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High-Temperature Alkaline Elektrolysis –Materials and Low-Temperature Models

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Abstract

Alkaline electrolysis is well established and does not depend on scarce catalysts but delivers only low current density compared to PEM electrolysis. Increasing the operating temperature improves the ionic conductivity and the electrode kinetics. Beyond this, it enables new thermal management approaches by controlling the operating pressure.

Nevertheless, material stability in concentrated KOH at increased temperature is a challenge. Ceramic diaphragms have been used up to 200 °C but need delicate handling due to their brittleness. Unfortunately, dense. flexible anion exchange membranes are usually not stable at increased temperature. Therefore we developed composite membranes of layered double hydroxides (LDH) with polybenzimidazole (PBI), which are devoid of instable functional groups. Their ionic conductivity increases with the LDH content and the KOH concentration. Membranes down to 25 µm were successfully tested and delivered 350 mA/cm² @2 V with only plain nickel foam as electrodes.

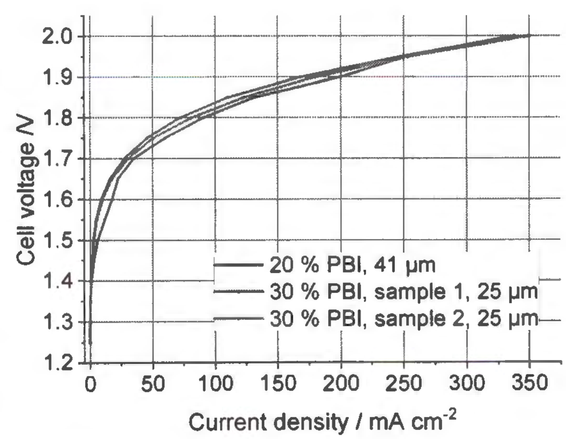

Figure 1. Polarization curves of different LDH-PBI membranes with Ni-foam electrodes at 80 °C in 32.5 wt% KOH.

Extreme conditions like high temperatures and KOH concentrations also make imaging techniques difficult to apply. We developed an approach to employ different salt solutions around room temperature as model electrolyte reflecting high temperature and concentration. A model electrolysis cell allows to dose gas into the liquid to model the gas evolution by electrolysis. This combination enables to gain insights into the two-phase flow in electrolysis under extreme conditions while measuring under mild conditions, which permits the use of advanced techniques like particle imaging velocimetry.