OFFICIAL ABSTRACT and CERTIFICATION

Highly Mesoporous Carbon Aerogel as Catalyst Support in Proton Exchange Membrane Fuel Cells

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Carbon aerogel possesses unique structural and electrical properties, such as high mesopore volume, specific surface area, and electrical conductivity, which make it suitable for use as a catalyst support in Proton Exchange Membrane Fuel Cells (PEMFC). In this study, we present a novel synthesis of highly mesoporous carbon aerogel via ambient-drying and investigate its application in PEMFCs. The structural effects of activation on carbon aerogel were also studied. Nitrogen adsorption-desorption, Non Localized Density Function Theory (NLDFT) analysis were carried out to observe the morphology and pore characteristics. We find that a resorcinol/catalyst ratio of 200 yields carbon aerogel with the highest mesopore ratio and volume. Pt on carbon aerogel and activated carbon aerogel show efficient activity in both oxygen reduction and hydrogen oxidation reactions compared to Pt on Vulcan XC-72, with increases up to 715% and 195% in specific power density, respectively. The enhanced performance of carbon aerogel is attributed to its high mesopore volume and low micropore volume. Activation increases total pore volume but also increases micropore volume, which limits oxygen transport at the cathode. Accelerated stress tests show that carbon aerogel has comparable durability with Vulcan XC-72, while activated carbon aerogel is less durable than both materials. Thus, the mesoporous carbon aerogel provides an efficient, lower-cost alternative to existing microporous carbon material as a catalyst support in PEMFCs.

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