Novel three-dimensional macroporous PbO$_2$ foam electrode for

efficient electrocatalytic decolorization of dyes

Supporting Information

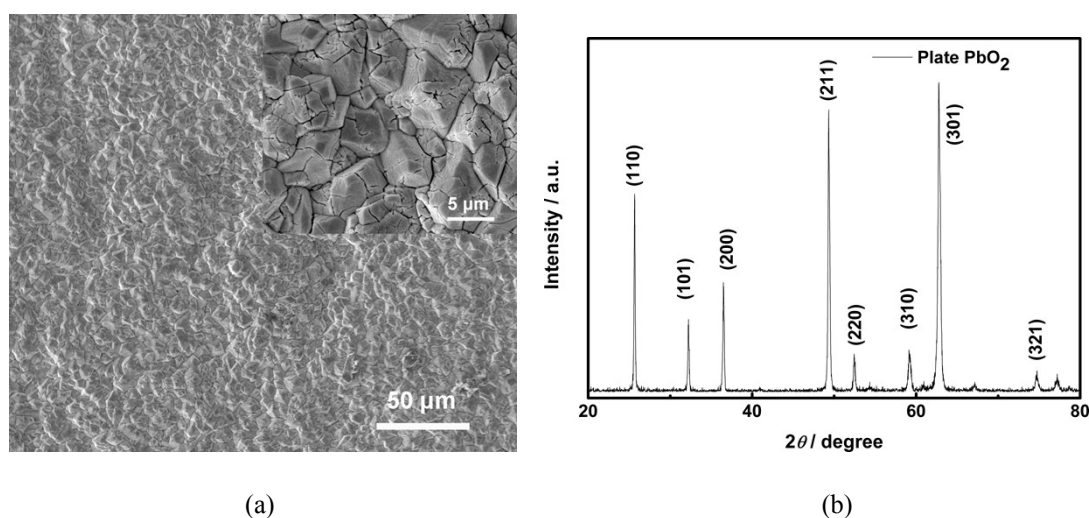(a)   (b)

Figure S1 (a) SEM image and (b) XRD pattern of plate PbO$_2$ electrode.

Figure S1 shows the SEM image and XRD pattern of titanium-based PbO$_2$ electrode.

The plate electrode was electrodeposited at room temperature, and displays cracked

macromeritic grains. The XRD pattern of plate PbO$_2$ electrode show the strong

diffraction intensity and the strongest diffraction peak appears at (301) plane. The cell

parameters were calculated according to Bragg's formula [1]:

$$d_{hkl} = \frac{1}{\sqrt{((h^2/a^2)+(k^2/b^2)+(l^2/c^2))}}$$

(1)

where d_{hkl} is the crystal face space, h, k and l are crystal face index, and a, b and c are

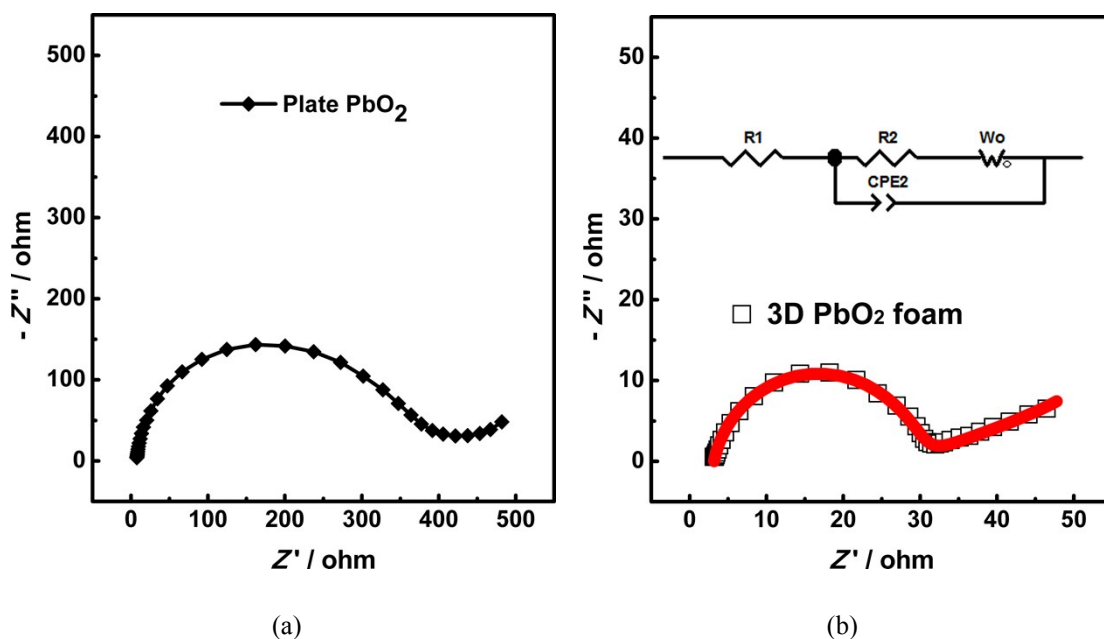the unit-cell parameters. Thereinto, $a=b$.

Figure S2 Nyquist plots of (a) plate PbO_2 electrode and (b) 3D PbO_2 foam electrode. The inset is the corresponding equivalent circuit model.

Figure S2 shows the electrochemical impedance spectra. The electrochemical impedance spectroscopy (EIS) experiment was carried out at 1.5 V (vs. SCE) through a SP-240 electrochemical workstation (BioLogic Science Instruments, France) in a conventional three-electrode system. The as-prepared electrode served as the working electrode, and a platinum sheet (2×2 cm^2) and saturated calomel electrode (SCE) were used as a counter and reference electrode, respectively. The supporting electrolyte was 0.25 M Na_2SO_4 solution. The frequency range was from 10^5 Hz to 0.1 Hz and the amplitude signal was 5 mV. The resulted EIS was fitted using the ZView program.
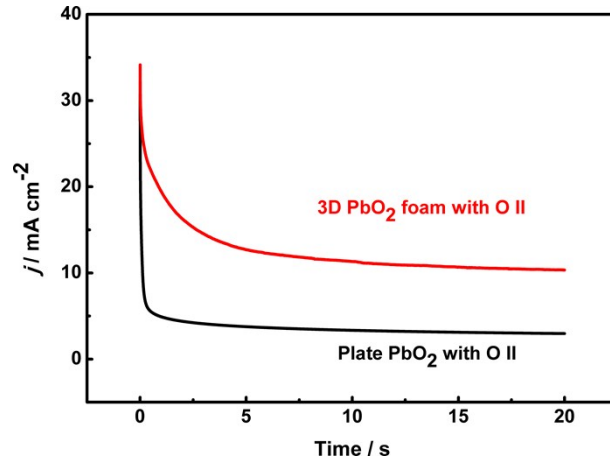
Figure S3 Chronoamperometric j-t curves at 3 V in 500 mg L^{-1} O II solution.

Figure S3 shows the chronoamperometric curves of both electrodes. Chronoamperometric experiments were employed to test diffusion response of orange II at electrodes in 0.25 M Na$_2$SO$_4$ solution at 3.0 V constant potential with orange II. The dye diffusion is preliminarily evaluated according to the Cottrell formula [2]:

$$I(t) = \frac{nFAD_O^{1/2}C_O^*}{\pi^{1/2}t^{1/2}}$$
(2)

where I is the current, t is time, n is transfer charge number, F is Faraday constant, A is electrode apparent surface area, D_O is diffusion coefficient, and C^*_O is bulk concentration. A equals to 4 cm^2, F equals to 96485 C mol^{-1}, n roughly equals to 74, and C^*_O is 1.43×10^{-6} mol cm^{-3}. On the basis of above results, diffusion coefficients are obtained from the slopes of I versus $t^{-1/2}$, and they are 2.29×10^{-6} and 4.18×10^{-5} cm^2 s^{-1}, respectively.

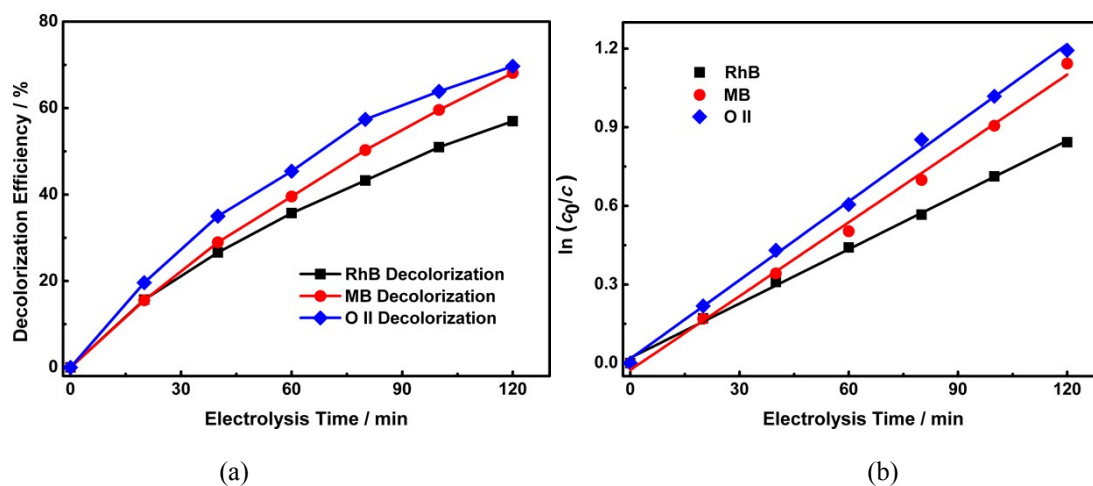(a)   (b)

Figure S4 Dye decolorization experiments on plate PbO_2 electrode.

Figure S4 shows the dye decolorization processes on plate PbO_2 electrode, and the processes follow the first-order kinetics model [3]:

$$dc/dt = -kc \tag{3}$$

Where c is the concentration of methylene blue at given time and k is the kinetic rate constant. The kinetic rate constants for methylene blue decolorization were obtained from the slope of Figure S5b.

References

[1] X. Cui, G. Zhao, Y. Lei, H. Li, P. Li, M. Liu, Novel vertically aligned TiO_2 nanotubes embedded with Sb-doped SnO_2 electrode with high oxygen evolution potential and long service time, Mater. Chem. Phys. 113 (2009) 314-321.

[2] A.J. Bard, L.R. Faulkner, Electrochemical methods, fundamentals and applications, John Wiley and Sons Inc., New York, 2001.

[3] B. Haspulat, A. Gülce, H. Gülce, Efficient photocatalytic decolorization of some textile dyes using Fe ions doped polyaniline film on ITO coated glass substrate, J.