Optimization and Scalability of Alkaline Membrane Water Electrolysis Anodes based on Ni-Fe-LDH

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Anion exchange membrane water electrolysis (AEM WE) bridges the gap between proton exchange membrane and classical alkaline water electrolysis, potentially combining their advantages while mitigating their respective limitations. In addition to optimized catalyst materials, the design of the catalyst layer significantly impacts the overall cell performance and durability.

This study presents the development of a high-performance electrode based on an in-house developed Ni_3Fe layered double hydroxide (LDH) catalyst.[1] Through optimized ink formulation, tumbler milling techniques, and tailored deposition parameters, the electrode design was refined to reduce internal and charge-transfer resistances, thereby enhancing overall cell performance.[2] Physico-chemical analysis confirmed that the catalyst's LDH structure was sustained after tumbler milling, but revealed a significant reduction in catalyst agglomerate size, leading to an increase in available surface area. By tailoring the catalyst dispersion composition, a more uniform catalyst-ionomer homogenization was realized within the catalyst layer, contributing to improved electrode design. The required cell potential to reach 2 A cm^{-2} was reduced by 140 mV with respect to a non-optimized electrode using the same catalyst material. The optimized Ni_3Fe-LDH anode demonstrated exceptional stability, operating continuously for 1000 hours with minimal degradation. In-depth characterization over the course of the stability test gave insight into changes of the catalyst structure and layer morphology revealing their impact on the cell performance.[3] To prove the technical scalability, we also investigated scale-up of the synthesis, electrode preparation and electrochemical characterization.

These findings provide a straightforward, scalable approach for catalyst treatment and dispersion control, offering critical insights for electrode development and improving AEM WE performance.

References

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