Intermediate-temperature electrolysis using layered double hydroxide as electrolyte

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High efficiency is crucial for the application of electrolyzers in the future energy infrastructure based on renewable sources. One way to increase the efficiency is increasing the operating temperature of electrolyzers. The higher temperature can reduce the overvoltage of the electrode reactions and increase the electrolyte conductivity.[1-3] In addition, high-quality waste heat can be generated and new operating and control strategies might become possible. The potential of intermediate-temperature electrolysis in the range of 100 to 200 °C has not yet been explored in detail. This is in part due to the associated challenges, especially the electrolyte and electrode stability under such conditions. Despite the progress in the field of anion exchange membranes, their stability is not yet sufficient for intermediate temperature operation.[4]

Layered double hydroxides (LDH) are solid, inorganic OH^--conductors. Stable conductivity has been observed even up to 200 °C.[5] LDHs have been used as additive for membranes to enhance the ionic conductivity and reduce cross-over in fuel cells and electrolyzers,[6-8] and a low-temperature electrolyzer with LDH as electrolyte has been presented.[9] However, a demonstration of LDH as electrolyte in an electrolyzer at intermediate temperature has been missing up to now.

We employed LDH as electrolyte in a steam-fed electrolyzer cell at up to 146 °C and observe that the current density increases significantly with increasing temperature. Despite using only simple nickel foam as electrodes and operating at neutral pH, a reasonable current density of 79 mA cm^{-2} is obtained. In further experiments we could show that thin composite membranes of LDH with high-temperature polymers can be prepared. The membranes are mechanically stable and already show good performance at 80 °C. These results demonstrate the suitability of LDH as electrolyte for intermediate temperature and highlight the potential of electrolysis at intermediate temperature.

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