Transition Metal Oxide Nanoparticle Catalyst for Zinc-Air Flow Battery

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Abundance of zinc and the non-flammable aqueous electrolyte makes zinc-air batteries (ZABs) an attractive candidate for grid-scale energy storage systems. However, the efficiency of ZABs are limited by the overpotentials of the oxygen reduction reaction (ORR) and oxygen evolution reaction (OER). State-of-the-art electrocatalysts for the ORR and OER typically consists of noble metals such as Pt and Ru. In our recent works, we have demonstrated the use of transition metal oxide (TMO) activated by hybridizing with reduced graphene oxide for use in high current density ZABs.[1] Zinc-air flow battery (ZAFB) circulates electrolyte to allow unlimited scalability of the capacity by increasing electrolyte storage tanks.[2] TMO catalysts are applied to the bifunctional cathode of a ZAFB as a proof of concept for industrial applications.

The TMO catalysts were synthesized from Fe and Co nitrate precursors in equal molar ratios. Sintering the nitrate precursors homogenously mixed with graphene oxide at 350 °C produced an extremely fine dispersion of Fe/Co oxides nanocrystals with a size of about 2 nm on the surface of thermally reduced graphene oxide (rGO). Catalytic properties were confirmed with cyclic voltammetry tests and results indicated the source of improved performance is due to the high activation of the catalysts granted by the high electrical conductivity and electrochemical surface area of rGO. The catalysts are loaded onto the bifunctional cathode of the ZAFB and tested at a high current density of 100 $mA\cdot cm^{-2}$. In absolute terms, the ZAFB is cycled between 60 min of discharge and 60 min of charge steps at 1500 mA. Under such extreme conditions, the ZAFB with catalysts managed to sustain 6 cycles before charging-discharging voltages began to diverge, possibly due to the delamination of the catalysts from the cathode. Without the catalysts, it was not possible to sustain a single discharge step at 1500 mA.

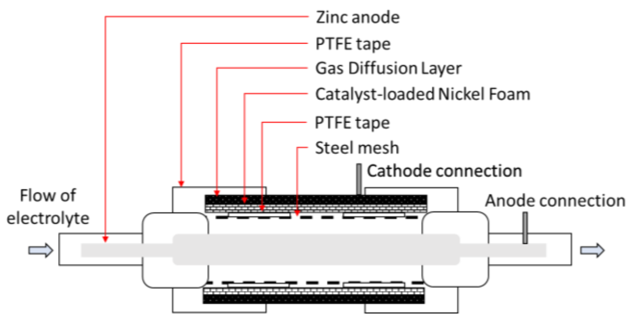

Figure 1. Cross-section of zinc-air flow battery assembly.

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