MONASH University

MONASH INNOVATION

HYDROGEN EVOLUTION ELECTRODE WITH PLATINUM-LIKE ACTIVITY

An easily scalable method to fabricate a novel electrode based on earth abundant elements that shows platinum-like hydrogen evolution performance under ambient condition in neutral aqueous medium. This electrode exhibits excellent catalytic stability, high mechanical strength and flexibility.

- **High hydrogen evolution reaction (HER) activity over the whole pH range**
- **Pt-like HER activity at neutral and alkaline pH**
- **Excellent catalytic stability, high mechanical strength and flexibility, and low cost**
- **Easily scalable fabrication process**
- **Potential application in water splitting for production of hydrogen**
- **Potential application in seawater electrolysis to produce hydrogen and chlorine**

THE CHALLENGE

Hydrogen generated from water electrolysis using renewable electricity is an abundant clean fuel. It is an ideal candidate for replacing fossil fuels in the future (Figure 1).

Water electrolysis requires effective electrocatalysts to attain high current density at low overpotential. However, development of high performance electrocatalysts based on earth-abundant elements remains a grand challenge, especially for applications in neutral aqueous media. In particular,

- Aqueous compatible and water-soluble molecular HER catalysts suffer from a large overpotential and/or low stability;
- Heterogeneous non-platinum HER catalysts can only be used in strongly acidic or alkaline media.

An ideal HER electrode should:

- exhibit extraordinary catalytic activity and long-term stability;
- consist of earth abundant elements, enabling mass production;
- be nontoxic and eco-friendly;
- have excellent mechanical strength and flexibility allowing for integration in any reactors to meet different requirements and standards.

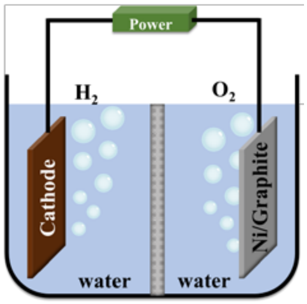

Figure 1. Illustration of a typical electrochemical cell for H_2 production.

THE TECHNOLOGY

We have developed an easily scalable method to fabricate an ultra-thin catalyst layer on a copper substrate for HER. The ultra-thin catalyst layer is chemically bonded to the copper substrate resulting in excellent mechanical properties such as strength and flexibility (Fig. 1).

We have identified a novel class of materials composed of only earth-abundant low-cost elements for efficient electrocatalytic HER over the whole pH range. Our catalyst exhibits Pt-like behaviour in neutral and alkaline media (Fig. 2) which is essential for producing H_2 and Cl_2 from seawater. Our catalyst also demonstrated excellent catalytic stability under ambient conditions (Fig. 3).

Combined with a photovoltaic cell and a commonly used water oxidation anode, a simple solar hydrogen production setup has been demonstrated.

THE OPPORTUNITY

This technology presents a number of exciting options for development. We seek a partner to take the technology to the next step towards a commercial process.

Dr Zhang and Prof Bond in the School of Chemistry have been working on electrocatalysis and related topics for more than a decade under the umbrella of the Monash Electrochemistry Group and are coinventors on the patent.

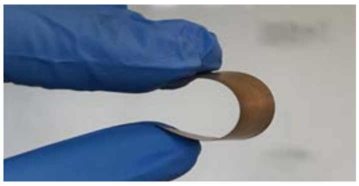

Figure 2. Photograph showing the mechanical stability of our electrode.

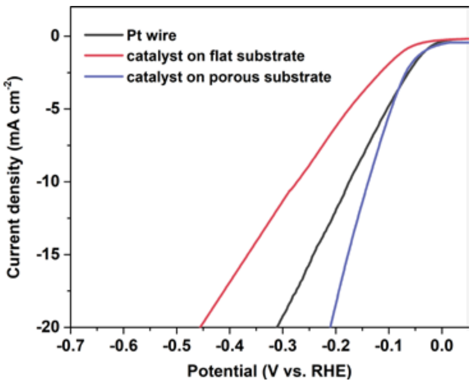

Figure 3. Linear scan voltammetries obtained on Pt wire and our catalysts in neutral phosphate buffer.

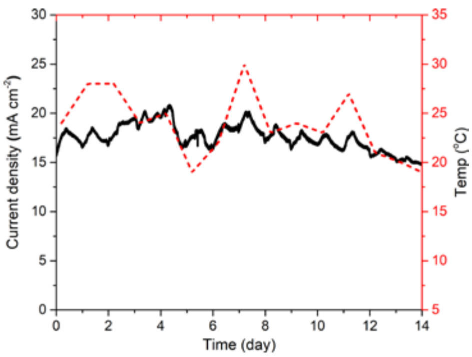

Figure 4. A 14-day stability test of our electrode in neutral media plotted together with temperature variation during the test period.

CONTACT US

Monash Innovation
T: +61 3 9905 9910
E: innovation@monash.edu
monash.edu/industry

GROUP OF EIGHT AUSTRALIA

CRICOS provider: Monash University 00008C
Produced by Monash Innovation: May 2018