Enhanced Electrocatalytic Intrinsic Activity of NiO Microflowers on Graphene Paper for Oxygen Evolution Reaction

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Abstract

Electrochemical water splitting represents a promising way to produce carbon-free renewable energy. Water splitting is composed of two half reactions: the oxygen evolution reaction (OER) and the hydrogen evolution reaction (HER), taking place at the anode and cathode, respectively. The OER is considered the limiting process of the overall water electrolysis, because it involves four sequential electron transfer, thereby having slow kinetics and a large energy barrier for water splitting. One important issue is the availability of raw. Although their significant economic importance for key sectors in the global economy, they have a high-supply risk and there is a lack of (viable) substitutes, due to the unique and reliable properties of these materials for existing. Oxides and hydroxides of non-precious transition metals (e.g., Fe, Co, Ni) have been extensively investigated and are currently prevailing electrocatalysts used in the OER. Among these, Ni oxide represents a promising candidate as anode material with enhanced electrochemical performances. NiO nanostructures (such as oriented arrays, multilayers, or interconnected networks) increase electrolyte permeability through the active material, facilitating the mass transport at the interface. Thanks to unique size dependent properties, mass diffusion, and high surface area, nanostructured NiO is often used as a high-performance OER catalyst.

In our work NiO microflowers (prepared by a low-cost and environmentally friendly chemical method) were dispersed onto a graphene paper (GP) substrate with different mass loading. The effect of the variation of the catalyst amount was evaluated through electrochemical analyses and the role of surface active sites was elucidated. Polarization curves, Tafel plot and Turnover frequencies were used as important parameters to evaluate the overall intrinsic activity of the dispersed catalysts. The NiO catalyst with optimized mass loading and material dispersion on GP required only 312 mV to deliver a current density of 10 mA cm^{-2} for the OER under alkaline conditions, with the charge transfer resistance of 4 ohms, and a TOF of 6.98 s^{-1}. A deep understanding of the effect of the variation of the mass loading of NiO microflowers elucidated the influence of the amount of catalyst in the OER. The presented low-cost and reproducible approach can provide a significant platform for the future development of high-efficiency electrocatalysts.

[1] Bruno, L.; Scuderi, M.; Priolo, F.; Mirabella, S. Enhanced Electrocatalytic Intrinsic Activity of NiO Microflowers on Graphene Paper for Oxygen Evolution Reaction (paper in preparation)

Oral Presentation preferred