Fabrication of Porous Carbon Supported Fe Nanoparticles by Arc Plasma Deposition (APD): Application for Rechargeable Li-air Battery

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Lithium-air cells can be considered the 'holy grail' of lithium battery because they offer a significantly superior theoretical energy density to conventional lithium-ion system. One of the biggest hurdles for rechargeable lithium-air battery is the high overpotential on charge and discharge, even at very low current density (0.01-0.05 mA/cm^2), which results in very low round-trip efficiencies (<60%) and low power capability. This is strongly believed to depend on the nature of catalysts applied and their loading process onto high-surface area cathode.

The present study aims to explore new method to uniformly disperse the catalyst onto carbon support while still preserve the original porous structure of carbon during the synthetic process. It is common sense that the surface area and porous structure of the carbon cathode are critical for the performance of Li-air batteries during the electrochemical reactions. A porous structure with an appropriate pore size provides the space to store the discharge products. In this study, we have proposed a new iron catalyst supporting method using a nanoparticle forming pulsed arc plasma source. This supporting method has the following features: 1. Distribution of nanoparticle diameter is small; 2. Nanoparticle diameter can be easily controlled by changing discharge parameters; 3. Nanoparticle diameter can be kept constant while its deposition rate is changed; 4. Since nanoparticles are adhered to the surface of the supporting material strongly, aggregation of the catalysts can be suppressed even at high temperature. As a consequence, the original structure of carbon is well preserved. Thus, the performance of the oxygen cathode during charge and discharge cycles is significantly improved.