IIT MADRAS
Indian Institute of Technology Madras

Technology Transfer Office
TTO – IPM Cell

Industrial Consultancy & Sponsored Research (IC & SR)

SOLVENT FILLED MULTIWALLED CARBON NANOTUBES FOR ENHANCED ELECTROCHEMICAL SENSING APPLICATIONS

IITM Technology Available for Licensing

Problem Statement

- Carbon nanotubes (CNTs) have diverse applications, including electrochemical systems, and **recent interest focuses on fluid behavior within CNTs (nano-fluidics) for enhanced electrochemical interfacial area.**
- Prior art studies show filling CNTs with liquids like acetonitrile improves supercapacitor efficiency, but challenges arise in simulating longer CNTs and multiwalled CNTs due to computational costs.
- Surface tension limits the entry of certain liquids into CNTs, and polar liquids like water do not wet CNTs due to their hydrophobic nature.
- **Existing methods for nanotube filling involve wet chemistry or capillarity forces**, but these approaches have limitations in efficiently filling multiwalled CNTs for enhanced electrochemical sensing applications.
- Therefore, there is a need for **improved solvent-filled multiwalled carbon nanotubes (MWCNTs)** to enhance electrochemical sensing sensitivity.

Technology Category/ Market

Category - Electrochemical Sensing

Applications - Biomedical Engineering, CNT-based devices, energy storage devices such as batteries and supercapacitors.

Industry - Medical diagnostics and monitoring, Environmental Monitoring, Energy storage and battery technology, Chemical Analysis.

Market - The CNT market is set to grow at a **15% CAGR from 2023 to 2028**. In 2022, it was valued at around US$5.72 billion and is predicted to reach US$13.32 billion by 2028.

TRL (Technology Readiness Level)

TRL - 3: Experimental Proof of Concept.

Research Laboratory

Prof. Kothandaraman, R., Dept. of Chemistry

Intellectual Property

- **IITM IDF Ref. 1785**
- **IN 400805 - Patent Granted**

Technology

- The present invention relates to related to a **solvent filled multiwalled carbon nanotube** for enhanced electrochemical sensing applications.

1. The technology introduces a method of enhancing electrochemical sensing using multiwalled carbon nanotubes (MWCNTs) filled with various organic solvents like ACN, DMSO, DMF, etc.
2. These solvent-filled MWCNTs exhibit higher sensitivity for detecting analytes such as dopamine, ascorbic acid, uric acid, and oxygen in aqueous solutions.
3. The enhanced sensitivity is attributed to the interaction between solvent molecules and MWCNTs through London forces.
4. NMR spectra of solvents extracted from MWCNTs confirm the filling process. Solvents like DMSO and DMF show signals in the NMR spectra, indicating their interaction and filling within MWCNTs.
5. Electrochemical analysis reveals that solvent-filled MWCNT-coated electrodes exhibit improved sensitivity and reversibility in detecting analytes such as dopamine.

Key Features / Value Proposition

1. **Enhanced sensitivity & wide analyte range.**
2. **Improved detection limit** of trace amounts of target molecules.
3. **Reversible electrochemical response** in redox reactions, enhancing measurement accuracy.
4. The technology demonstrates **stability in sensor performance even after drying**, particularly with high boiling solvents like DMSO, ensuring the longevity and reliability of the sensing platform.

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