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Supporting information for:

Montmorilonite Nanosheets with Enhanced Photodynamic Performance for Synergistic Bacterial Ablation

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Preparation of Na-MMT

The properties of MMT are closely related to the types of intercalation cations. The common type of MMT in nature is Ca-MMT. Generally, the pulping performance of Na-MMT is better than that of Ca-MMT. In this experiment, Na-MMT was synthesized from Ca-MMT through its cations exchange properties. Ethanol and water as mixed solvent, the volume ratio of ethanol and deionized water is 1:9, and the solid-liquid mass ratio of the prepared Ca-MMT suspension is 1: 19. Weighed 10 g of Ca-MMT, dispersed it into 190 ml of the above mixed solvent, and then added 5wt% anhydrous sodium carbonate (relative to the mass of Ca-MMT). The suspension was ball-milled for 3 h, and aged for 24 h. Then, the precipitate was obtained by centrifuging three times with water and ethanol, respectively. Finally, the precipitate was dried for 3 h in a blast drying oven at 105°C. Na-MMT powder was obtained.

Preparation of 2D-MMT nanosheets

Weighed 1.5 g of Na-MMT and dispersed it in 100 ml deionized water, then conducted ultrasonic treatment for 30 min (under normal temperature), then transferred the sample to polytetrafluoroethylene beaker, put it in a refrigerator at -20°C for 5 h, then took the sample out of the refrigerator and put it into the freeze dryer to dry slowly (about 48 h), the collected solid powder was re-dispersed into deionized water, and then the above freeze-drying operations were repeated. The final collected solid powder is 2D-MMT nanosheets.

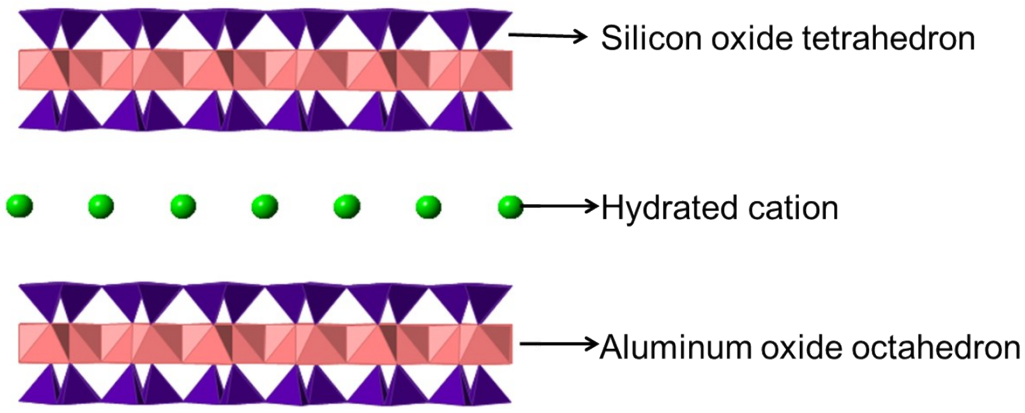

Figure S1 Crystal structure of MMT.

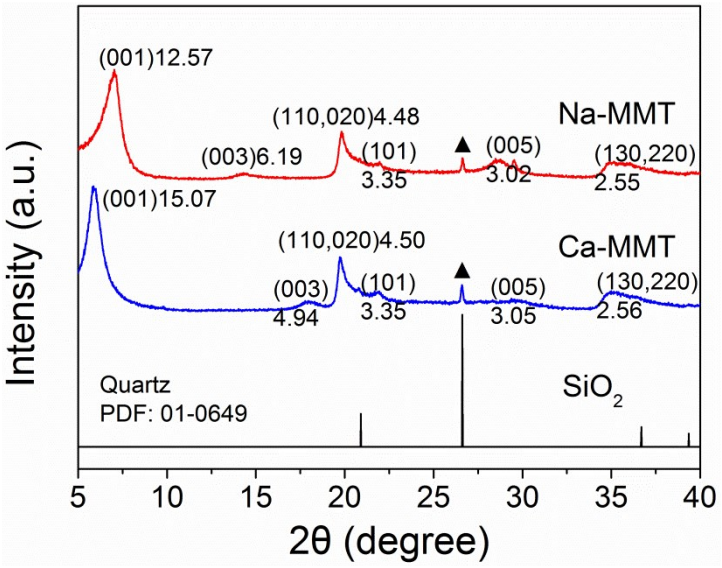

Figure S2 XRD spectra of Na-MMT, Ca-MMT and quartz (standard PDF card 01-0649 for quartz).

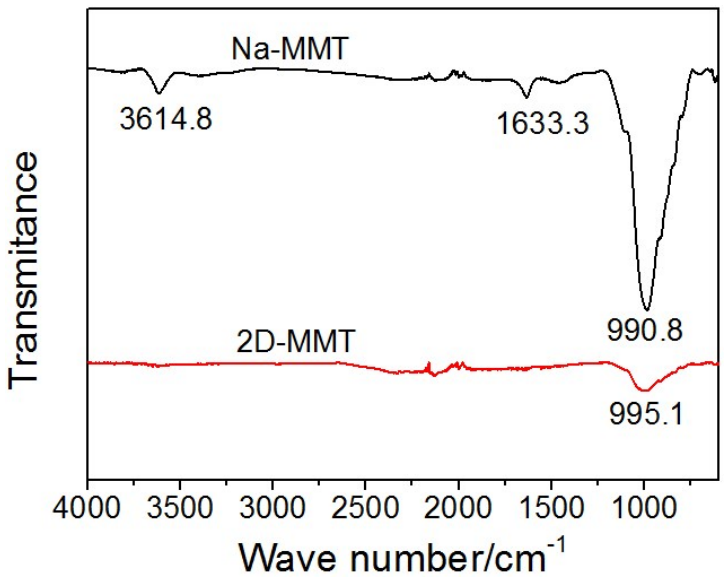

Figure S3 FT-IR spectra of Na-MMT and 2D-MMT.

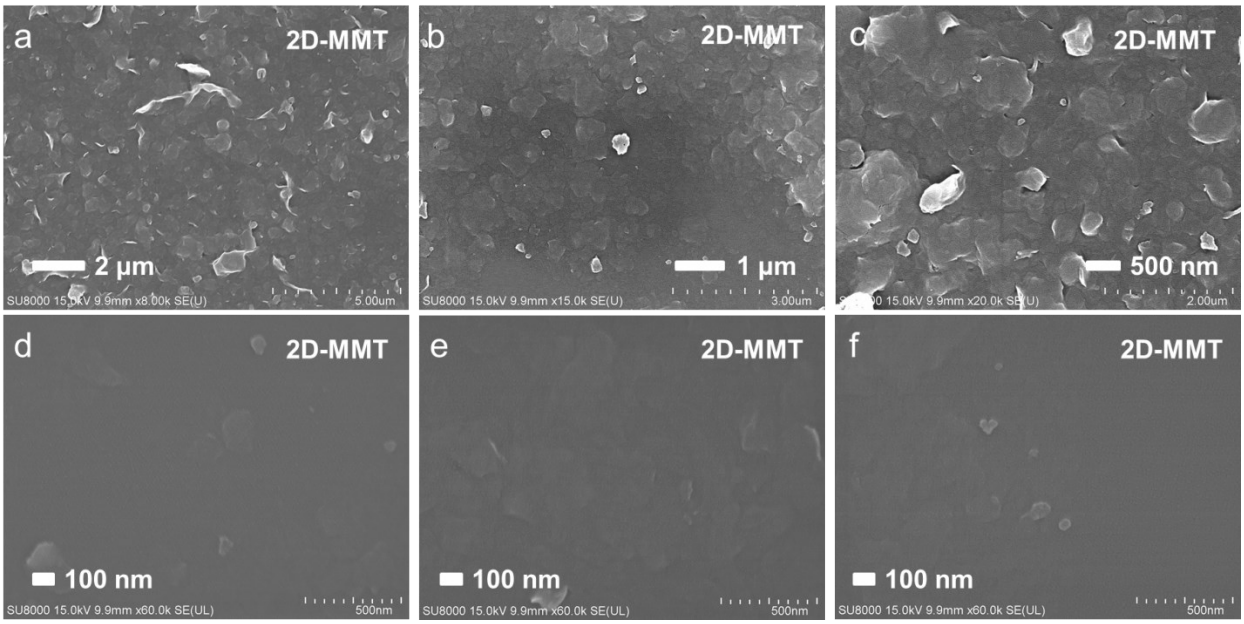

Figure S4 SEM images of 2D-MMT nanosheets at different magnifications.

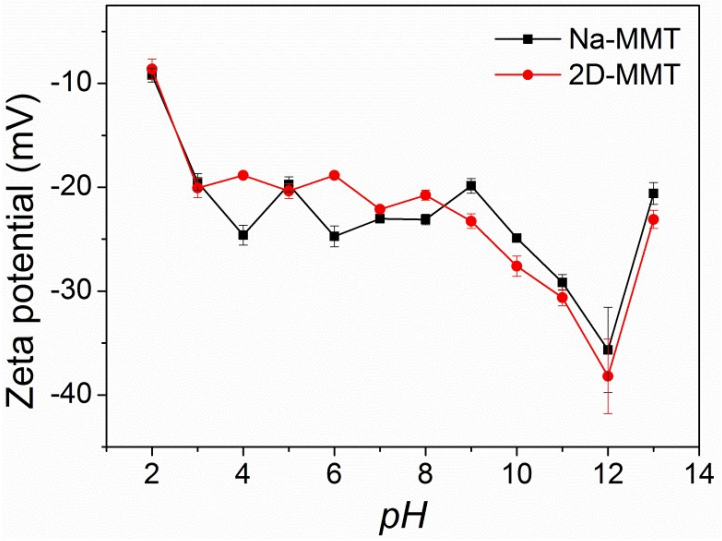

Figure S5 Zeta potential of Na-MMT and 2D-MMT.

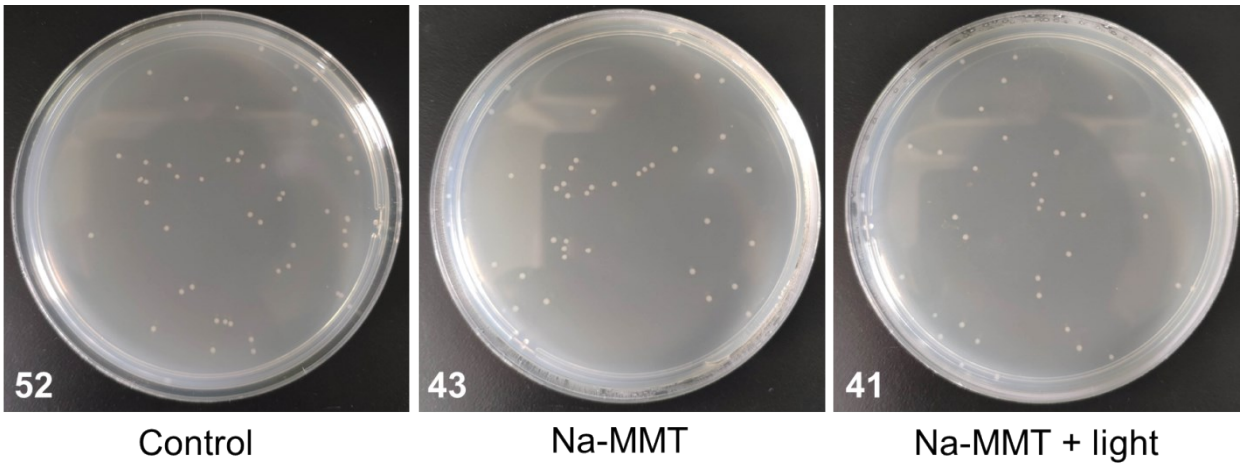

Figure S6 Antibacterial tests with E. coli strains upon various treatments. Control group was treated without Na-MMT or light irradiation. Na-MMT group was treated with Na-MMT (1 mg ml^{-1} in PBS solution). Na-MMT + light group was treated with Na-MMT (1 mg ml^{-1} in PBS solution) and white light illumination (λ = 400-800 nm, P = 4 mW cm^{-2}, t = 20 min). After the treatment, the bacteria solution was diluted and plated on the agar plate for another 18 h at 37°C.

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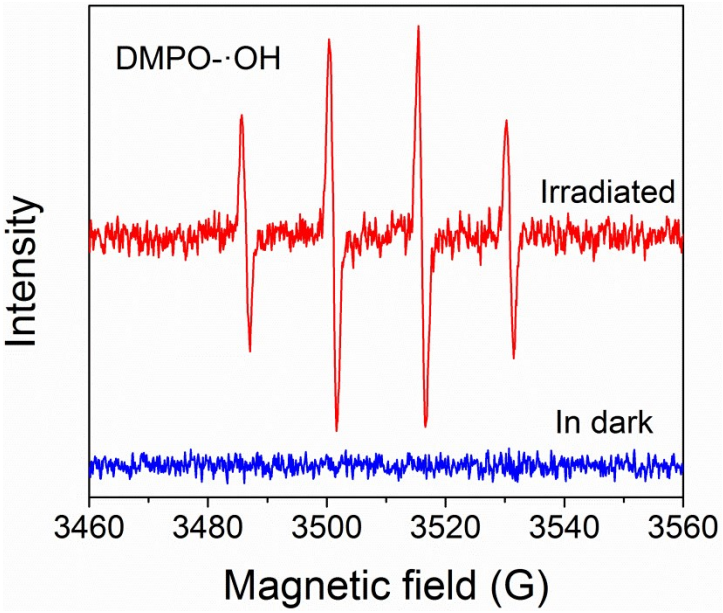

Figure S7 EPR spectra of ·OH generated by 2D-MMT under light (λ = 400-800 nm) for 20 min and without light condition.

Table S1 Contents information of major elements for Ca-MMT, Na-MMT and 2D-MMT were determined by XRF.

Sample	SiO_2	Al_2O_3	Fe_2O_3	MgO	CaO	Na_2O	K_2O	MnO	TiO_2	P_2O_5
--	Si (%)	Al (%)	Fe (%)	Mg (%)	Ca (%)	Na (%)	K (%)	Mn (%)	Ti (%)	P (%)
Ca-MMT	54.37	14.89	3.43	4.64	2.21	0.21	0.2	0.02	0.25	0.12
Na-MMT	51.52	14.34	3.31	4.51	1.72	2.22	0.17	0.02	0.23	0.1
2D-MMT	55.17	15.34	3.55	4.83	1.87	2.28	0.17	0.02	0.25	0.1

Table S2 Contents information of trace elements for Ca-MMT, Na-MMT and 2D-MMT nanosheets was determined by XRF.

Sample	Ba (ppm)	Sr (ppm)	Zr (ppm)	Loss on ignition (%)
Ca-MMT	112.4	133.1	828.3	19.57
Na-MMT	145	116.5	793.4	21.78
2D-MMT	156.2	128.6	866.2	16.30

Table S3 Assignment of XRD reflections obtained for bactericides.

Sample	2Θ (degree)	d_{001} (Å)	FWHM (degree)
Na-MMT	7.03	12.57	0.74
2D-MMT	5.80	15.24	0.99

Table S4 Zeta potential value of Na-MMT and 2D-MMT nanosheets at pH = 2-13 (Error bars, mean ± s.d. n = 3).

pH	Z (Na-MMT)	Error bar	Z (2D-MMT)	Error bar
2	-9.2	-9.2±0.669	-8.6	-8.6±0.964
3	-19.5	-19.5±0.818	-20.1	-20.1±0.945
4	-24.6	-24.6±0.954	-18.9	-18.9±0.208
5	-19.7	-19.7±0.723	-20.4	-20.4±0.702
6	-24.7	-24.7±1.006	-18.9	-18.9±0.252
7	-23.0	-23.0±0.404	-22.1	-22.1±0.321
8	-23.1	-23.1±0.500	-20.8	-20.8±0.473
9	-19.8	-19.8±0.702	-23.3	-23.3±0.709
10	-24.9	-24.9±0.400	-27.6	-27.6±0.985
11	-29.2	-29.2±0.751	-30.6	-30.6±0.764
12	-35.7	-35.7±4.102	-38.2	-38.2±3.604
13	-20.6	-20.6±1.058	-23.1	-23.1±0.872

Table S5 BET details of the Na-MMT (Ref), Na-MMT and 2D-MMT nanosheets.

Sample	S_{BET} ($m^2\ g^{-1}$)	Pore volume ($cm^3\ g^{-1}$)	Pore diameter (nm)
Na-MMT (Ref.)	29.00	0.035	5.13
Na-MMT	86.78	0.099	4.59
2D-MMT	215.87	0.167	3.11

Table S6 PH values of liquid medium, Na-MMT and 2D-MMT suspension at room temperature (Taking the average of the three measurements).

Sample	pH
Liquid medium	7.0
Ca-MMT	7.5
Na-MMT	8.9
2D-MMT	9.1