Supporting Information for:

Reactive Electrochemical Filter System with an Excellent Penetration Flux Porous Ti/SnO_2-Sb Filter for Efficient Contaminant Removal from Waters

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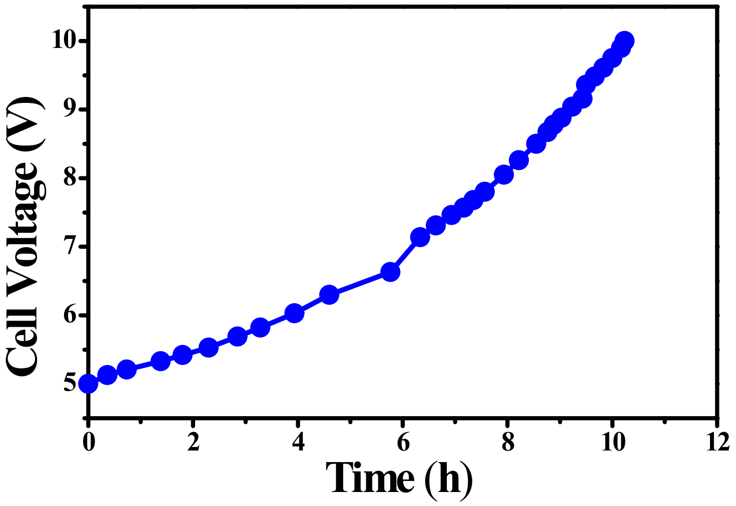

Fig. S1 Cell potential variation with time in accelerated life tested performed in 0.5 M H_2SO_4 solution under 1 A cm^{-2} at 25 °C.

Table S1 Comparison of the service life of different Ti/SnO_2-Sb electrodes in the literature

	Current density (A cm^{-2})	Accelerated service life (h)	Actual service life (year) (under 10 mA cm^{-2})
Our study	0.5	10.23	2.92
Sun et al.[1]	0.5	2	0.57
Yang et al.[2]	0.1	100	1.14
Wang et al.[3]	0.1	160	1.83
Zhang et al.[4]	1	0.95	1.08

Text. S1-The calculation details of mass transfer performance

At sufficiently high anodic potentials, the limiting anodic current density (I_{lim}) can be described by the following equation:[5]

$$I_{\text{lim}} = \frac{D_{\text{Fe(CN)}_6^{3-}} zF}{2\delta} C_{\text{b}} = k_{\text{d}} C_{\text{b}} \tag{S1}$$

where $D_{\text{Fe(CN)6/3-}}$ is the diffusion coefficient for $Fe(CN)_6^{3-}$ (m s^{-1}), $z = 1$ is the number of electrons transferred for $Fe(CN)_6^{4-}$ oxidation, F is the Faraday constant (96485 C mol^{-1}), δ is the boundary layer thickness (m), and C_{b} is the bulk concentration of $Fe(CN)_6^{4-}$ (mol m^{-3}). Thus, the observed rate constant (k_{obs}, m s^{-1}) for $Fe(CN)_6^{4-}$

oxidation at the reactive electrochemical filter system was determined using the limiting current approach,[6, 7] and the k_{obs} was calculated by the following equation:

$$k_{\mathrm{obs}} = \frac{I_{\mathrm{lim}}}{zFAC_{\mathrm{b}}} \tag{S2}$$

where A is the anode geometric surface area (m^2). However, the measured I_{lim} by electrochemical station also contains other streams such as charging current and cause an overestimation of k_{obs}. To measure k_{obs} more precisely, additional $\mathrm{Fe(CN)_6}^{3-}$ oxidation experiments at sufficiently high anodic potentials, which determined by measuring the anodic current density – potentials curves at a scan rate of 10 mV s^{-1}, were conducted in a flow-through mode at a constant penetration flux. The k_{obs} can be calculated by the following equation.

$$k_{\mathrm{obs}} = 10^{-2} \frac{V}{A} \frac{\int dC_{\mathrm{b}}}{\int C_{\mathrm{b}} dt} \tag{S3}$$

where V is the treatment solution volume (m^3). Based on the measured k_{obs} values at various penetration fluxes, a simple model accounts for the competition between kinetics and mass transfer reported by Chaplin was used to fit the k_{obs} values (blue line in Fig. 4) by the following equation:[6]

$$k_{\mathrm{obs}} = \frac{kk_{\mathrm{m}}}{k + k_{\mathrm{m}}} \tag{S4}$$

where k_{m} is the normalized mass transfer rate constant (m s^{-1}) and it was set equal to J (m s^{-1}), k is the normalized kinetic rate constant (m s^{-1}).

Text S2-The calculation details of electrochemically active surface

Total voltammetric charge (q_T*, mC cm^{-2}) is the entire electroactive surface of an electrode, which is obtained when the scan rate (v) tends is approaching zero.[8,9] Specifically, q_T* can be obtained by plotting the reciprocal of q* against the square root of the potential scan rate (equation S4).

$$(q^*)^{-1} = (q_T^*)^{-1} + kv^{1/2} \tag{S4}$$

where k is a constant. Total voltammetric charge q_T* is composed of two fractions, outer voltammetric charge (q_O*) and inner voltammetric charge (q_I*), which represent the charge related to the outer geometric and inner unattainable electrode areas, respectively. Among them, q_O* is related to the most accessible electroactive surface area, and can be obtained according to the following equation:

$$q^* = q_O^* + kv^{-1/2} \tag{S5}$$

Additionally, the ratio between the inner voltammetric charge (q_I^*, mC cm^{-2}) and the total voltammetric charge (q_T^*, mC cm^{-2}) was defined as the electrochemical porosity (q_I^*/q_T^*, %).[10] And the roughness factor (R_f), which was calculated by comparing the determine capacitance of the electrode with the average double-layer capacitance of a smooth oxide surface (60 μF),[11], was defined the electroactive area per geometrical area.[12]

The q_T* and q_O^* for the porous Ti/SnO_2-Sb filter are investigated as a function of different scan rates (v) as presented in Fig. S2(b) and (c), respectively.

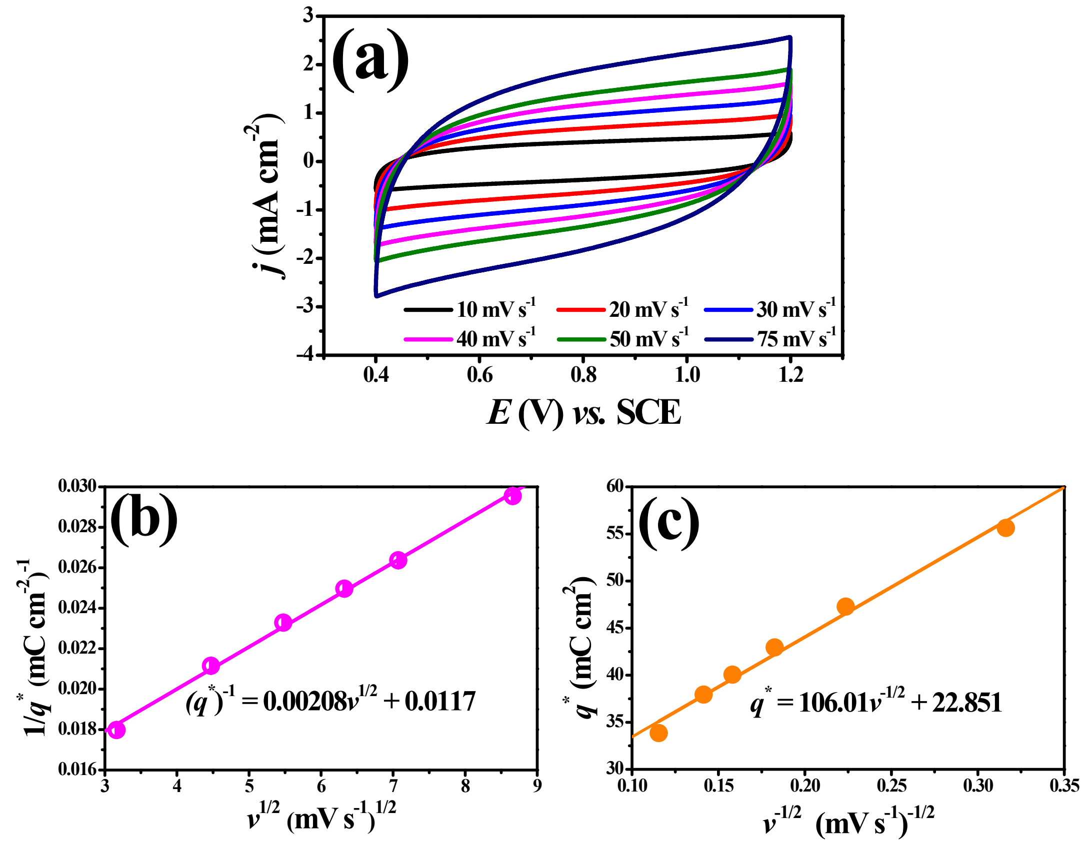

Fig. S2 (a) CV curves of porous Ti/SnO_2-Sb filter at different scan rate, penetration flux: 12.3 m^3 m^{-2} h^{-1}; (b) Reciprocal voltammetric charge *vs.* the square root of scan rate; (c) Voltammetric charge *vs*. the reciprocal square root of scan rate.

Table S2 Total, Outer and Inner charge, q_I^*/q_T^* and R_f of the porous Ti/SnO_2-Sb filter

q_T^*/(mC cm^{-2})	q_O^*/(mC cm^{-2})	q_I^*/(mC cm^{-2})	q_I^*/q_T^*(%)	R_f
85.7 ± 2.2	22.9±1.4	62.8	73.3%	1428.2 ± 37.2

Table S3 Comparison of mass transfer performance of different electrode

	Anode	Standard probing molecule	Initial concentration (mM)	k_{obs} (m s^{-1})	k (m s^{-1})
Our study	porous Ti/SnO_2-Sb filter	$K_4Fe(CN)_6$	5	4.35×10^{-4}	4.7×10^{-4}
Guo et al.[13]	TiO_2 magnéli phase membrane	$K_4Fe(CN)_6$	5	1.4×10^{-4}	1.7×10^{-4}
Tsierkezos et al.[14]	CNT filter	$K_4Fe(CN)_6$	1	1×10^{-4}	-
Li et al.[15]	Ti/SnO_2-Sb tubular	Pyridine	1.3	2.24×10^{-5}	-

Table S4 Comparison of oxidation performance of different electrode

	Anode	Model pollutant	Initial concentration (mM)	Oxidation (%)	time (t, h)	Oxidation Flux (*OF*, mol m^{-2} h^{-1})
Our study	porous Ti/SnO_2-Sb filter	RhB	0.10	99%	0.25	0.044
Liu et al.[16]	CNT-filter	Tetracycline	0.2	>99%	-	0.024
Li et al.[15]	tubular Ti/SnO_2-Sb	Pyridine	1.3	About 99%	3	0.024
Santos et al.[17]	Porous Ti_4O_7 membrane	Phenol	1	About 60%	3	0.024

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