A METHOD OF PREPARING PALLADIUM DENDRITES ON CARBON NANOTUBES

IITM Technology Available for Licensing

Problem Statement

- Palladium is a **catalyst** used in variety of reactions involving **electro-oxidation** and **reduction.**
- Solid polymer electrolyte (**SPE**) reactors are made of palladium catalysts and allow **facile transport** of **ionic species** to the catalyst surface through the membrane under an applied potential.
- However, the control over **morphology** of palladium nanostructures on carbon or CNTs based substrates has been difficult, especially with the **conventional method** of the **chemical reduction**.

Hence, there is a demand of a new method to address the above mentioned issues.

Technology Category/ Market

Chemical Engineering: Process design, Reaction

Industry: Fuel cell, Reactor Design, Chemical mfg.

Applications: Organic synthesis, hydrogen storage

Market: The global Palladium Catalyst market size was valued at USD **547.99** M in 2022, expected with **CAGR** of **4.79%**, reaching USD **725.68 million** by **2028**.

Technology

A method of **preparing palladium dendrites**

a. **Coating carbon nano-tubes (CNTs) on a graphite substrate**

b. **Activating the substrate electrochemically**

c. **Electrodepositing palladium on the activated substrate**

wherein steps **a) to c)** are carried out without using a **template, surfactant** and/or **additive**.

- The **morphology** of the palladium particles from spherical to dendritic structure is tailored by **controlling** the **deposition potential** on electrochemically activated **CNTs** substrate.
- The dendritic **nanostructures** is grown by **increasing** the **precursor concentration** at an appropriate deposition potential.
- The preparation of palladium dendrites is done at **room temperature** and **atmospheric pressure.**
- The CNT is coated as a **thin layer** on a graphite substrate (**graphite electrode**) by dispersing CNTs in a mixture of an ionomer (**Nafion®**) and solvent (**isopropanol**), followed by blending **ultrasonically.**
- **CNT loading** on the graphite substrate is about **100 µg cm^{-2}** and coated graphite is **air dried**.
- The CNT coated graphite substrate is activated **electrochemically** by potential cycling **(100 cycles)** in acidic electrolyte (**sulfuric acid** with **0.5M** strength) that helps to improve hydrophilicity & generates CNT **surface defects.**
- **Platinum wire** and **Ag/AgCl** (3M NaCl) is used as counter & reference electrodes, respectively.
- The **potential range** is **-0.2 to 1.1 V vs. Ag/AgCl** and scan rate is **100 mV s-1**.
- Palladium is deposited by **constant potential technique** and the deposition potential and precursor concentration are **modified** to **increase** the dendritic morphology.

Fig. 1 provides scanning electron micrographs of electrodeposited Pd on electrochemically activated CNT coated substrate at

a) 0.2 V, b) 0.3 V, c) 0.4 V and d) 0.5 V.

Fig. 2 provides scanning electron micrographs of electrodeposited Pd on electrochemically activated CNT coated substrate at 0.2 V with varying precursor concentrations:

(a) 1 mM, (b) 1.5 mM and (c) 2 mM.

Wherein, CNTs were electrochemical activation in nitrogen saturated 0.5 M H_2SO_4 prior to deposition.

Key Features / Value Proposition

Technical Perspective

- The palladium dendrites have **increased surface area** and **highly efficient catalytic activity**, that is highly preferable for their use.

Industrial Perspective

- Used in the field of **fuel cells, organic synthesis, hydrogen storage and sensing.**
- Used in the SPE **reactors** to enhance the **hydrogenation reaction rates** of triglycerides.

User Perspective

Environment friendly & are widely **preferred.**

Intellectual Property

IDF Ref: 889
IN Patent No. 306280 **(Granted)**
PCT Application No. PCT/IN2013/000522

TRL (Technology Readiness Level)

TRL- **3/4** Proof of concept ready Stage

Research Lab

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Images

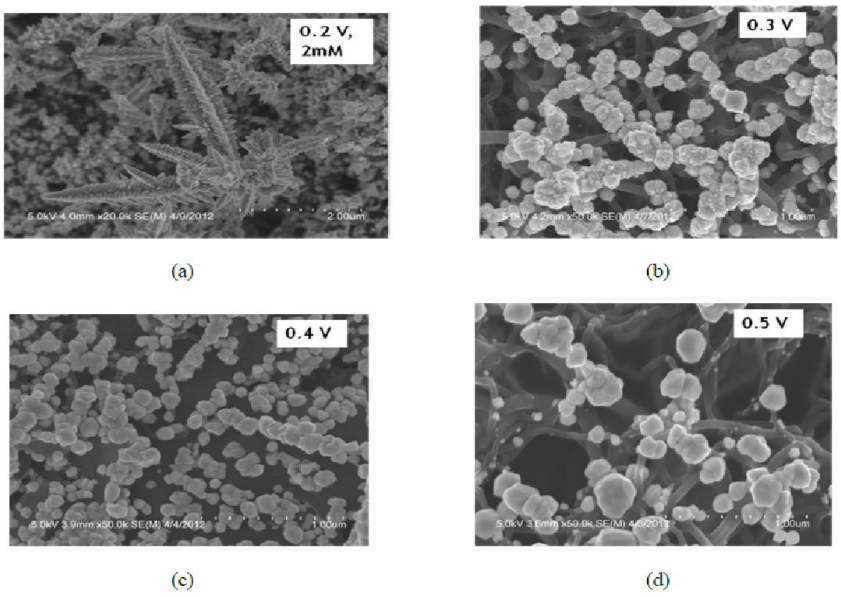

FIG: 1

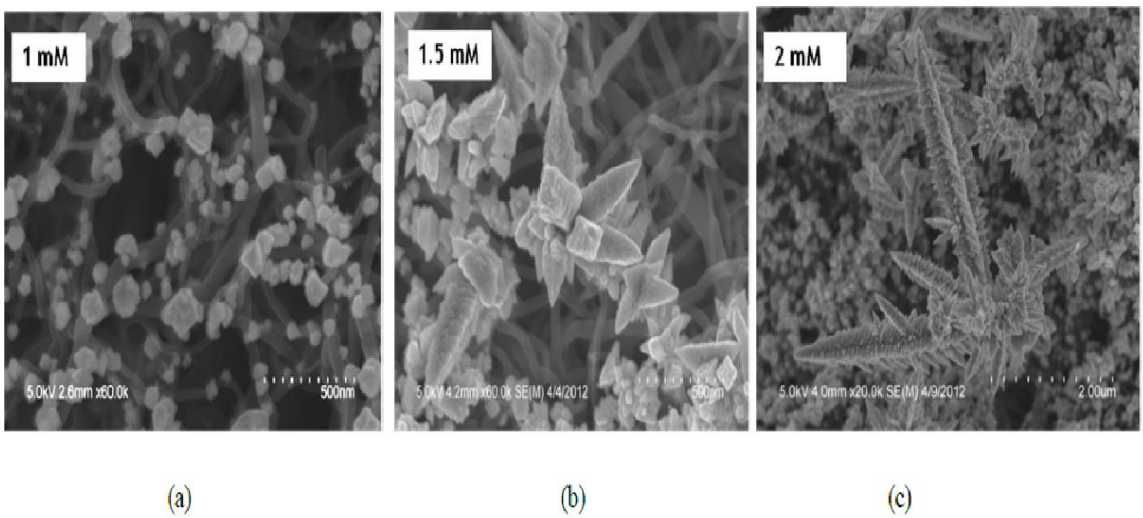

FIG: 2

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