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Ammonia modification of high-surface-area activated carbons as metal-free electrocatalysts for oxygen reduction reaction

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Abstract: A coconut-shell-based carbon was activated with KOH and three methods of ammonia modification were used to prepare nitrogen-containing activated carbon of high surface area. Thus, a cost-effective, scalable, and metal-free electrocatalyst was developed for use in oxygen reduction reaction (ORR). Elemental analysis, X-ray photoelectron spectroscopy (XPS), Scanning electron microscopy (SEM) and nitrogen adsorption have been used to analyze the physicochemical properties of activated carbons. The electrocatalytic performance of activated carbons was investigated with respect to ORR using cyclic voltammetry and linear sweep voltammetry in an alkaline electrolyte. The results indicate that the species distribution of nitrogen-containing groups was significantly affected by the method and temperature of ammonia modification. These factors consequently determined the electrocatalytic performance of the modified activated carbons. When the nitrogen-containing activated carbon was prepared by methods I and II at 950 °C, it exhibited an electrocatalytic activity toward ORR that was comparable to that of commercial 20% Pt/C catalyst in terms of onset potential and limiting current density. Moreover, they catalyzed ORR approximately in a four-electron pathway and showed good tolerance toward methanol crossover. In addition, we investigated the influence of

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