Development of Fe-N-C Electrocatalysts for Oxygen Reduction Reaction using Waste Tires as a Cost-effective Carbon Source

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Abstract

Owing to thermodynamic complexity and kinetic sluggishness, oxygen reduction reaction (ORR) taking place at the cathodic side of the fuel cell engenders a key bottleneck in its large-scale commercialization. Pt-based electrocatalysts are often employed to deal with the aforementioned problem, however, their scarcity and rocketing price make the system uneconomical. In such a scenario, Fe-N-C electrocatalysts are emerging as a promising alternative and can be profitably fabricated using waste plastic and biomass as a carbon precursor. Where the huge worldwide production of waste tires is causing severe ecological concerns, their upcycling into Fe-N-C electrocatalysts can provide a sustainable pathway for green energy and environmental safety, supporting the theme of the circular economy. Based on these considerations, we herein present a methodical investigation for designing the Fe-N-C ORR electrocatalysts using tossed out tires. Fragmented waste tires were first transformed into carbonaceous char using microwave pyrolysis and then activated with KOH in order to engineer the surface area, whereas the Fe & N functionalization step involved high-temperature pyrolysis in a controlled atmosphere. Eventually, the derived electrocatalyst was ball-milled and acid washed. In this study, electrocatalytic performance at each fabrication step was closely elucidated in all three pH (acidic, neutral, and alkaline) and correlated with the physiochemical nature of the resulting electrocatalyst. The derived Fe-N-C demonstrated satisfactory ORR performance in a definite tetra-electronic fashion in acidic and neutral electrolytes. Nevertheless, relatively superior peroxide yield in alkaline conditions indicates a possible shift in the reaction mechanism.