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Developing an eco-friendly and efficient gas diffusion electrodes for enhanced performance of H_2O_2-based advanced oxidation processes (Oral)

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Developing sustainable and resilient electrodes for in-situ generation and dosing of hydrogen peroxide (H_2O_2) can be a game changer for deployment of H_2O_2-based advanced oxidation processes. Herein, we engineered a novel gas diffusion electrode (GDE) composed of Printex L6 carbon (PL6C) modified with iron selenide (FeSe) nanoparticles (NPs). The GDE serves as a heterogeneous electrocatalyst for the in-situ electrogeneration of hydrogen peroxide (H_2O_2) via a 2-electron oxygen reduction reaction (ORR) pathway. Additionally, the synergistic generation of hydroxyl radicals (•OH) through a 3-electron ORR pathway [1] and other coexisting mechanisms was investigated. The direct and indirect electrogeneration of reactive oxygen species was explored by studying the degradation of the psychiatric drug amitriptyline. The electrocatalytic materials were characterized by electroanalytical and material characterization techniques. Benchmarking between pristine PL6C and the nano-modified GDE showcased an increase of 1.5-fold in H_2O_2 concentrations under identical operation conditions. Notably, the FeSe NP-modified GDE exhibited near-100% Faradaic efficiency during the 2-electron ORR process at a current density of 25 mA cm^{-2}, while the unmodified PL6C GDE demonstrated a lower efficiency of 77%. By integrating the optimized system with 8 W of UVA radiation, photo-electro-Fenton-based degradation of 10 mg L^{-1} amitriptyline was accomplished. This synergistic approach led to complete degradation of the pollutant amitriptyline within 90 minutes of reaction time. These results underscore the efficiency and versatility of the PL6C GDE modified with FeSe NPs for both i*n situ* H_2O_2 electrogeneration through the 2-electron ORR and the degradation of emerging contaminants via the 3-electron ORR.

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References:

[1] S. Cheng, Y. Liu, H. Zheng, Y. Pan, J. Luo, J. Cao, F. Liu, FeCo-ZIF derived carbon-encapsulated metal alloy as efficient cathode material for heterogeneous electro-Fenton reaction in 3-electron ORR pathway: Enhanced performance in alkaline condition, Sep Purif Technol 325 (2023). https://doi.org/10.1016/j.seppur.2023.124545.