Highly Active, Non-Platinum Metal Catalyst Material as Bi-Functional Air Cathode in Zinc Air Battery

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Abstract : Current research on energy storage has been paid to metal-air batteries, because of attractive alternate energy source for the future. Metal – air batteries have the probability to significantly increase the power density, decrease the cost of energy storage and also used for a long time due to its high energy density, low-level pollution, light weight. The performance of these batteries mostly restricted by the slow kinetics of the oxygen reduction reaction (ORR) and oxygen evolution reaction (OER) on cathode during battery discharge and charge. The ORR and OER are conventionally carried out with precious metals (such as Pt) and metal oxides (such as RuO_2 and IrO_2) as catalysts separately. However, these metal-based catalysts are regularly undergoing some difficulties, including high cost, low selectivity, poor stability and unfavorable to environmental effects. So, in order to develop the active, stable, corrosion resistance and inexpensive bi-functional catalyst material is mandatory for the commercialization of zinc-air rechargeable battery technology. We have attempted and synthesized non-precious metal (NPM) catalysts comprising cobalt and N-doped multiwalled carbon nanotubes (N-MWCNTs-Co) were synthesized by the solid-state pyrolysis (SSP) of melamine with Co_3O_4. N-MWCNTs-Co acts as an excellent electrocatalyst for both the oxygen reduction reaction (ORR) and the oxygen evolution reaction (OER), and hence can be used in secondary metal-air batteries and in unitized regenerative fuel cells. It is important to study the OER and ORR at high concentrations of KOH as most of the metal-air batteries employ KOH concentrations > 4M. In the first 16 cycles of the zinc-air battery while using N-MWCNTs-Co, 20 wt.% Pt/C or 20 wt.% IrO_2/C as air electrodes. In the ORR regime (the discharge profile of the zinc-air battery), the cell voltage exhibited by N-MWCNTs-Co was 44 and 83 mV higher (based on 5th cycle) in comparison to of 20 wt.% Pt/C and 20 wt.% IrO_2/C respectively. To demonstrate this promise, a zinc-air battery was assembled and tested at a current density of 0.5 Ag^{-1} for charge-discharge 100 cycles.

Keywords : oxygen reduction reaction (ORR), oxygen evolution reaction(OER), non-platinum, zinc air battery
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