Supporting Information

Undiscovered multiple roles of multivalent cations in the pollutant removal from actual water by persulfate activated by carbon materials

Han-Chao Zhang, Jiang-Jin Han, Xin Zhang, Pu-Can Guo, Dong-Hua Xie, Guo-Ping Sheng*

CAS Key Laboratory of Urban Pollutant Conversion, Department of Environmental Science and Engineering, University of Science and Technology of China, Hefei, 230026, China

***Corresponding author**:

Prof. Guo-Ping Sheng

Fax: +86-551-63601592

E-mail: gpsheng@ustc.edu.cn

This supporting information contains 11-page document, including 4 figures and 5 tables as well as this cover page.

Text S1

Linear sweep voltammetry measurement. The Linear sweep voltammetry (LSV) measurement was conducted at room temperature in a three-electrode configuration with an electrochemical workstation (CHI 760E, Chenhua Instrument Co., China). The MCNTs was coated on the fluorinated tin oxide glass as the working electrode, and the Pt was used as the counter electrode and an Ag/AgCl electrode was used as the reference electrode. A 20 mmol/L boric acid buffer was used as the electrolyte. The current at a working electrode was measured with increasing the potential from 0.2 to 1.4 V with a scan rate of 20 mV/s.

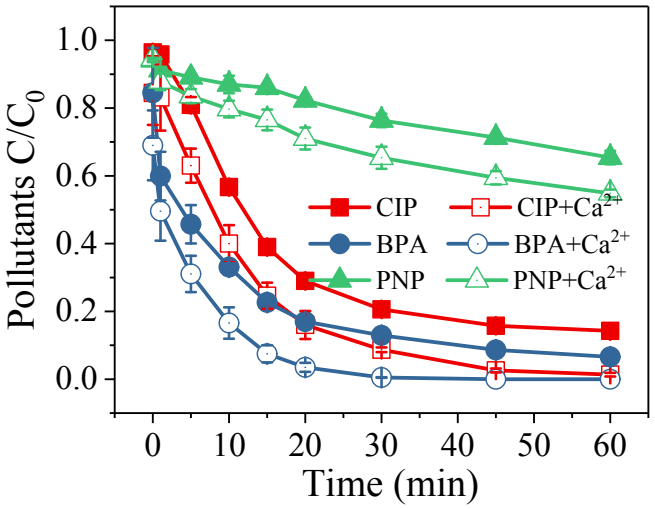

Figure S1. Effect of Ca^{2+} on the CIP, BPA, and PNP degradation kinetics in the PDS activation by the MCNTs. Reaction conditions: [CIP] = [BPA] = [PNP] = 2 mg/L, [MCNT] = 100 mg/L, [PDS] = 1 mmol/L [Ca^{2+}] = 1 mmol/L, pH 7.0.

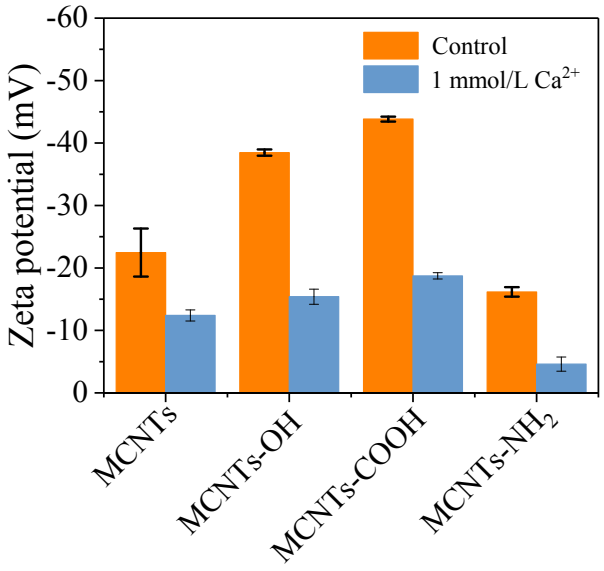

Figure S2. Effect of Ca^{2+} on the zeta potential of various MCNTs with various functional groups. Reaction conditions: [MCNT], [MCNT-OH], [MCNT-COOH], [MCNT-NH_2] = 100 mg/L, [Ca^{2+}] = 1 mmol/L, pH 7.0.

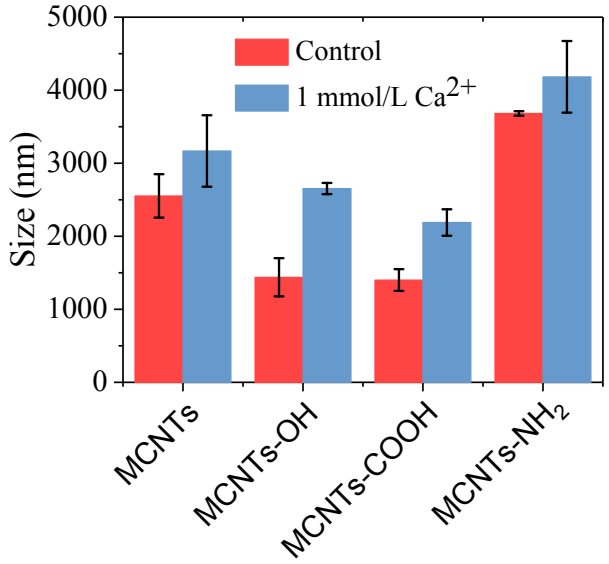

Figure S3. Effect of Ca^{2+} on the hydrodynamic size of various MCNTs with various functional groups. Reaction conditions: [MCNT], [MCNT-OH], [MCNT-COOH], [MCNT-NH_2] = 100 mg/L, [Ca^{2+}] = 1 mmol/L, pH 7.0.

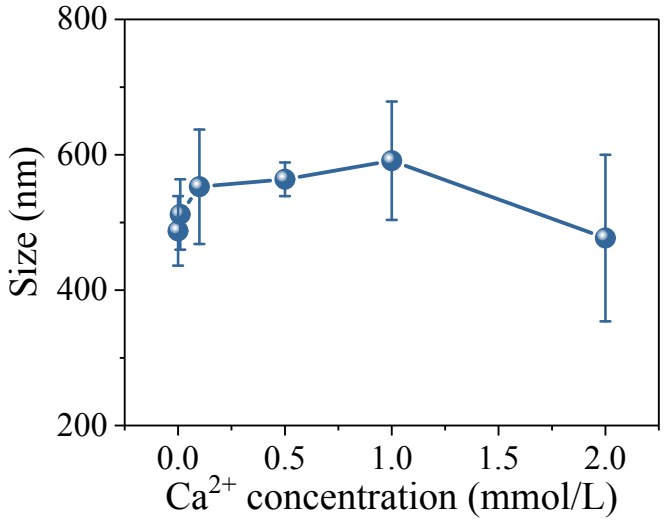

Figure S4. Effect of Ca^{2+} on the hydrodynamic size of SRNOM in the solution.

Table S1. characteristics of four actual waters

	DOC (mg-C/L)	TN (mg/L)	NH_4^+-N (mg/L)	NO_3^--N (mg/L)	TP (mg/L)	UV_{254}
SC Effluent	6.8±0.9	17.5±0.1	0.974±0.115	4.27 ± 0.12	0.112±0.006	0.089±0.007
river water	8.4±1.2	14.9±2.0	0.460±0.019	4.10 ± 0.01	0.064±0.001	0.134±0.009
lake water	9.6±1.8	12.1±0.8	0.270±0.012	3.27 ± 0.17	0.125±0.006	0.120±0.012
ground water	2.6±0.8	7.6±0.8	0.022±0.005	1.15± 0.35	0.040±0.003	0.02±0.001

DOC: Dissolved organic carbon

TN: Total Nitrogen

TP: Total Phosphorus

Table S2. HPLC test conditions for various micropollutants.

	mobile phase			Flow rate (mL/min)	UV detector (nm)
	methanol	acetonitrile	0.1% formic acid		
BPA	-	40%	60%	0.8	273
CIP	-	20%	80%	0.5	277
SMX	40%	-	60%	0.8	263
PNP	-	80%	20% (H_2O)*	0.5	318

*：The mobile phase of PNP was acetonitrile and H_2O, not 0.1% formic acid.

Table S3. element content of different carbon nanomaterials

	MCNTs	MCNTs-OH	MCNTs-COOH	MCNTs-NH_2	g-MCNTs
C at.%	97.27	93.51	95.54	97.35	99.11
N at.%	0.21	0.23	0.18	1.12	-
O at.%	2.52	6.26	4.28	1.53	0.89

Table S4. multivalent cations concentration of actual water before and after CER treated

	Ca^{2+} (mg/L)		Mg^{2+} (mg/L)		Fe^{2+} (mg/L)		Al^{3+} (mg/L)	
	Before	After	Before	After	Before	After	Before	After
SC Effluent	37.47±1.32	0.019±0.002	6.85±0.83	n.d.	0.028±0.04	0.010±0.002	0.044±0.008	0.005±0.001
River water	38.11±2.57	0.298±0.125	7.12±0.92	n.d.	0.009±0.001	0.005±0.001	0.039±0.004	0.018±0.005
Lake water	15.15±0.81	0.023±0.010	5.45±0.24	n.d.	0.166±0.017	0.107±0.011	0.18±0.001	0.128±0.017
Ground water	93.70±3.49	0.024±0.004	22.12±1.27	n.d.	n.d.	n.d.	0.029±0.002	0.017±0.003

n.d.：not detected

Table S5. The pH in the four actual water before and after CER treatment

	pH		Total organic carbon (mg/L)	
	Before	After	Before	After
Secondary effluent	7.68	8.01	6.88±0.44	7.00±0.53
River water	8.01	7.92	9.02±0.72	8.82±0.59
Lake water	8.02	8.31	10.77±0.43	10.90±1.50
Ground water	7.73	8.05	2.78±0.33	3.08±0.75