



Industrial Consultancy & Sponsored Research (IC&SR)

Flame based Heat Treatment for Enhancement of Hydrogen Evolution Reaction (HER) Kinetics in Ceria-based Electro-catalysts

IITM Technology Available for Licensing

PROBLEM STATEMENT

- ❖ Hydrogen evolution catalysis is crucial for global hydrogen economy growth.
- ❖ Overpotential, the excess energy needed for chemical reactions, can decrease efficiency and current density.
- ❖ Reducing overpotential enhances efficiency and maximizes current density.
- ❖ Previous findings show cerium nickel-based electro catalysts often underperform for hydrogen evolution catalysis (HER) but show excellent performance for oxygen-emitting reaction (OER).
- ❖ The focus is on improving existing (HER) performance without changing the cerium nickel concentration.
- ❖ This method enhances for activate electrodeposited samples for (HER) by altering catalyst surface morphology and creating material defects.

TECHNOLOGY CATEGORY MARKET

Technology: Enhancement of Hydrogen Evolution Reaction (HER)

Category: Chemistry & Chemical Analysis

Industry: Electro catalyst

Application: Fuel Cell ,Chemical

Market: The global market size was valued of USD 15.83 Billion in 2023, with projections to achieve USD 29.9 Billion by 2031, a compound annual growth rate (CAGR) of 9.51% from 2024 to 2031

INTELLECTUAL PROPERTY

IITM IDF Ref.2433

Patent No: IN 545302

TRL (Technology Readiness Level)

TRL- 4, Experimentally validated in Lab;

Research Lab

Prof. Tiju Thomas,
Dept. of Metallurgical and Materials Eng.

TECHNOLOGY

A method of making an electrode for Hydrogen Evolution Reaction (HER)

1. Preparing an electrolyte solution comprising a cerium precursor, a nickel precursor, a salt, and water
2. Transferring the electrolyte solution to an electrochemical cell comprising an electrode;
3. Applying a potential or current to electrodeposit a coating of cerium nickel-based electrocatalyst on the electrode; and
4. Subjecting the coating of cerium nickel-based electrocatalyst to heat treatment.

Fig 1

Electrodeposition method of the hydroxides/oxides of cerium and nickel metal onto the SS

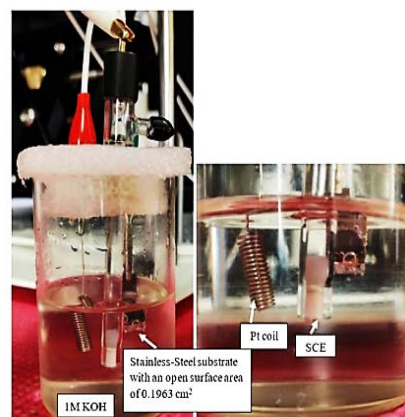


Fig 2

Flame heat treatment process opted after the electrodeposition



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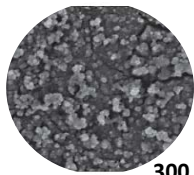
Dr. Dara Ajay, Head TTO
Technology Transfer Office,
IPM Cell- IC&SR, IIT Madras

IITM TTO Website:
<https://ipm.icsr.in/ipm/>

Email: smipm-icsr@icsrpis.iitm.ac.in

sm-marketing@imail.iitm.ac.in

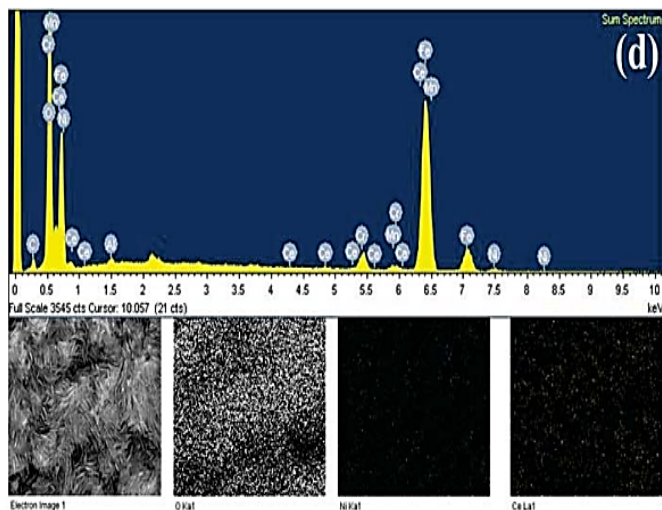
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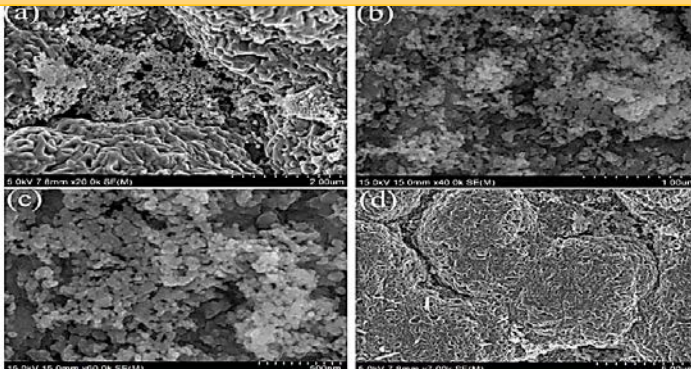
300 nm

Fig 3 shows a SEM images of the catalyst with no exposure to the flame

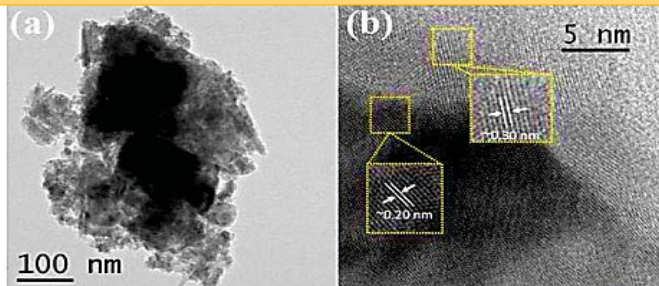
The below fig 5 shows EDAX mapping of sample-165s post 24 h of stability test for (HER) in 1 M KOH



The below Fig 4 shows a SEM images of the catalyst exposed to a well characterized flame for 165 seconds at different magnification



The below Fig 5 shows a TEM images of the post stability test of 24 h for (HER) in 1 M KOH for sample-165s



Key Features / Value Proposition

❖ Combination effect

- Combining nickel and ceria can yield high hydrogen production yields.

❖ Post-heat treatment

- samples showed significant reduction in lower over potential (185 mV/dec) exposed to flame for 165 sec.

❖ Enhance current density

- current density of 100mAcm⁻² at 440 mV vs RHE, which increased after 24 hours of stability test.
- lower overpotential, and reduce Tafel slope for HER kinetics in alkaline medium.

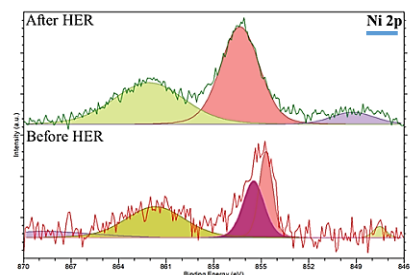
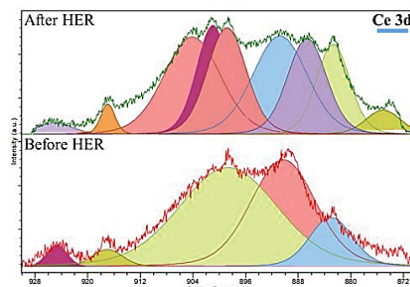
❖ Affordable Electrode

- High activity and long-term stability and affordable electrode with electrodeposited ceria-based electrocatalyst for HER in alkaline medium,

❖ Advantages

- Simple, Economical, and minimal resource-efficient method

XPS spectra of Ce 3d, and Ni 2p for sample-165s before HER and after 24 h of stability test for HER in 1 M KOH.



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Dr. Dara Ajay, Head TTO
Technology Transfer Office,
IPM Cell- IC&SR, IIT Madras

IITM TTO Website:
<https://ipm.icsr.in/ipm/>

Email: smipm-icsr@icsrpis.iitm.ac.in

sm-marketing@imail.iitm.ac.in

Phone: +91-44-2257 9756/ 9719