3-D INTERFACE AUGMENTED ULTRATHIN CATALYTIC METAL LAYER SUPPORTED ON SUBSTRATES AND METHODS OF FABRICATION

IITM Technology Available for Licensing

Problem Statement

- Develop cost-effective and efficient catalysts to overcome sluggish kinetics in water electrolysis for hydrogen production, addressing challenges like high overpotentials and slow oxygen and hydrogen evolution reactions.
- Create innovative methods to reduce reliance on noble metals, such as platinum, in catalysts for hydrogen production and fuel cells, considering the limited abundance of these materials in the earth's crust.
- Improve the performance of noble-metal-free catalysts to match the efficiency of noble-metal catalysts in various applications, including **water electrolysis, fuel cells, and exhaust gas purification** in catalytic converters.

Intellectual Property

- IITM IDF Ref**. 2484**
- **IN 202241077011**
- **PCT/IN2023/051231**

Technology Category/ Market

Category- Advanced Energy Conversion Systems
Applications- Clean Energy Generation, Industrial Catalysts
Industry- Renewable Energy, Hydrogen Production

Market - Global thin and ultra-thin films market is expected to reach USD 22,812.53 million by 2029, registering a **CAGR of 15.4%** during 2022-2029.

TRL (Technology Readiness Level)

TRL - 4: Technology validated in lab scale.

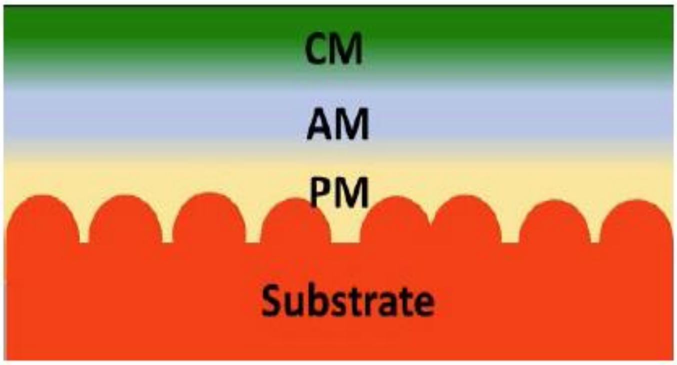

FIG.1

FIG.1. The catalytic material assembly comprises Substrate, Passive Material (PM), Active Material(AM) and Catalytic Material(CM).

Technology

- **Develop a catalytic device with a unique assembly structure, comprising a substrate, a film with active, passive, and catalytic materials, where the active material supports the catalytic material and the passive material acts as a bridge between them.**
- **Explore various substrate materials, including ceramic, semiconductor, and organic/inorganic crystals, to optimize the device's properties, such as electrical conductivity and structural integrity.**
- **Implement a fabrication method involving thermal treatments and deposition techniques like sputtering or PVD/CVD to create a patterned assembly film, potentially in a nano-ribbon structure, with optional exposure to oxy-carbo-nitriding for enhanced performance.**

Research Lab

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Key Features / Value Proposition

1. Market Potential for Ultrathin CM in Water Electrolysis:
Key Features: Substantial reduction in noble metal loading, enhanced electrolyzer performance, and potential dual functionality as a catalyst and conductive electrode.
Market Value Proposition: Cost-effective and efficient solution for advancing water electrolysis technology, contributing to sustainable hydrogen production.

2. Revolutionizing Fuel Cell Technology with Ultrathin CM:
Key Features: Replacing conventional electrodes with Ultrathin CM assembly reduces noble metal loading, serves as a catalyst and conductor, enhancing fuel cell performance.
Market Value Proposition: Cost reduction in fuel cell manufacturing, improved efficiency, and increased competitiveness in the clean energy sector.

3. Advanced Sensing Applications with Ultrathin CM Films:
Key Features: Versatile detection of various gaseous molecules and VOCs through changes in electrical conductivity, offering a reliable and responsive sensing solution.
Market Value Proposition: Efficient monitoring of environmental gases, providing industries with accurate and real-time data for safety and compliance.

Advantages

- As organic substrates are not involved, **CM film is free of poisoning** caused due organic substrate. For example, CO poisoning due to carbonaceous support.
- Lower strain in the CM is attributed to it being continuous and supported onto the PM/AM, resulting in longer life and stability.
- Low metal loading and effective utilization of expensive catalytic metal that are part of CM.
- **Ultrathin CM film would be biocompatible.**
- The assembly could be used for sensing gasses, fluids, or biological samples by measuring the change in electrical properties of the assembly.
- It could be used for **methanol production from CO2.**
- The catalytic device in the present invention can withstand annealing up to Tm/2, where Tm is the lowest melting point of substrate, PM, AM and CM.
- The AM and PM acts as a barrier layer against the diffusion of CM into the substrate.
- The method produces ultrathin metal film (UMF) on ceramic substrates. UMF has good adhesion to the substrate and is stable in corrosive, acidic, and alkaline environments.
- In some instances where CM films fully cover the AM, **CM can be continuous and acts as a conductor as well as a catalyst.**

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Images

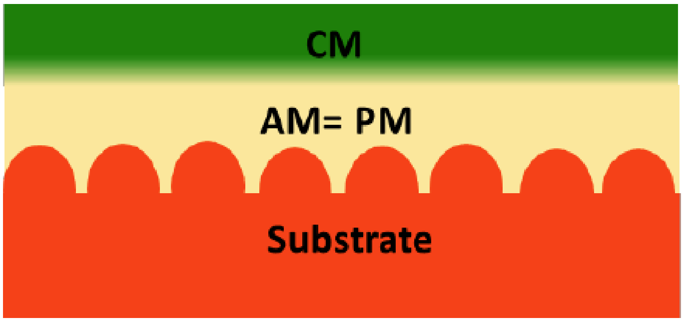

FIG.2

FIG. 2. Catalytic material assembly comprises Substrate, Passive Material/Active Material.

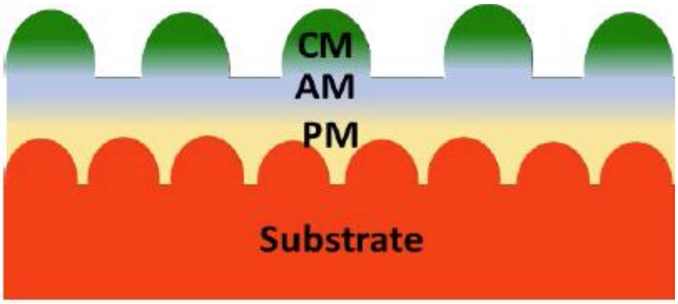

FIG.3

FIG. 3. CM partially covers the AM, and CM is not continuous, this will lead to further reduction in noble/ expensive catalytic material loading compared to CM being continuous.

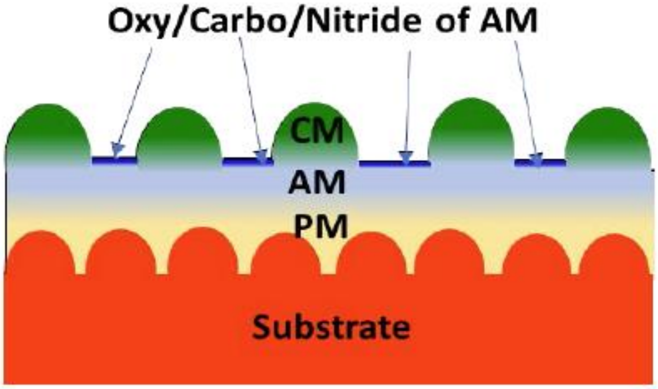

FIG.4

FIG. 4. A catalytic material assembly comprises Substrate, Passive Material (PM), Active Material (AM) and Catalytic Material (CM). Interface between CM and AM, and AM and PM could be chemically graded.

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