World Academy of Science, Engineering and Technology
International Journal of Chemical and Materials Engineering
Vol:17, No:09, 2023

Mn3O4-NiFe Layered Double Hydroxides(LDH)/Carbon Composite Cathode for Rechargeable Zinc-Air Battery

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Abstract : Rechargeable zinc-air batteries (ZAB) are gaining significant research attention owing to their high energy density and copious zinc resources worldwide. However, the unsolved obstacles such as dendrites, passivation, depth of discharge and the lack of an efficient cathode catalyst restrict their practical application1. By and large, non-noble transition metal-based catalysts are well-reputed materials for catalysing oxygen reduction reaction (ORR) and oxygen evolution reaction (OER) with greater stability in alkaline medium2. Herein, we report the synthesis and application of Mn_3O4-NiFeLDH/Carbon composite as a cathode catalyst for rechargeable ZAB. The synergetic effects of the mixed transition metals (Mn/Ni/Fe) have aided in catalysing ORR and OER in alkaline electrolyte with a shallow potential gap of 0.7 V. The composite, by its distinctive physicochemical characteristics, shows an excellent OER activity with a current density of 1.5 mA cm^{-2} at a potential of 1.6 V and a superior ORR activity with an onset potential of 0.8 V when compared with their counterparts. Nevertheless, the catalyst prefers a two-electron pathway for the electrochemical reduction of oxygen which results in a limiting current density of 2.5 mA cm^{-2}. The bifunctional activity of the Mn_3O_4-NiFeLDH/Carbon composite was utilized in developing rechargeable ZAB. The fully fabricated ZAB delivers an open circuit voltage of 1.4 V, a peak power density of 70 mW cm^{-2}, and a specific capacity of 800 mAh g^{-1} at a current density of 20 mA cm^{-2} with an average discharge voltage of 1 V and the cell is operable upto 50 mA cm-2. Rechargeable ZAB demonstrated over 110 h at 10 mA cm^{-2}. Further, the cause for the diminished charge-discharge performance experienced beyond the 100th cycle was investigated, and carbon corrosion was testified using Infrared spectroscopy.

Keywords : rechargeable zinc-air battery, oxygen evolution reaction, bifunctional catalyst, alkaline medium
Conference Title : ICEEE 2023 : International Conference on Electrochemistry and Electrochemical Engineering
Conference Location : San Francisco, United States
Conference Dates : September 25-26, 2023