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研究论文

基于薄层反应器的有机污染物光电催化氧化反应性能与机理

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摘要 基于薄层反应器快速耗竭氧化特点, 研究了典型环境内分泌干扰物双酚 A 在 TiO2 纳米管阵列电极上的光电催化氧化反应性能与反应机理. 结果表明, 薄层反应器中光电流、初始峰值电流、耗竭反应净电量和空白光电流等光电催化物理参数均能反映光电催化反应速率, 并适用于催化反应的机制分析. 峰值光电流与双酚 A 初始浓度拟合结果表明, 双酚 A 在电极表面的吸附符合朗格缪尔等温吸附方程, 且光电流与吸附浓度正相关, 而瞬态光电流时间响应曲线拟合结果发现, 双酚 A 在电极表面光电催化过程随时间呈一级指数衰减模型变化, 且该模型也适合于乙二醇、谷氨酸、酒石酸、甲醇、二乙醇胺和尿素等其他有机物的光电催化氧化过程. 可为各种光电催化传感器实时监测有机物浓度提供理论基础, 并可用于快速比较测定多种纳米电极材料的催化性能.

关键词: 光电催化 二氧化钛阵列 薄膜反应器 有机物降解 双酚 A

Abstract: The characterization and mechanism of the photoelectrocatalytic oxidation of a typical endocrine disrupting chemical, bisphenol-A (BPA), on TiO_2 nanotube arrays (TNAs) were investigated using a thin-layer reactor where BPA was rapidly and exhaustively oxidized. Physical parameters such as the photocurrent, the initial peak photocurrent, the exhaustive charge quantity, and the blank photocurrent were found to be related to the degradation rate and the reaction mechanism. The Langmuir equation was used to fit the relationship between the initial peak photocurrent response and the BPA concentration indicating the proportionality between the photocurrent responses and the adsorbed organic concentration. A first-order exponential decay fitting of transient photocurrent profiles indicated the validity of first-order organic degradation kinetics for the photoelectrocatalysis. These relationships were found to be valid for many other organics including urea, glycol, glumatic acid, tartaric acid, methanol, and diethanolamine. The quantitative relationship found in this study provides a theoretical foundation for the real-time determination of the degradability of toxic organics by photoelectrocatalytic sensors.

Keywords: photoelectrocatalysis, titania nanotube array, thin-layer reactor, organic degradation, bisphenol A

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