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Validation and characterization of suitable materials for bipolar plates in PEM water electrolysis

Manuel Langemann[1,*], David Fritz[1], Martin Müller[1], Werner Lehnert[1], Detlef Stolten[1,2]

[1] *Forschungszentrum Jülich GmbH, Institute of Energy and Climate Research, Electrochemical Process Engineering (IEK-3), Germany*
[2] *Chair for Fuel Cells, RWTH Aachen University, Germany*

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The demand for renewable, green and sustainable energy has been increasing exponentially over the past decade, by the introduction of more wind power plants. In phases with high energy production and low energy demand the excess energy could be stored in the form of Hydrogen to be used at a later date. To produce clean hydrogen by a water-splitting reaction the polymer electrolyte membrane (PEM) water electrolysis is an attractive technique. PEM water electrolysis offers a good part-load performance to handle the fluctuations of the intermittent energy sources it would likely be coupled with. One component of the PEM electrolysis cell is the metallic bipolar plate, which offers multiple functions during the PEM water electrolysis. On one hand the bipolar plate ensures the supply of water in the cell and on the other hand it provides the electrical connectivity along the cell stack. As state-of-the-art material for bipolar plates titanium is used and could be replaced by lower-cost materials such as stainless steel to reduce the overall cost. However, under the harsh environment conditions in the PEM water electrolysis stainless steel is not corrosion-resistant and metal ions can dissolve. The emission of metal ions could poison the membrane and catalyst material and lead to a reduction of cell performance. Next to the temperature and cell potential the pH value is one of the parameters which influence the corrosion development of the bipolar plates. For this purpose a series of pH-value measurements were conducted by a real cell to get the required pH-values. Furthermore, we have tested different substrate materials like stainless steel, aluminium alloys and Ni-base materials (Inconel® 625) to determine suitable bipolar plate materials. Additional coatings such as Au, TiCN or TiN in different harsh PEM water electrolysis environments for application and as protection layer were also tested. With these results we have determine possible candidates for a long-term test under real simulated PEM water electrolysis conditions.

Keywords: PEM electrolysis, bipolar plate, stainless steel, coating, corrosion