Catalysis Of The Hydrogen Evolution Reaction Using Ruthenium Ion Complexed Carbon Nitride Materials

Tech ID: 33001 / UC Case 2018-101-0

BACKGROUND

Hydrogen remains a promising energy source and the development of efficient technologies for hydrogen storage and conversion is important. Mechanistically, suitable electrocatalysts are required to achieve a high hydrogen generation rate as the hydrogen evolution reaction (HER) involves multiple electron-transfer steps. Thus far, platinum based materials supported on carbon exhibit the best electrocatalytic performance for HER in acidic conditions - the best conditions for HER. However, commercial applications are hindered by the high cost and low availability of such materials.

A variety of materials based on transition metals have been developed that show apparent HER electrocatalytic activities. However, such catalysts corrode in acid electrolytes. Carbon-based materials (such as graphene, CNT, and amorphous carbon) have also been explored as viable catalysts for HER and do not corrode in acid solutions. However, the activity of such compounds is substantially lower than that of platinum.

TECHNOLOGY DESCRIPTION

Hydrogen evolution reaction catalysts that are made up of ruthenium ions incorporated into graphitic carbon nitride/reduced graphene oxide hybrids form a composite that results in electron redistribution and dramatic enhancement of HER performance relative to carbon nitride, carbon nitride/graphene oxide, and Ru-carbon nitride.

These electrocatalysts require an overpotential of only −80 mV to reach a current density of 10 mA cm^{-2}, a Tafel slope of 55 mV dec^{-1}, and an exchange current density of 0.462 mA cm^{-2}

This performance is similar to Platinum/Carbon with an even lower energy barrier for hydrogen evolution.

Details are in the caption following the image

APPLICATIONS

Clean hydrogen production by electrolysis

Hydrogen evolution reaction under acidic conditions

ADVANTAGES

Cheaper than platinum based electrodes

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OTHER INFORMATION

KEYWORDS

Hydrogen evolution reaction, Hydrogen evolution reaction under acidic conditions, Ruthenium, carbon nitride, graphene oxide, Clean hydrogen, Electrocatalytic hydrogen

CATEGORIZED AS

- Energy
- Hydrogen

RELATED CASES

2018-101-0

More durable than transition metal electrodes

More efficient than other carbon based electrodes with a lower activation energy

INTELLECTUAL PROPERTY INFORMATION

Country	Type	Number	Dated	Case
United States Of America	Issued Patent	11674232	06/13/2023	2018-101
United States Of America	Issued Patent	11352704	06/07/2022	2018-101
United States Of America	Published Application	20230295816	09/21/2023	2018-101

RELATED MATERIALS

- Ruthenium Ion-Complexed Graphitic Carbon Nitride Nanosheets Supported on Reduced Graphene Oxide as High-Performance Catalysts for Electrochemical Hydrogen Evolution - 11/09/2017
- HYDROGEN EVOLUTION REACTION CATALYZED BY RUTHENIUM ION-COMPLEXED GRAPHITIC CARBON NITRIDE NANOSHEETS - 08/02/2017

ADDITIONAL TECHNOLOGIES BY THESE INVENTORS

- METHOD FOR DETECTION AND SEPARATION OF ENANTIOMERS USING VESICLE-LIKE NANOSTRUCTURES SELF-ASSEMBLED FROM JANUS NANOPARTICLES
- Rapid Preparation of Electrocatalysts by Magnetic Induction Heating and Rapid Quenching
- Platinum Oxide Nanoparticles For Electrocheical Hydrogen Evolution Influence Of Platinum Valence State
- Ru,N-Codoped Carbon Outperforms Platinum Toward Hydrogen Evolution Reaction In Alkaline Media By Atomically Dispersed Ruthenium

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