THE INFLUENCE OF Co OXIDE-DOPPED CeO_2/Y_2O_3 CORE ON THE OXYGEN EVOLUTION REACTION ACTIVITY OF IrO_2 SHELL

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Abstract

The consecutive microwave-assisted hydrothermal shelling combined with aerosol-assisted calcination was applied as a synthesis route for IrO_2-shelled CoCeY oxide core composites, designed as potential high-efficiency catalysts for the oxygen evolution reaction (OER) with a reduced iridium content. The search for such efficient OER catalysts is of great significance in advancing metal-air rechargeable batteries and hydrogen production via water electrolysis, where minimizing the use of costly noble metals remains a critical challenge. CoCeY oxide supports were synthesized using a one-step ultrasonic spray pyrolysis (USP) process, in which precursor aqueous solutions of $CeCl_3$, $Y(NO_3)_3$, and $Co(NO_3)_2$ were mixed in mole ratios of Ce:Y:Co = 8:2:5 and Ce:Y:Co = 2:8:5. The USP process was carried out under precisely controlled conditions, with the conversion temperature carefully maintained using a thermostated furnace to achieve uniform particle formation and a well-defined phase composition. Nebulization and aerosol generation took place in an oxygen-rich atmosphere, with a regulated gas flow rate of 2 dm^3 min^{-1}, while the synthesis temperature was consistently held at 800 °C. These parameters enabled the development of CoCeY (∑M) composite structures with the required crystallinity and morphology, providing a stable and suitable framework for further catalyst modification. After the synthesis of oxide supports, the materials were subjected to microwave hydrothermal treatment in the presence of $IrCl_3$ while maintaining a stable temperature, resulting in composite structures with tailored IrO_2 mole ratios (∑M:Ir = 3:7 and ∑M:Ir = 7:3). The catalytic performance of the synthesized thin-layer composites for OER was assessed through polarization measurements in acidic media. Electrochemical structure-activity relationships were further examined using impedance spectroscopy, providing insights into charge transfer properties and interfacial kinetics. Additionally, the impact of post-synthesis thermal treatment on the structural and electrochemical properties of the composites was investigated. A strong correlation between structural parameters, physicochemical state, composition, and OER activity was identified, offering valuable guidance for the design of advanced, cost-effective electrocatalysts.

Keywords: *oxygen evolution activity; anode durability; water splitting; activity distribution through bulk powders.*

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