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Two-Dimensional Nanoframes for High Activity Oxygen Evolution Catalysts For Water Electrolyzers

Discovery and development of high activity oxygen evolution catalysts for proton-exchange membrane (PEM) electrolyzers for splitting water into oxygen and hydrogen

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Field
Catalysis/Material Science
Energy

Technology
Catalyst for oxygen evolution for PEM-based electrolyzers

Key Features
- Activity of the catalyst is higher than commercial catalysts.
- Framework is made from inexpensive materials.
- Synthesis is scalable and does not require severe conditions.
- Less susceptible to corrosion than carbon containing materials.

Stage of Development
Proof-of-concept achieved

Status
Seeking commercial development and/or licensing partner

Patent Status
US Application filed
(October 2017)

Background

Oxygen evolution reaction (OER) electrocatalysts are a key component of proton exchange membrane (PEM) electrolyzers for production of oxygen and hydrogen from water and electricity. The largest potential markets are for producing hydrogen for energy storage and industrial uses. Hydrogen can be used directly as a fuel for chemical reactions. Hydrogen fueling stations are being developed as part of transportation infrastructure. Hydrogen production provides a means to store energy from renewable solar and wind sources. OER catalyst can also be used producing oxygen for breathing in submarines and spacecraft. Higher activity, improved stability, and lower cost catalysts are needed to facilitate the growth of these technologies.

Technology & Competitive Advantage

Rhodes et al., at Texas State University have found a two-dimensional (2D) nanoarchitecture with specific compositions can function as an oxygen evolution catalyst in acidic conditions with higher activity and lower cost than currently used commercial IrO_2-based catalysts (Figure 1). The Rhodes group has prepared two-dimensional nanoframes that consist of a catalytically active phase integrated with a carbon-free support structure. The catalysts are prepared via a scalable process. Nanosheets are decorated with low levels of precious metals and a proprietary thermal treatment is used to prepare the integrated catalyst nanoarchitecture.

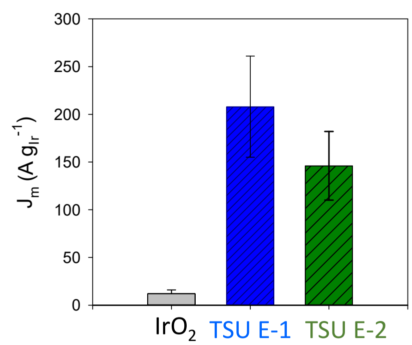

Figure 1. Enhanced OER mass activity (@1.51 V_{RHE}) of Texas State 2D nanoframe catalysts (E-1 and E-2) compared with IrO_2.

The metallic carbon-free framework structure has a high surface area and through-connected porosity. The interaction of the precious metal with lower cost transition metals increases the OER activity and reduces cost. The carbon-free materials are more resistant to corrosion than carbon-supported catalysts.

Opportunity

The market for conversion of water and electricity into hydrogen and oxygen by electrolysis is expected to expand. Due to the constantly growing utilization, large market growth for electrolytic hydrogen production is expected in the next 10 to 20 years. The market could be in the range of several tens of GW and will become even larger until 2050 if an 80% reduction in CO_2 emissions remains a worldwide goal. There is also a niche market for use as oxygen generators for submarines and spacecraft along with chemical hydrogen generation.