Epitaxial Graphene Coatings from Coffee Grounds on Nano-SiC Particles: Durability Evaluation for Electrochemical Cell Electrodes Using Cyclic Voltammetry

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**Abstract:** Currently, electrode catalysts commonly employ carbon-supported platinum (Pt/C) materials, featuring Pt nanoparticles evenly distributed on conductive carbon black. This configuration serves not only as a support but also provides numerous active sites, making it highly effective for catalysing the oxygen reduction reaction (ORR) due to its suitable activity. While many new materials are being researched as substrates for platinum catalysts, this study focused on SiC supports that combine the durability advantages of oxide supports with the conductivity benefits of carbide supports. To address the issue of lower electrochemical surface activity for the ORR of silicon carbide (SiC) compared to traditional carbon supports, this study developed graphene layers on the surfaces of SiC nanoparticles to enhance their surface electrocatalytic activity and improve interactions with the platinum catalyst. Specifically, coffee grounds, a readily available waste material, were utilized as the carbon source to achieve this epitaxial graphene nanosheet coating. It is concluded that carbon monoxide (CO) gas and methane (CH4) gas extracted from coffee waste serve as carbon sources, and these gases are used to form graphene layers on SiC nano-powder through the Chemical Vapor Deposition process. The activity and durability of the electrocatalyst for the ORR were evaluated using cyclic voltammetry (CV) and linear sweep voltammetry (LSV) with a rotating disk electrode (RDE). The SiC/G support demonstrated very durable performance, as evidenced by an ECSA loss of only 26.9% with SiC/G@Pt, which was significantly lower than that of Pt/C (36.9%) after 5000 cycles. In addition, silicon carbide nanostructures have been reported to be electrochemically active for the reversible insertion of lithium ions. The authors evaluated the electrochemical properties and durability of Nano-SiC powders with epitaxial graphene layers derived from coffee grounds for use as battery anodes, and compared these to conventional Si-C anode materials.

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