Electro-Fenton Reaction by Porous Carbon Based Electrocatalysts for Water and Wastewater Treatment

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Electro-Fenton is a promising method to treat persistent organic pollutants in wastewater. In the process of electro-Fenton, the H_2O_2 are produced by electrochemical reduction of O_2 via two-electron pathway, and the generated H_2O_2 are catalyzed by Fe^{2+} to produce highly reactive •OH radical. The efficiency of pollutant degradation is highly dependent on the cathode catalysts for H_2O_2 generation. The selectivity towards H_2O_2 production from O_2 reduction is related to the adsorption energy of the •OOH intermediate on electrocatalysts surface. Carbon-based materials are attractive catalysts for H_2O_2 production due to their good electrical conductivity, excellent stability, low cost and the tunable surface properties. The adsorption properties of •OOH intermediate on carbon-based materials can be tuned by incorporation of defect or heteroatom (N, S, B, F), which breaks the integrity of π conjugation system and induce charge redistribution, thus facilitating H_2O_2 generation. Herein, adsorption properties of •OOH intermediate on porous carbon materials was controlled by doping sp^3-C or F species. The resultant carbon-based material exhibited significantly enhanced catalytic activities for electrochemical synthesis of H_2O_2. Benefited from the high H_2O_2 production rate (44.2-41.2 mmol L^{-1} h^{-1}), atrazine and perfluorooctanoate was rapidly degraded by electro-Fenton with first-order kinetic constant of 11.2 h^{-1} and 1.15 h^{-1} (-0.4 V vs.SCE, pH of 2), respectively. The real secondary effluent was successfully treated to meet the National Standard for wastewater Discharge of China (COD < 50 mg L^{-1}) with a low specific energy consumption of 6.38 kWh kg^{-1} COD^{-1}. Our works provided a new insight into the preparation of high-efficiency metal-free catalysts for electro-Fenton degradation of organic pollutants.