Efficient Hydrogen Production Using Proton Exchange Membrane Water Electrolysis - Precious Metals/hydrophobic Gas diffusion layer

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Abstract

The ever-increasing energy demands of modern society force us to search for alternative energy storage and conversion systems due to the reduction of fossil fuel in the earth crust and to prevent CO_2 emission to the atmosphere. The two key electrochemical processes such as oxygen evolution reaction (OER) and hydrogen evolution and oxygen reduction reaction (HER & ORR), play an important role in water-splitting, rechargeable fuel cells, and metal-air batteries. To solve the energy deficiency problems, the production of hydrogen with high purity is a key source through as an environment-friendly proton exchange membrane water electrolysis (PEMWE).

Herein, Pt-C/IrO_2 (cathode and anode) electrocatalysts are used and investigated water electrolysis (WE) performance at 25 ºC and 80 ºC with efficient gas evolution rates. We have a novel cell design, which can be applied for the pressurizing WE experiment, for that, we used hydrophobic gas diffusion layer (GDL) that consisting of acetylene black (AB), poly-tetrafluoroethylene (PTFE), and polyvinylidene fluoride (PVDF), which provided high water supporting ability lead to high pressure WE with improved current-voltage curve and efficient gas (H_2 &O_2) separation. We performed the WE up to 0.4 MPa as water pressure using electrocatalysts supported GDL and the current density reached to ~117 and 262 mA/cm^2 at 25 ºC and 80 ºC, respectively (1.6 V). More importantly, the produced hydrogen evolution rate is comparable to theoretical value calculated from Faradays Law. Furthermore, we also used Layered Protonated Titanium Oxide ($H_2Ti_2O_5 \cdot H_2O$; LPT) was prepared by a solvothermal method and investigated WE performance. Therefore, the pressurizing water electrolysis and LPT leading to improve the water transportability to the electrode and beneficial for myriad application.

References

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