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MDPI

Supplementary Materials

A High Flux Electrochemical Filtration System Based on Electrospun Carbon Nanofiber Membrane for Efficient Tetracycline Degradation

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Text S1. Materials and reagents

Polyacrylonitrile (PAN, Mw 150,000), N, N-dimethylformamide (DMF), oxalic acid (OA) were purchased from MackLin (Shanghai, China). Terephthalic acid (PTA) and tetracycline (TC) were acquired from Aladdin (Shanghai, China). Anhydrous sodium sulfate (Na_2SO_4) were obtained from Damao Chemical Reagent Co., Ltd (Tianjin, China). Sulfuric acid (H_2SO_4), sodium hydroxide (NaOH), ethanol (EtOH) and tert-butyl-alcohol (TBA) were purchased from Guangzhou Chemical Reagent (China). Unless otherwise stated, the reagents used were analytical grade without further purification.

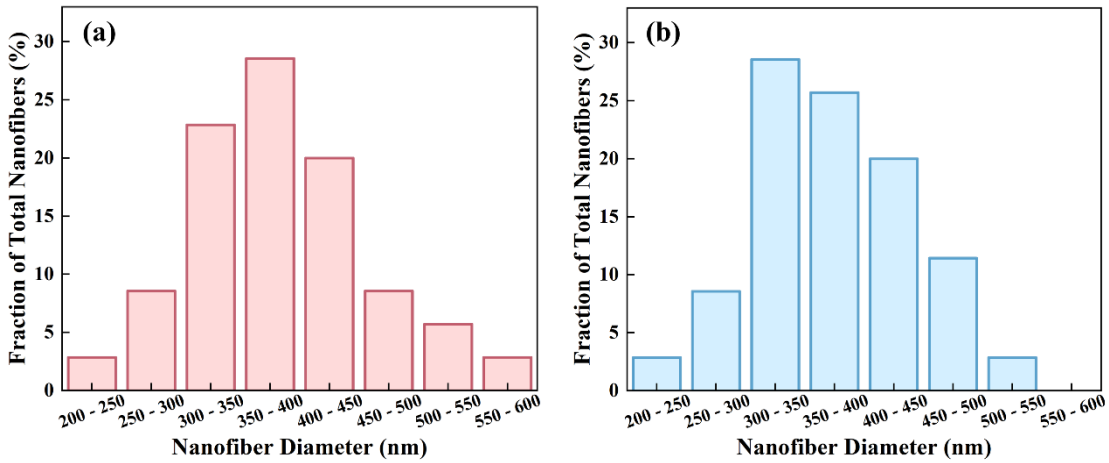


Figure S1. Histograms of nanofiber diameter of (**a**) electrospun nanofibers (2.5 wt% PTA) and (**b**) carbonized nanofibers (ECNFM-2.5%-1000).

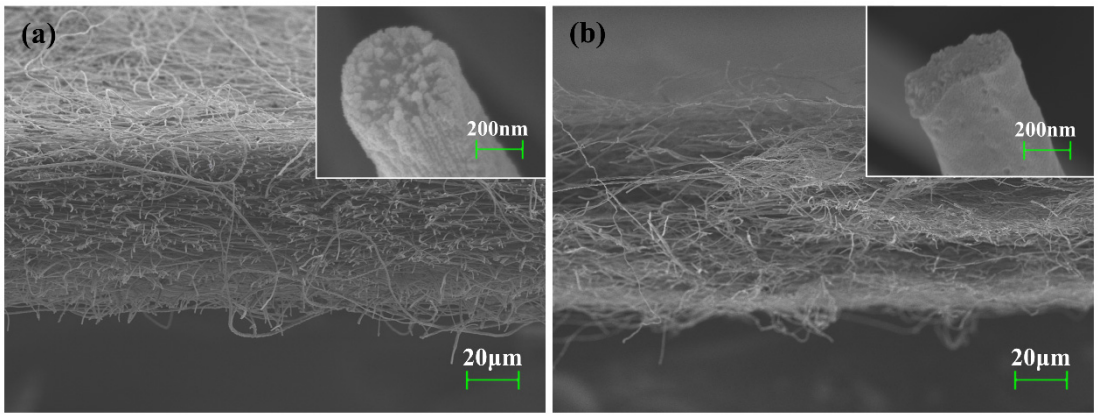


Figure S2. Cross-sectional images of (**a**) electrospun nanofibers (2.5 wt% PTA) and (**b**) carbonized nanofibers (ECNFM-2.5%-1000).

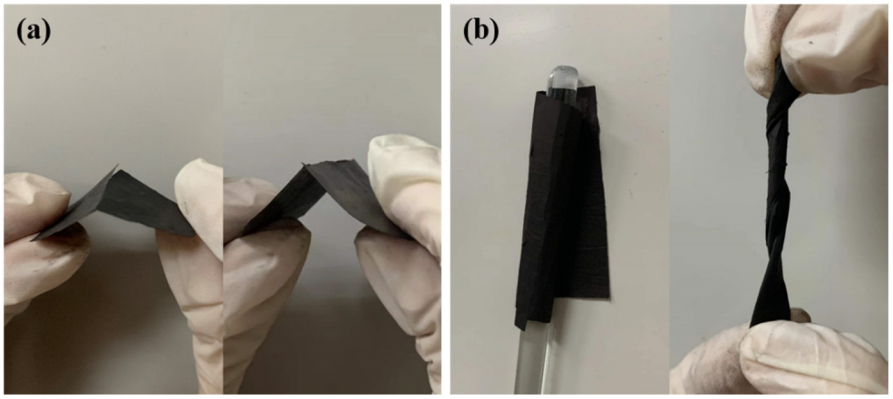


Figure S3. Photographs of (**a**) ECNFM and (**b**) ECNFM-2.5%-1000.

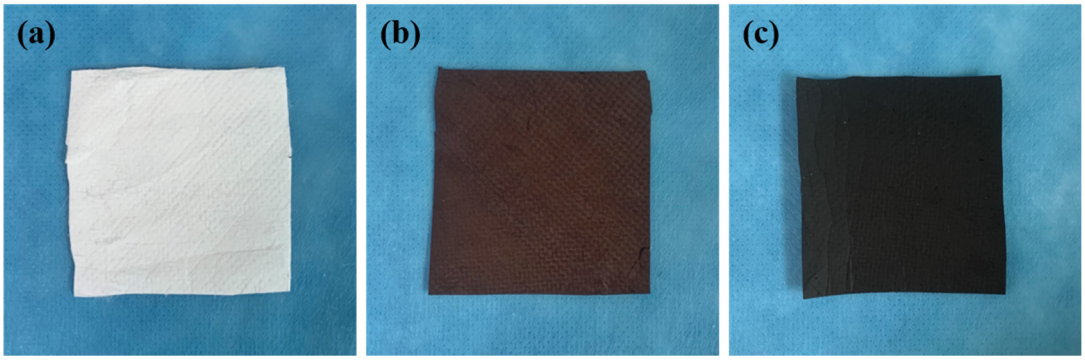


Figure S4. Photographs of (**a**) electrospun, (**b**) stabilized, (**c**) carbonized nanofiber membrane.

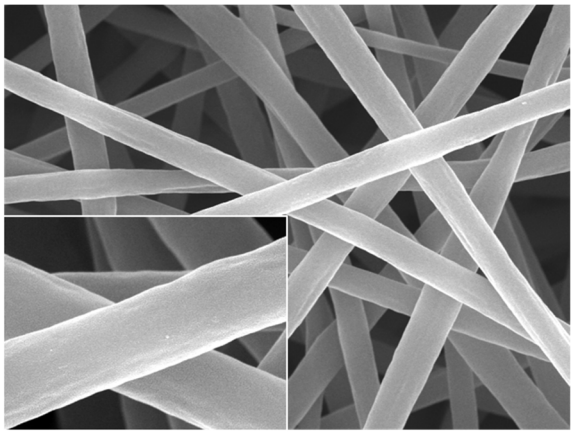


Figure S5. SEM images of ECNFM-2.5%-1000 after 8-h continuous operation.

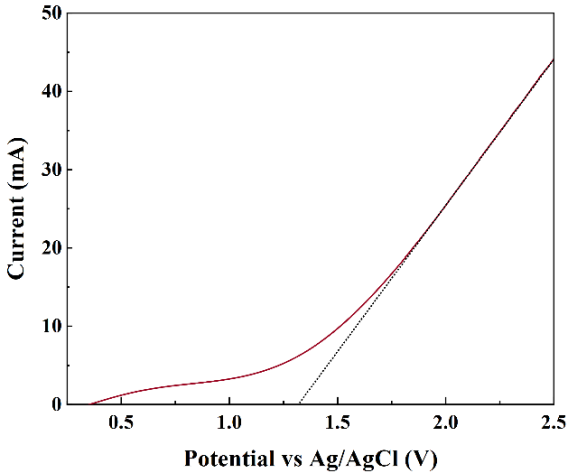


Figure S6. Linear sweep voltammetry (LSV) curve.

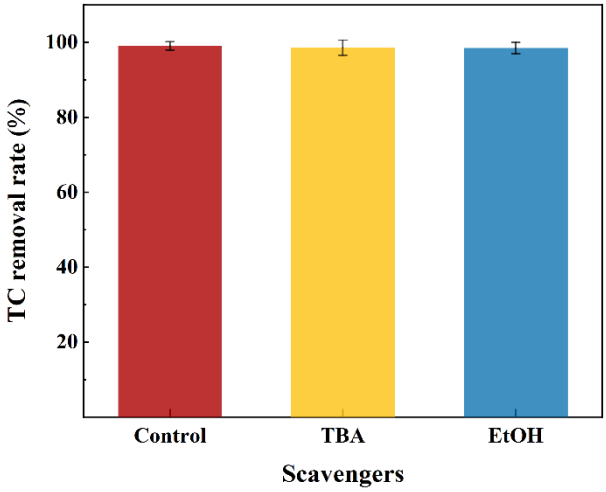


Figure S7. Effect of scavengers on TC removal rate. Experimental conditions: voltage = 2 V, natural pH = 6.1, [Na_2SO_4] = 0.1 mol L^{-1}, [TC] = 10 ppm.

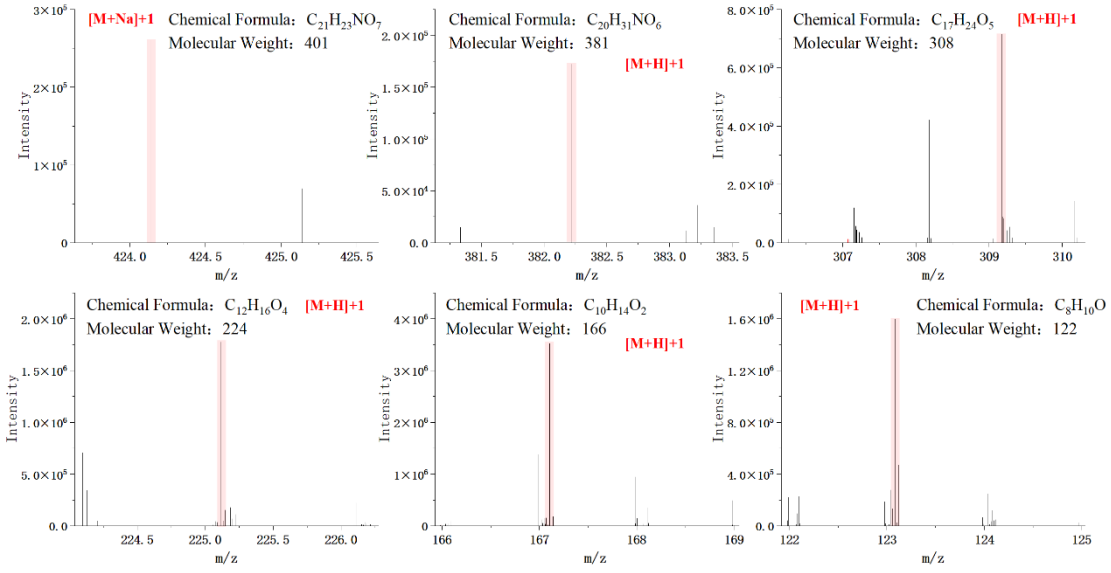


Figure S8. Secondary MS spectra of TC and the possible identified intermediates.

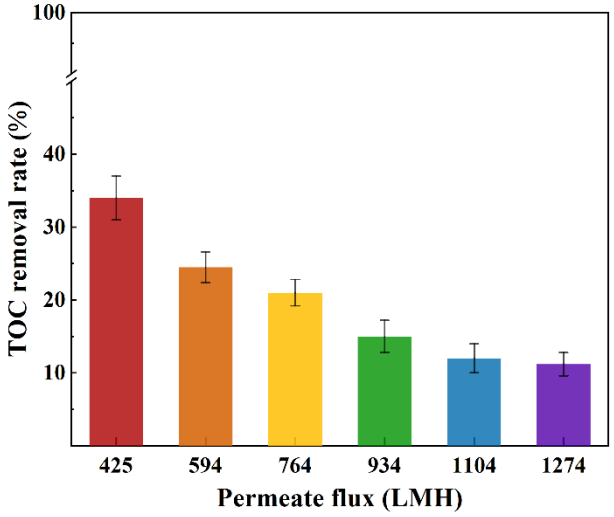


Figure S9. TOC measurement as a function of permeate flux. Experimental conditions: voltage = 2 V, natural pH = 6.1, [Na_2SO_4] = 0.1 mol L^{-1}, [TC] = 10 ppm.

Table S1. Characteristics of ECNFM.

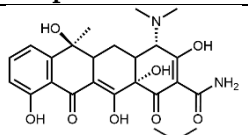
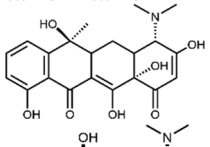
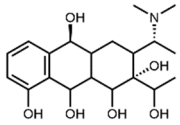
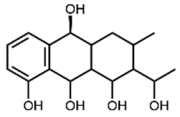
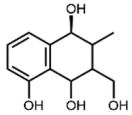
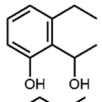
Materials	Mean pore diameter (μm)	Porosity (%)	Permeation Flux (L m^{-2} h^{-1} bar^{-1})
ECNFM-0-1000	1.07	80.0	7.66×10^4
ECNFM-2.5%-1000	2.52	92.8	1.15×10^5

Table S2. Performance comparison of ECNFM-based electrochemical filter with other electrochemical filtration system.

Anode (Working electrode)	Pollutant	Current density (mA cm^{-2})/ Potential (V)	Permeate flux (L h^{-1} m^{-2})	Removal rate (%)	Energy consumption (kWh m^{-3})
CNT/PTFE filter	Tetracycline (0.2mM)	1.5 V	127.48	>95	0.084
Bi-doped SnO_2-loaded Ti_nO_{2n-1} membrane	Atrazine (10μM) Clothianidin (10μM)	3.5 V	600	>99.9	<0.42 0.83
Porous carbon membrane	Phenol (10ppm) Methyl orange (10ppm)	2.0 V 1.0 V	74.6	90 100	-
Ti_4O_7 reactive electrochemical membranes	Sulfamethoxazole (100 μM)	2.03 V	300	~95.7	-
PANI-CNT membrane	Methylene Blue (5ppm)	3.0 V	70	84.1	-
Bi-SnO_2-coated CNT membrane	Bisphenol A (30ppm)	3.0 V	170	76.80	-
Coal-based carbon membrane	Bisphenol A (50ppm)	2.0 V	43.7	97	-

RuO2/TiO2 nanorods-loaded Carbon nanofibers	Methyl blue (200ppm) Bisphenol A (0.5ppm) Sulfadiazine (0.5ppm)	1.0 mA cm^{-2}	360	99.9 98 98	-
TiO_2@SnO_2-Sb	p-chloroaniline (10um)	3.0 V	17.4	85.5	0.38
Sb-SnO_2-coated carbon membrane	Tetracycline (50ppm)	3.0 V	150	99.3	-
RuO_2-coated Ti mesh	p-chloroaniline (50um)	2.0 V	17	91	1.09
Molecular imprinting TiO_2@SnO_2-Sb	2,4-dichlorophenoxyacetic acid (1ppm)	3.0 V	17	62.4	0.58
Ti/SnO_2-Sb/Ce-PbO_2	Benzophenone-3 (10ppm) 4-hydroxybenzophenone (10ppm)	25 mA cm^{-2}	-	91.6 96.5	3.3–62.1 3.6–79.5

Table S3. The information of the possible intermediate products.

Compounds	Formula	m/z	Proposed structure
TC	$C_{22}H_{24}N_2O_8$	444	
A	$C_{21}H_{23}NO_7$	401	
B	$C_{20}H_{31}NO_6$	381	
C	$C_{17}H_{24}O_5$	308	
D	$C_{12}H_{16}O_4$	224	
E	$C_{10}H_{14}O_2$	166	
F	$C_8H_{10}O$	122