Nitrogen-doped SWCNT-supported Pt Electrocatalysts Synthesized by Solution Plasma for Fuel Cells Application

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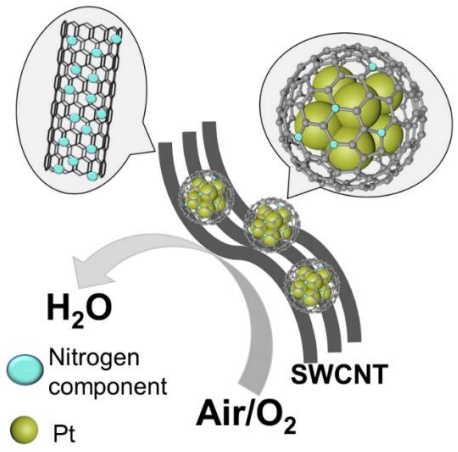
Platinum (Pt)-based electrocatalysts are widely regarded as the preferred choice for the oxygen reduction reaction (ORR) in polymer electrolyte fuel cells (PEFCs). However, their limited durability remains a significant challenge. Under the typical operating conditions of the cells, Pt is exposed to the highly oxidizing environment such as high potentials and O_2 atmospheres. Long-term exposure leads to a gradual loss of electrochemical surface area (ECSA) owing to Ostwald ripening, agglomeration of Pt nanoparticles, and the corrosion of carbon supports. This permanent loss of ECSA adversely affects the performance and lifespan of PEFCs.[1] To address this issue, high-crystallinity and high-purity single-walled carbon nanotubes (SWCNTs), synthesized via enhanced direct injection pyrolytic synthesis (e-DIPS)[2] as a support through nitrogen doping pretreatment to further prepare Pt/N-SWCNT by the solution plasma (SP) method. Pt nanoparticles in the catalyst were encapsulated with nitrogen-doped carbon shells.[3]



When Pt/N-SWCNT was used as a cathode catalyst in a membrane electrode assembly (MEA), it exhibited remarkable durability, with the maximum power density decreasing by only 20.8% after the accelerated degradation test (ADT) of 16,000 cycles. Under a high-potential accelerated condition (1.0–1.5 V), the Pt/N-SWCNT-MEA demonstrated a significantly lower maximum power density loss of 39.5%, outperforming Pt/SWCNT-MEA (48.3%) and commercial Pt/C (93.2%). These findings indicate the pivotal role of SWCNTs as a robust support material and nitrogen-doped carbon shells in enhancing the stability and activity of the catalyst, thereby contributing to the superior performance of PEFCs.

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