Synthesis of Porous Carbon Supported Palladium Nanoparticle Catalysts by Atomic Layer Deposition: Application for Rechargeable Lithium-O2 Battery

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Abstract

The Li-air battery, considered as the 'holy grail' of lithium batteries, is receiving a great deal of interest due to its extremely high theoretical energy density. In this study, atomic layer deposition (ALD) was used to deposit nanostructured palladium on porous carbon as the cathode material for Li-O_2 cells using palladium hexafluoroacetylacetonate ($Pd(hfac)_2$) and formalin as precursors. Scanning transmission electron microscopy showed discrete crystalline nanoparticles decorating the surface of the porous carbon support, where the size could be controlled in the range of 2-8 nm depended on the number of Pd ALD cycles performed. X-ray absorption spectroscopy at the Pd K-edge revealed that the carbon supported Pd existed in a mixed phase of palladium carbide and palladium oxide. The conformality of ALD allowed us to uniformly disperse the Pd catalyst onto the carbon support while preserving the initial porous structure. As a result, the charging and discharging performance of the oxygen cathode in a Li-O_2 cell were improved. Our results suggest that ALD is a promising technique for tailoring the surface composition and structure of nanoporous supports in energy storage devices.