Rapid Preparation of Electrocatalysts by Magnetic Induction Heating and Rapid Quenching

Tech ID: 33007 / UC Case 2022-820-0

BACKGROUND

Carbon-supported nanocomposites are attracting particular attention as high-performance, low-cost electrocatalysts for electrochemical water splitting. These are mostly prepared by pyrolysis and hydrothermal procedures that are time-consuming (from hours to days). In addition, it is difficult to produce a nonequilibrium phase from such methods.

Methods of synthesis of nanocomposites are limited, and the range of materials that can be produced and the extent of structural engineering remain narrow. Thus, further development of effective protocols for the synthesis of materials with novel structures and properties is important.

TECHNOLOGY DESCRIPTION

The technology to create these new composites is an ultrafast heating/quenching method based on magnetic induction heating/rapid quenching (MIHRQ).

This technique has been used to prepare carbon-supported FeNi spinel composites in seconds. The composites exhibit a clear mixing of the Ni and Fe phases and a Cl-rich surface. In electrochemical measurements, the composites display an outstanding electrocatalytic performance towards the Oxygen Evolution Reaction, with an ultralow overpotential of only +260 mV to reach the high current density of 100 mA cm^{-2} This is due to the formation of a nonequilibrium structure that is optimal for the adsorption of key reaction intermediates and eventual production of oxygen and hydrogen.

The technique has also been used to produce and deposit metallic Ru nanoparticles evenly on carbon paper by thermal decomposition of $RuCl_3$ salt in an ambient atmosphere. Because of the short heating duration, $RuCl_3$ was incompletely decomposed, leading to residual Cl on the Ru surface. This can be controlled by altering the magnetic current and heating time.

Surprisingly, the residual Cl improved the ability of the composites to catalyze the hydrogen evolution reaction. Surface Cl species influenced the electronic structure of metallic Ru and the adsorption configuration and energetics of H*. Among the series, the best sample was obtained with a magnetic current of 300 A and heating time of 6 s, which demonstrated an HER activity similar to that of commercial

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OTHER INFORMATION

KEYWORDS

Carbon nanocomposites, Rapid synthesis of carbon nanocomposites, Magnetic induction heating/rapid quenching, Hydrogen Evolution Reaction Acidic Conditions, Hydrogen Evolution Reaction Alkaline Conditions, Oxygen Evolution Reaction, Clean Hydrogen Production, Hydrogen by Electrolysis

CATEGORIZED AS

- **Energy**
  - Hydrogen

RELATED CASES

2022-820-0

Pt/C in both alkaline and acidic media with a respective η_{10} of −12 and −23 mV.

APPLICATIONS

Rapid creation of carbon/metal nanoparticle composites for catalyzing water splitting reaction (seconds as opposed to hours/days).

Creation of high performance catalysts for Hydrogen Evolution Reaction (both for alkaline and acidic conditions) and Oxygen Evolution Reaction with cheaper resources.

ADVANTAGES

It's the fastest and cheapest way known to produce custom electrocatalysts for water splitting.

INTELLECTUAL PROPERTY INFORMATION

Country	Type	Number	Dated	Case
Patent Cooperation Treaty	Reference for National Filings	WO 2023/136974	07/20/2023	2022-820

Patent Pending

RELATED MATERIALS

- Ultrafast Preparation of Nonequilibrium FeNi Spinels by Magnetic Induction Heating for Unprecedented Oxygen Evolution Electrocatalysis - 06/01/2022
- Rapid preparation of carbon-supported ruthenium nanoparticles by magnetic induction heating for efficient hydrogen evolution reaction in both acidic and alkaline media - 05/06/2022

ADDITIONAL TECHNOLOGIES BY THESE INVENTORS

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

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