Bifunctional catalyst derived from NiFe layered double hydroxides decorated with Ag nanowires for oxygen evolution and reduction reactions in alkaline media

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Abstract

In this work, the NiFe layered double hydroxides (Ni_3Fe LDH) decorated with Ag nanowires (Ag NWs), as a bifunctional catalyst, was applied in oxygen reduction reaction and oxygen evolution reaction under alkaline media. First, the Ag nanowires were prepared via a polyol reduction method, and to optimize their linewidth and shape by changing the stirring rate and the precursor dropping rate. The Ni_3Fe LDH was then deposited on the Ag nanowires by a hydrothermal process. As the results in surface morphology, the linewidth of Ag NWs was shortened with increasing stirring rate and precursor dropping rate. In FTIR analysis, a few residual PVP was still observed on Ag NWs while the intercalation anions of CO_3^{2-} and NO_3^- were identified. As characterized in XPS and XAS, it was found that Fe sites in decorated Ni_3Fe LDH were strongly influenced by Ag NWs, including the electronic effect (binding energy positively shifts) and the local structure environment (shorter Fe-O and Fe-M bond length). In OER performance, a mass activity of 432 mA mg^{-1}_{LDH} was reached by S-Ni_3Fe LDH/Ag NWs-F(2:1)-10mL, much better than Ni_3Fe LDH (121 mA mg^{-1}_{LDH}) and IrO_2 (149 mA $mg^{-1}_{catalyst}$), attributed to a large number of accessible active sites on the catalytic surface. However, the ORR activities of the Ni_3Fe LDH/Ag NWs catalysts showed no advantage compared to as-synthesized Ag NWs and commercial Pt/C catalyst, which may be attributed to a few residual of PVP and too thick of LDH layer on Ag surface thereby inhibit O_2 diffusion. In OER stability test, a chronoamperometric method was used for 24 hours, S-Ni_3Fe LDH/Ag NWs-F(2:1)-10mL showed enhanced current retention by 160%, better than Ni_3Fe LDH (76.3%) and IrO_2 (91.6%), more suitable as an OER catalyst.

Keywords – *Rechargeable zinc-air battery, alkaline electrolyte, bifunctional catalyst, layered double hydroxide, Ag nanowires*