the Netherlands
Figure S1. TEM image of Ti$_3$C$_2$T$_X$ nanosheets.

Figure S2. Photographs of original PU sponge (a) and Ti$_3$C$_2$T$_X$@PU (b).
Figure S3. SEM images of original PU sponge (a, b) and Ti$_3$C$_2$TX@PU (c-f).

Figure S4. XRD pattern of Ti$_3$C$_2$TX@PU, suggesting the presence of Ti$_3$C$_2$TX.
Figure S5. FTIR spectrums of Ti$_3$C$_2$Tx@PU and PU sponge.

Figure S6. XPS survey spectrum and high-resolution Ti 2p of Ti$_3$C$_2$Tx nanosheets (a, b) and Ti$_3$C$_2$Tx@PU (c, d), suggesting the nature of chemical adhesion of MXene to PU sponge.
Figure S7. Hydrophobic and oleophobic feature of PU sponge (a) and hydrophobic and oleophilic feature of Ti$_3$C$_2$T$_X$@PU (b).

![Image of PU sponge and Ti$_3$C$_2$T$_X$@PU samples]

Figure S8. Absorption capacity of Ti$_3$C$_2$T$_X$@PU for various organic liquids.

![Bar chart showing absorption capacity for different liquids]

Figure S9. Permeating behavior of one heavy oil droplet (200 μL) on the surface of Ti$_3$C$_2$T$_X$@PU at 20 °C.

![Images showing permeation over time]
Figure S10. UV-vis-NIR absorption spectrum of MXene solution with the mass concentration of 0.05 mg/mL (a) and absorption spectrum of Ti$_3$C$_2$T$_X$@PU in the range of the standard solar spectrum (AM 1.5G) (b).

Figure S11. Photographs (a, b) and IR images of top and side surface of crude oil which has been placed at 27 °C (c, d) and irradiated under 100 mW cm$^{-2}$ for 10 min (e, f).
Figure S12. Temperatures of top surface and bottom surface of Ti$_3$C$_2$T$_x$@PU under the irradiation of the natural sunlight (Aug. 28th, 2019, Tianjin).

Figure S13. Resistance and surface temperature of Ti$_3$C$_2$T$_x$@PU (3×3×1 cm$^3$) at different applied voltages.

Figure S14. Photographs of the absorbing process without the aid of Joule heating.
Table S1. Summary of the property parameters of Ti$_3$C$_2$T$_x$@PU, graphene-wrapped sponge, HC-wood and CNT/PDMS-PU sponge.

<table>
<thead>
<tr>
<th>Sorbent</th>
<th>Energy source</th>
<th>Maximum surface temperature (°C)</th>
<th>Absorption ability (g cm$^{-3}$)</th>
<th>Absorption ability (g g$^{-1}$)</th>
<th>Reference</th>
</tr>
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<tbody>
<tr>
<td>Graphene-wrapped melamine sponge</td>
<td>Electricity</td>
<td>350</td>
<td>0.910</td>
<td>N/A</td>
<td>[27]</td>
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<tr>
<td>HC-wood</td>
<td>Solar energy</td>
<td>61 (1 sun)</td>
<td>0.694</td>
<td>N/A</td>
<td>[28]</td>
</tr>
<tr>
<td>CNT/PDMS-PU sponge</td>
<td>Solar energy</td>
<td>88 (1 sun)</td>
<td>0.237</td>
<td>20</td>
<td>[29]</td>
</tr>
<tr>
<td>Ti$_3$C$_2$T$_x$@PU</td>
<td>Solar energy</td>
<td>75 (1 sun)</td>
<td>0.972</td>
<td>48</td>
<td>This work</td>
</tr>
</tbody>
</table>

