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Evaluation of 3D porous electrodes in a zero-gap cell for alkaline water electrolysis

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In modern AWE systems, a zero-gap cell architecture is used where electrodes are directly pressed on the membrane to reduce the ohmic losses related to the electrolyte. This technology requires perforated plates or novel porous 3D electrodes. Additionally, at high H_2-production rates, the enormous gas evolution leads to losses which are related to the blocking effect of adherent gas bubbles and/or the increased electrolyte resistance [1]. In this regard, optimized porous structure is required which enables enhanced removal of gas bubbles and a direct flow to the backside of the electrodes resulting in high cell efficiency.

In this contribution, powder metallurgy route in combination with a space holder method [2,3] were used to produce novel porous 3D electrodes so called porous metal foil and porous sintered metal papers. Additionally, powder metallurgic modified porous metal foams were investigated. This approach allows to adjust the porosity, the thickness as well as the pore size of the catalytic material. Consequently, the accessible surface area of the electrode can be enhanced and the flow of gas bubbles through the porous structure can be optimized. The implementation of the porous electrodes in a zero-gap single cell were investigated with respect to the cell resistance, cell voltage and the pressure distribution on the separator. Here, the porous electrodes were used as anode, whereas electrodeposited Ni-Sn electrodes [4] or Raney-Ni electrodes [5] were utilized as cathode. Single cell measurements indicates that the efficiency at high current densities (up to 1 Acm^{-2}) is mainly related to the efficient gas bubble removal. Cell voltage of 1.83 V at 1 Acm^{-2} was determined if an anode with an optimized pore structure is utilized.

Additionally, a single lab-electrolyzer was equipped with reference electrodes to get access to the half-cell potential with the objective to evaluate the cathode and anode in-operando [6].

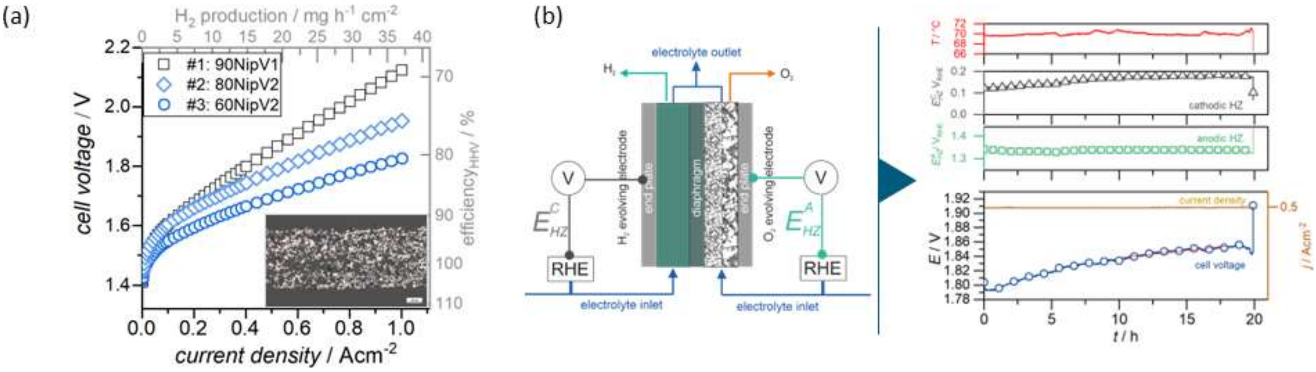

Figure 1. (a) Cell performance of different porous electrodes and (b) Single cell equipped with reference electrodes to evaluate in-operando the cathode and anode performance.

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