

Indian Science Technology and Engineering facilities Map (I-STEM)

Invites application for

1. **Partial financial support for using R&D facilities in other institutions through the I-STEM web portal to Users from Academic Institutions and Start-ups (Format-1)**

Format for requesting support for accessing and using facilities through the I-STEM web portal.

(i) Details of the Personal Information

- a. Name of the Researcher/Faculty Member: **Sangeetha Ramamoorthy**
- b. Name of Supervisor: **Dr. Chaitanya Lekshmi Indira (Chaitanya.l@cmrit.ac.in)**
- c. Name of the Institution: **CMR Institute of Technology Bangalore**
- d. Name of the Department: **Chemistry**
- e. Degree registered for: **Ph.D. (Under VTU)**
- f. Mob. No. **+919740090446** g. Email ID: **sangvammohit@gmail.com**

(ii) Project/Research topic Details:

a. Project Title/Research Title:

Enzyme based Metal oxide Nanocrystals Sensitized Carbon Paste Electrodes derived from biowaste for Detection of neurotransmitters in Human Serum.

b. Sub area: Electrochemical biosensors for fast detection of neurotransmitters

c. Area Description:

Electrochemical enzyme-based metal oxide sensitized carbon paste electrodes that is prepared from biowaste materials for detection of neurotransmitters (NT) such as “feel-good” hormone in human serum

d. Aims & Objective (in Bullets):

- Selective and efficient detection of NT could be achieved through electrochemical biosensors and to eliminate the electrode fouling selective enzyme is used as bio element in the working electrode.
- Increased electron transduction could be achieved through immobilization of enzyme using metal oxide modified with carbon paste derived from biowaste materials that limits the grain boundary poisoning as well.
- In addition, to achieve enhanced sensitivity and selectivity for NT detection, the metal oxide nanocomposite that are fast electron transport materials could be used. Stability of the device could be enhanced by modifying the metal oxide with one dimensional carbon materials

e. Duration (MM/YYYY): 6 Months

f. Project Summary (1000 words):

Neurotransmitters (NT) concentration imbalance play a major role in various regulation of various brain functions such as modulation of cognition and behaviours, voluntary actions, mood, sleep,

concentration, motivation etc. Therefore, quantitative estimation of NT is very important, that is usually achieved through capillary electrophoresis, High-performance liquid chromatography, mass spectrometry etc. The limitation of these methods is prolonged detection time, large sample volume, complex sampling method, high cost and bulky instrumentation. All these limitations could be overcome by using electrochemical biosensors provide a viable alternative due to their simple preparation, easy handling and faster detection. However, electrode fouling during NT detection due to oxidation products and interference of co-existing similar electroactive biomolecules are the major drawbacks. This could be overcome by employing selective enzyme based amperometry detection of NT's are ever increasing attention due to their potential applications. To further increase the sensitivity and efficiency of the enzyme electrochemical biosensors combining the biologically active species with those of semiconducting metal oxides (ZnO, TiO₂, SnO₂ etc.) which provide high surface to volume ratio, high surface activity, facile charge transfer capacity and compatibility with biomolecules. Metal oxides have high isoelectric point (IEP) that makes nanomaterials suitable for absorption of proteins with low IEP. Additionally, semiconductor oxides with wide bandgap play a major role in sensors due to their semiconducting, piezoelectric and pyroelectric behaviours. Further, they are nontoxic, high surface area and have good biocompatibility and chemically stable. Therefore, they function as an ideal immobilization support for enzymes and they retain their active sites, bioactivity, stability and hence provide higher signal transduction. However, grain boundary poisoning affects the conductivity of the biosensors that could be overcome by incorporation of biomass derived porous carbon could be considered beneficial compared to other materials in terms of biosensors fabrication. The cost effective, cheap, more environmentally friendly porous carbon nanomaterials were synthesized by biomass pyrolysis followed by hydrothermal carbonization in this method. These bioderived carbon materials will increase the electrocatalytic behaviours of the working electrode due to the graphitic nature and high surface area that further enhance the performance of the electrochemical sensors. Very easy and cheap sol-gel method could be used for metal oxide preparation. Optimized procedure would be carried out for immobilization of the enzyme with metal oxide porous carbon nanocomposite as support. Mechanism of the device involves enzymatic oxidation of NT leads to simultaneous reduction of the selective enzyme. The regeneration of the enzyme was achieved by reduction of ferricyanide (Fe(CN)₆]³⁻ that act a mediator for scavenging electrons from the active sites of the enzyme and themselves get reduced to ferrocyanide [Fe(CN)₆]⁴⁻ which is more at the bioelectrode surface. Further, the oxidation of the ferrocyanide to ferricyanide was achieved through applied potential that gives the signal corresponds to the concentration of the NT. To the best of our knowledge, this is the novel idea for the investigation of the NT with lower limit of detection (LOD) in picomolar ranges well below its detection limit.

g. Technical Details

- a. TRL (Technology Readiness Level): **Research to prove feasibility**
- b. Methodology:

Synthesis of metal oxide

Nanosized metal oxide was synthesized by hydrolytic sol-gel method following the procedure available from literature. Metal acetate dissolved in methanol was stirred and titrated with alkalis until get a pH of 9 and then dried followed by calcinated.

Synthesis of porous carbon

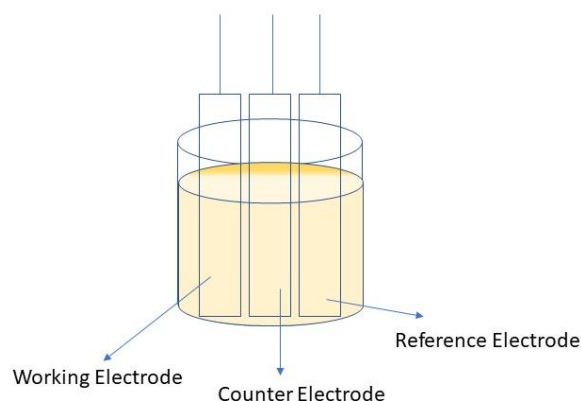
Pyrolysis of biowaste followed by hydrothermal carbonization

Preparation of working electrode

The synthesized porous carbon powder and silicon oil was mixed well to get a uniform mixer and then synthesized metal oxide was added, then mixed until uniform mixer to get, silicon oil could be added if needed. After getting uniform metal oxide modified carbon paste electrode, selective enzyme prepared in PBS was added and mixed uniformly. The different paste is filled tightly in peek cavity and their surface was smoothened with wax paper which act as a working electrode.

c. Design & development:

The above prepared working electrode, purchased Pt electrode and Ag/AgCl electrode as the counter and reference electrode. All the three electrodes were dipped in ferricyanide solution for cyclic voltammetry and impedance spectroscopy measurement.



d. Facilities and Instrumentation required

All the chemicals, electrodes and glassware's for performing the experiment to be purchased

e. Consumables (Scientific materials)

- 1. Metal acetate-----Rs. 200
- 2. NaOH-----Rs. 40
- 3. Methanol-----Rs. 400
- 4. Neurotransmitter-----Rs. 25000
- 5. Enzyme-----Rs. 13000

6. Peek cavity-----Rs. 5000
 7. Pt electrode-----Rs. 5000
 8. Ag/AgCl electrode-----Rs. 7000
 9. PBS solution-----Rs. 5000
- Total—Rs. **60640**

- h. **Expected output and outcome**
- i. **Industry/Institute Collaboration** **If, yes**
- (i) Name of the Collaborating Industry/Institute
- (ii) Collaboration Details
- (iii) Additional Details if any
- j. **Funding required from I-STEM (with justification:**

Details of Requirements & Mode of the Engagement: (Attach the quotation for the consumables)

- (i) Short term Engagement:
- a. Usage of testing/characterization facilities across the country (Characterization Mode)
 - i. Testing Charges
 - ii. Consumable charges
 - iii. Travel Cost (Boarding and Lodging, if any)
 - b. Usage of fabrication and testing facilities across the country (Fabrication Mode)
 - i. Fabrication and testing Charges
 - ii. Consumable charges (if any)
 - iii. Travel Cost (Boarding and Lodging, if any)
- (ii) Medium term Engagement:
- a. Execution of project in any one of the Host Institution (Project Mode)
 - a. Fabrication and or testing Charges
 - b. Consumable charges (if any)
 - c. Travel Cost (Boarding and Lodging, if any)
 - b. Execution of project in Multi Host Institutions (Project Mode)
 - a. Fabrication and or testing Charges
 - b. Consumable charges (if any)
 - c. Travel Cost (Boarding and Lodging, if any)

(Round-trip to the Host Institution by 2nd class (Non-AC) railway via the nearest route)

Details of User's Bank Account:

(Please send a copy of the cancelled cheque/copy of the passbook carrying all the information needed)

Beneficiary Name (User's name) Sangeetha R

PAN: CJQPR0362F

Bank Account No. 843410110009084
India, Kundalahalli, Bangalore

Name of the Branch: AECS layout, Bank of

IFSC Code: BKID0008434

Note: Proposed proposal must be executed within stipulated duration (max. 6 month) to avoid fund availability issues. Travel form will be provided by the I-STEM office. The users will submit the technical report, original invoice (duly signed by the Head of the Institution) raised by the Host Institution through I-STEM portal only along with a copy of the travel forms and original tickets through post to the Nodal Officer, I-STEM, Indian Institute of Science, Bangalore. A scan copy of all the documents may be sent in advance.