Advancing alkaline water electrolysis by increasing the operating temperature

Felix Lohmann-Richters, Lukas Ritz, Sonja Frerich, Ismael Quirantes Bamohamed, Robert Vaßen, Anna Mechler, Martin Müller
Forschungszentrum Jülich GmbH, Electrochemical Process Engineering (IET-4)
Forschungszentrum Jülich GmbH, Materials Synthesis and Processing (IMD-2)

52425 Jülich, Germany
f.lohmann-richters@fz-juelich.de

Increasing the operating temperature in water electrolysis can significantly improve the current density and reduce the overvoltages. This improvement is due to both, thermodynamic and kinetic effects. The electrode reactions are accelerated and the ionic conductivity increased.
We built an alkaline water electrolysis stack from commercially available materials and achieved a notable improvement with temperature, reaching 2 A/cm^2 @ 1.78 V at 125 °C, 3 bar$_g$. However, commercial diaphragms are not suitable for long-term operation at this temperature, and certainly not at higher temperatures. Component stability is generally challenging at increased temperatures, but the separator is the most crucial component. It is typically made from polymers that lack sufficient chemical and mechanical stability and hydrophilicity at increased temperature. Ceramic diaphragms can overcome this limitation and have been demonstrated at up to 250 °C. [1] For all other electrolyzer components, 200 °C appear challenging but attainable and the pressure required at this temperature remains reasonable. In addition, this temperature level would enable improvements at the system level, such as operating the stack in thermal balance and offering high-quality waste heat. [2] We prepared ceramic diaphragms using plasma spray and observed good performance at 120 °C. These diaphragms are now being further optimized and will enable exploring even higher temperatures.
This talk will elaborate on the challenges, opportunities and recent progress in alkaline electrolysis at increased temperatures.

[1] C. Chatzichristodoulou *et al.*, *J. Electrochem. Soc. 163*, 2016, F3036.
[2] F. P. Lohmann-Richters *et al., J. Electrochem. Soc.* 168**,** 2021, 114501.