Electrochemical Testing of Sodium Dodecylbenzene Sulfonate Using Biochar and Graphene-Modified Screen-Printed Electrodes as a Model Compound for Per- and Polyfluoroalkyl Detection

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Developing low-cost, eco-friendly sensors for detecting PFAS-like pollutants is critical for environmental monitoring and agricultural runoff. This study investigates the electrochemical response of sodium dodecylbenzenesulfonate (SDBS), a structurally relevant PFAS surrogate, using screen-printed electrodes modified with cattail-derived biochar, iron-doped cattail biochar, and graphene-polyaniline as a comparative control. Biochar materials were synthezised via controlled pyrolysis at 500°C, with iron-doping introduced to enhance surface-mediated electron transfer. Cyclic Voltammetry was used to evaluate anodic and cathodic peak currents before and after SDBS exposure in phosphate-buffered saline, designed to stimulate environmentally relevant ionic strength (industrial water). Non-doped biochar electrodes exhibited moderate suppression, indicating analyte adsorption but partial electron transfer. In contrast, iron-doped biochar electrodes demonstrated strong signal enhancement, confirming that redox-active surface sites facilitate efficient electron transfer upon analyte adsorption. Graphene-PANI electrodes displayed near-total signal collapse, revealing that excessive conductivity can destabilize electrochemical sensing by overwhelming adsorption-driven signal transduction. Peak-to-peak separation analysis supported these findings, showing slower electron-transfer kinetics for non-doped biochar and graphene and enhanced kinetics for iron-doped biochar. By demonstrating that sustainable, low-cost biochar can outperform highly engineered, expensive electrode materials under environmentally relevant conditions. This work provides a practical framework for scalable pollutant sensing and gives foundational insights on how PFAS-like pollutants behave electrochemically.

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