

Efficient Saline Water Electrolysis for Green Hydrogen Production without the Interfering Chlorine Evolution

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Green hydrogen (H_2) produced through water electrolysis in combination with renewable energy sources such as solar and wind has become an important vector of decarbonizing the chemical industry and energy sector [1], which will help to achieve the carbon neutrality goals set out by many countries. For widespread deployment of green H_2 , the cost of water electrolysis must be substantially reduced to make the electrolyzed H_2 competitive relative to that produced by conventional steam reforming. For the commercial alkaline and proton exchange membrane (PEM) electrolyzers currently being deployed, there is generally a stringent requirement for the quality of water fed into the electrolyzer [2]. As a result, ancillary equipment is in most cases needed to desalinate and purify water before it is used for electrolysis. Such desalination/purification units markedly increase the overall cost of the system and thereby the price of H_2 . Therefore, it is highly desirable to develop efficient catalytic materials and membranes as well as to design new electrolyzer configurations to enable direct usage of low-grade or saline water for H_2 production. This is particularly favorable for large-scale offshore H_2 production emerged very recently, taking advantage of the largely abundant and free seawater resources and the capability of installing MW/GW-scale offshore wind and solar farms, as pointed out by the recent techno-economic analyses [3]. However, direct seawater electrolysis faces formidable technological challenges, in particular the chloride evolution reaction (CER) happening at the anode, which competes with the oxygen evolution reaction (OER) and generates unfavorable chlorine and/or hypochlorite that will corrode catalysts, membranes and other components over time and thereby substantially reduce the operation lifetime of the electrolyzer.

In this presentation, we will demonstrate that coupling the cathodic hydrogen evolution reaction (HER) with the hydrazine oxidation reaction (HzOR) taking place at the anode enables the alkaline-saline water electrolysis to occur at a high current density without the unfavorable, interfering CER [4]. Using the bifunctional carbon paper supported Co-Ni-P nanowires (Co-Ni-P/CP) as the cathode and anode (**Figure 1a**), we have accomplished hydrogen production in alkaline-saline-hydrazine electrolyte at 500 mA cm^{-2} with a small cell voltage of only 0.533 V and outstanding stability of 80 hours with minimal degradation (**Figure 1b-d**).

REFERENCES

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FIGURES

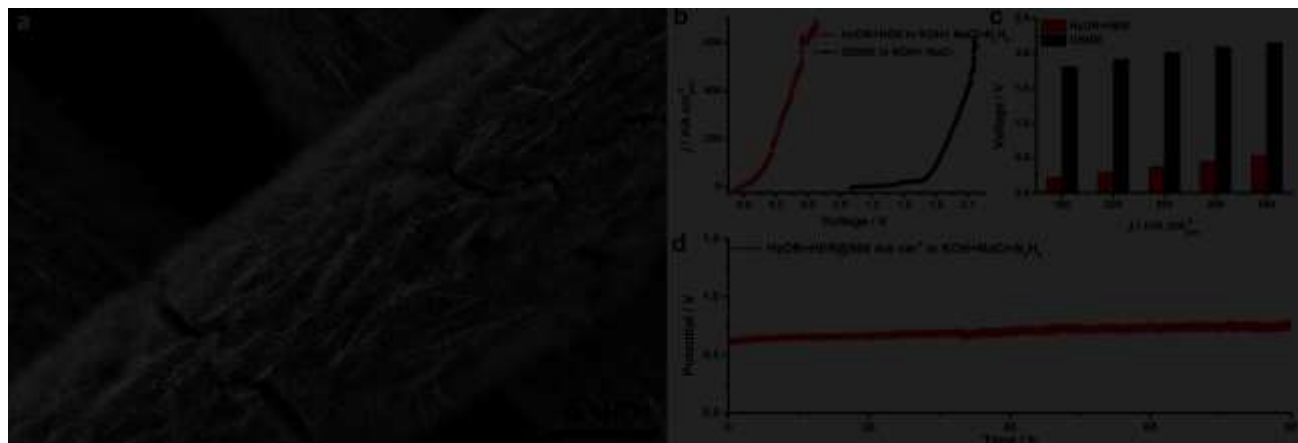


Figure 1: (a) SEM image showing the bifunctional Co-Ni-P NW electrode. (b) LSV curves of the coupled HzOR + HER and overall saline water electrolysis. Scan rate: 5 mV/s . (c) Comparison of cell voltages. (d) Chronopotentiometric curves of the HzOR + HER.