Fabrication and Electrocatalytic Performance of a Two-Dimensional β -PbO₂ Macroporous Array for Methyl Orange Degradation

Song Yuzhu, Chen Zhen*, Gui Lai, Yu Qiang, Zhu Wei, Wu Dan, and Zheng Tao

Faculty of science, Kunming University of Science and Technology, Kunming 650093, People's Republic of China

*E-mail: chenzhen69@qq.com, songyuzhu1@foxmail.com

doi: 10.20964/2019.08.45

Received: 18 March 2019 / Accepted: 17 May 2019 / Published: 30 June 2019

To further improve the electrocatalytic degradation activity of PbO₂ electrodes for refractory organic pollutant treatment, a novel two-dimensional β -PbO₂ macroporous array electrode (2D-PbO₂) was fabricated by electrochemical deposition based on a two-dimensional colloidal crystal template, which was constructed using the Langmuir-Blodgett film technique. The structure and surface morphology of 2D-PbO₂ electrodes and traditional flat electrodes (Flat-PbO₂) were characterized by scanning electron microscopy (SEM) and X-ray diffraction (XRD). The anode polarization curves, cyclic voltammetry (CV) curves and electrochemical impedance spectroscopy (EIS) measurements were investigated to compare the electrocatalytic activity of the two kinds of electrodes. The electrocatalytic degradation of methyl orange (MO) was performed by CV, and UV spectroscopy was used to monitor changes during the electrocatalytic degradation process. The results show that the as-prepared electrode exhibited a two-dimensional ordered micron spherical cavity array structure with a large specific surface area. The coating surface is composed of single β -PbO₂ microcavities 5-6 μm in size, and the spacing of the micron holes is approximately 2 μm . Compared with the Flat-PbO₂ electrodes, the 2D-PbO₂ electrodes show a higher exchange current density ($j^0=1.478\times10^{-5} \text{ A}\cdot\text{cm}^{-2}$), smaller apparent activation energy ($E_a=12.09 \text{ kJ}\cdot\text{mol}^{-1}$), larger electric double layer capacitance ($C_{dl}=60 \text{ }\mu\text{F}\cdot\text{cm}^{-2}$) and smaller charge transfer resistance ($R_{ct}=16.89 \text{ }\Omega\cdot\text{cm}^2$), resulting in better electrocatalytic performance. In the electrocatalytic degradation process of MO, the conjugated chromophore group in the molecular structure of MO has been damaged by direct oxidation methods. The reaction followed pseudo first-order kinetics, and the value of the apparent rate constant (k_{app}) is 0.06814 min^{-1} , approximately 2.35 times that of the Flat-PbO₂ electrodes (0.02902 min^{-1}). The electrocatalytic degradation efficiency was significantly improved.

Keywords: 2D-PbO₂ electrodes; Langmuir-Blodgett films technique; electrocatalytic degradation; methyl orange

[FULL TEXT](#)

© 2019 The Authors. Published by ESG (www.electrochemsci.org). This article is an open access article distributed under the terms and conditions of the Creative Commons Attribution license (<http://creativecommons.org/licenses/by/4.0/>).