

Property-performance relationship assessment of tailored nanoparticles for alkaline water electrolysis

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Abstract

Tackling climate change is one of the major challenges nowadays asking for a reduced use and alternatives to fossil fuels. While hydrogen is currently often produced in fossil fuel reforming processes, water electrolyzers are a promising technological, electrocatalytic solution producing hydrogen (and oxygen) by splitting water electrically via renewable energy that can open up a novel, sustainable hydrogen-based energy landscape. Hydrogen can be used in hydrogen fuel cells, CO₂ reduction to form base chemicals or synthetic fuels, steel production, and many other industrial and chemical processes.

The two reactions occurring in water electrolyzers, hydrogen and oxygen evolution (HER, OER), are in mutual dependence. To overcome the slow OER process that particularly limits the overall electrolyzer efficiency, novel material designs for OER catalysts are needed. Expensive precious metals can be replaced by cheaper and less critical metals such as cobalt, iron, and nickel in alkaline electrolyzers as OER catalysts.

In contrast to state-of-the-art alkaline electrolyzers, anion-exchange membrane (AEM) electrolyzers avoid highly alkaline solutions and consist of a catalyst-membrane-catalyst assembly. Property tuning of non-precious OER catalyst materials for AEM electrolyzers is of high interest to increase the overall electrolyzer efficiency using non-critical materials supporting the development of next generation electrolyzer applications for a more sustainable energy landscape. In our contribution, we present the synthesis and characterisation of well-defined mixed (cobalt, iron, nickel) oxide or (oxy)hydroxide nanoparticles with distinct composition. The OER performance is evaluated in a rotating disk electrode (RDE) setup and correlated to the precatalyst and post-electrocatalysis properties.

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