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NiSe-Ni₃Se₂/Multiwalled Carbon Nanotubes as Efficient Electrocatalysts for the Oxygen Evolution Reaction in Alkaline Media

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Abstract: The development of effective catalysts for the oxygen evolution reaction (OER) is of great importance to combat energy-related concerns in the environment. Herein, we report a one-step solvothermal method employed for the fabrication of nickel selenide hybrids (NiSe-Ni₃Se₂) and a series of nickel selenide hybrid/multiwalled carbon nanotube composites (NiSe-Ni₃Se₂/MWCNT) as electrocatalysts for OER in alkaline media. The catalytic activities of these catalysts were investigated via several electrochemical characterization techniques, such as linear sweep voltammetry, chronoamperometric studies at constant potential, electrochemical surface area determination, and Tafel slope calculation, under alkaline conditions. Morphological observations demonstrated the agglomeration of non-uniform NiSe-Ni₃Se₂ microspheres around carbon nanotubes (CNTs), demonstrating the successful synthesis of NiSe-Ni₃Se₂/MWCNT nanocomposites. Among the tested electrocatalysts, the 20% NiSe-Ni₃Se₂/MWCNT nanocomposite demonstrated the highest activity, exhibiting an overpotential of 325 mV to achieve a current density of 10 mA.cm⁻² in 0.1 mol.dm⁻³ KOH solution. The NiSe-Ni₃Se₂/MWCNT nanocomposites showed improved activity toward OER compared to bare NiSe-Ni₃Se₂ hybrids and MWCNTs, exhibiting an overpotential of 528, 392 and 434 mV for 10%, 30% and 50% NiSe-Ni₃Se₂/MWCNT nanocomposites, respectively. These results compare favourably to the overpotential of noble catalysts, such as RuO2 and IrO2. Our results imply that the addition of MWCNTs increased the activity of NiSe-Ni₃Se₂ hybrids due to an increased number of catalytic sites, dispersion of NiSe-Ni₃Se₂ hybrid nanoparticles, and electronic conductivity of the nanocomposites. These nanocomposites also demonstrated better long-term stability compared to NiSe-Ni₃Se₂ hybrids and MWCNTs. Hence, NiSe-Ni₃Se₂/MWCNT nanocomposites possess the potential as effective electrocatalysts for OER in alkaline media.

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