Application of Carbon Aerogels in Lithium-Air Batteries

Raposa, Balint Zsolt (School: Lutheran Petofi High School Aszod)

One of the main challenges with today’s batteries is their relatively low volumetric and specific capacities. The highest specific capacity can be achieved with lithium-air batteries, which use metallic lithium as the anode and typically some form of porous carbon as the cathode. To enhance performance, aerogels—among the world’s lightest solid materials—are ideal candidates for cathodes. Resorcinol-formaldehyde (RF)-based carbon aerogels serve this purpose well. In my work, I utilized two types of carbon aerogels as cathode materials: one derived from pyrolyzed RF polymer and the other a graphene-oxide-modified version of this carbon gel. I integrated the carbon aerogels I had pyrolyzed into lithium-air batteries to improve the cell’s performance, energy density, and capacity compared to cells using activated carbon. In my research, I examined the pore structure and surface properties of these materials in aqueous media using NMR relaxometry and cryoporometry, exploring their impact on battery efficiency. I found that the graphene-oxide-containing sample's pores filled with water in a layered manner, indicating a more hydrophilic surface, which suggests a denser arrangement of oxygen-containing functional groups compared to the unmodified carbon aerogel. The pore sizes were reduced after adding graphene oxide, resulting in an increased specific surface area. Incorporating the reduced graphene-oxide-modified aerogel enabled the creation of a more efficient, higher-capacity battery than with the RF carbon aerogel. This improved performance is likely due to the aerogel’s higher oxygen content and altered morphology. The increased oxygen content provides more active sites for oxygen reduction, meaning that a greater specific power output can be obtained from the battery.

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