Synthesis & Characterization of Phosphorus/Nitrogen Co-Doped Carbonized Waste Cigarette Filters: Application as Textile Dye Adsorbents & Oxygen Reduction Electrocatalysts

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Two main issues within our global community are pollution and electricity access. The textile dye industry produces 7x10^5 tons of dye annually, approximately 20% of which pollute water sources. While fuel cells have potential as environmentally-friendly electricity sources, their platinum-based oxygen reduction catalysts are highly expensive and inaccessible. In this research, waste cigarette filters were explored as textile dye adsorbents and oxygen reduction electrocatalysts for fuel cells. Undoped waste cigarette filters (CF) and phosphorus/nitrogen co-doped waste cigarette filters (PNCF) were carbonized via a simple, microwave-assisted technique, using ammonium polyphosphate as the dopant. The physical characteristics (surface area, porosity, etc.) of CF and PNCF were examined. Batch adsorption experiments were performed under different conditions (initial dye concentration, temperature, etc.) to understand their adsorption capabilities for methylene blue. The potential of PNCF as an oxygen reduction electrocatalyst was examined through cyclic voltammetry in alkaline solution. Due to increased surface functionality, the maximum adsorption capacity of PNCF was 303.03 mg/g (300% higher than commercial activated carbon), compared to 212.77 mg/g for CF. A tea bag model was proposed to apply PNCF. Tea bags successfully prevented PNCF from entering solution whilst allowing 10 mg PNCF to remove >90% methylene blue. For fuel cells, PNCF exhibited a favorable oxygen reduction potential at -0.231 V and was electrochemically stable. Therefore, PNCF demonstrated the potential to serve as an inexpensive, accessible alternative to commercial activated carbon adsorbents and platinum-based catalysts, and utilizing PNCF could simultaneously help combat cigarette filter pollution.

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Fourth Award of $500

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