

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: **Immandhi Sai Sonali Anantha**
- b. Name of the Institution/Start-up: **GITAM Deemed to be University**
- c. Name of the Department: **Department of Chemistry**
- d. Degree registered for/Product being developed (for start-up): **PhD (Full Time)**
- e. Mob. No.: **9398921721**
- f. Email ID: **sonalianantha@gmail.com**

(ii) Project/Research topic Details:

- a. Project Title/Research Title: **Advanced photo-oxidation technologies for water treatment.**

- b. Sub area: **Green Catalysis**

c. Area Description:

Green principles and Green chemistry are at the forefront and core of technology development for the removal of organic and inorganic contaminants present in the environment. Emerging contaminants (ECs) is a class of organic contaminants that is attracting the interest of several researchers and funding bodies. It stems from the fact that these compounds are not covered by existing regulations of water quality and are thought to be potential threat to humans and the ecosystem. Their potential adverse effects in humans include growth inhibition, disruption of endocrine system, growth of resistant strain of micro-organisms to the pharmaceuticals, and carcinogenic or genotoxic effect. Each year, several thousands of new chemicals are released into the environment. ECs are released into the environment via domestic, industrial, or agricultural source. These ECs consists of a wide class of different compounds as well as their metabolites. They include pharmaceuticals and personal care products (PPCPs), veterinary products, pesticides, food additives, and industrial compounds. In the last decade, there has been a growing interest on facile treatment of PPCPs from the environment. They have been dumped in the environment after their usage by humans, but they are only recently detected and quantified based on improved sophisticated analytical techniques. Advanced Oxidation Processes (AOPs) particularly heterogeneous photocatalysis is a promising opportunity to improve the available techniques for the removal of hazardous quantities from wastewater. The main principle is that the generation and use of reactive oxidizing species (ROS) for the involvement of reaction with the surface adsorbed impurities (pollutants).

d. Aims & Objective (in Bullets):

Sustainable and cost-effective viable technologies are an imperative need for the removal of contaminants from wastewater before discharged into the environment. Advanced oxidation processes (AOPs) are elegant technologies for the eradication of problems pertinent towards treatment of wastewater. Among the AOPs, heterogeneous photocatalysis has attracted immense attention as significant alternative especially for the treatment of wastewater containing organic substrates due to fiscal benefits and provision to harness solar energy. Usually TiO_2 , WO_3 , Fe_2O_3 , ZnO , CdS , CeO_2 , ZnS , MoO_3 , SnO_2 and ZrO_2 are selected as photocatalysts due to possessing ideal band gap between unoccupied conduction band and occupied valence band. The efficiency of photocatalytic reaction entirely depends upon the creation of longer-lived photogenerated electrons and holes. But above said metal-oxides are although having good optoelectronic nature, chemical inertness, photochemical and catalytic properties fails in absorption of narrow light range. The drawback of photocatalysts is the inability to absorb visible light, which tends to additional energy requirement problems and also the recombination of photogenerated electron/hole pairs, which lead to lower its photocatalytic activity. So, Inorder to improve the efficiency of such photocatalysts, some strategies such as other kind of metal doping, anchoring of reduced graphene oxide and functionalized MWCNTs and incorporation of high surface area adsorbents into their matrix are employed to get efficient and invaluable heterogeneous photocatalysts.

- ❖ The aim of this work is to apply selected green and economical AOPs (heterogeneous catalyzed photocatalysis and ozonation) for the degradation of some identified PPCPs present in wastewaters of different integrities.
- ❖ This will be achieved by Prime aspect of the proposal is to synthesize novel recyclable semiconducting nanocomposites (active with visible light irradiation) through different modifications viz. doping of metal/metal oxide and integration of Cellulose/graphene oxide/MWCNTs etc. and their characterizations to be used as potential photocatalysts.
- ❖ Testing the efficiencies and recyclability of the novel nanocomposites, in degradation of toxic organic pollutants and refractory compounds under controlled conditions and using solar radiation to make drinking water safe and palatable.
- ❖ Testing the efficacy of the novel catalyst material in treating natural water samples and developing low cost/ low technology apparatus of providing safe drinking water to rural communities.
- ❖ Adsorption equilibrium and kinetic studies will also be considered.

e. Duration (MM/YYYY): 04/2022-12/2025

f. Project Summary (1000 words):

Alarming situation has occurred throughout the globe with rapid increase in usage of hazardous materials and their erroneous disposals. Particularly, in the case of drinkable water, quality deteriorated due to the addition of wastes (toxic and non-biodegradable) from various sources. Access to the clean water is un-surmountable task to the most developing regions of the country. In order to curtail many avoidable deaths, the grandiose treatment of the wastewater is need of the hour. In the proposed project, besides the existing conventional biological treatment processes of wastewater, new Advanced Oxidation Processes (AOPs) will be developed with help of novel effective recyclable heterogeneous photocatalysts (active to visible light irradiation) to work hand in glove to provide drinkable water. Such new AOPs have emerged as viable, cost-effective, efficient and sustainable green technologies by utilizing hydroxyl and superoxide radicals as active reactive species for the treatment of toxic wastewaters and bio-recalcitrant organic compounds. The project proposes to gain of further insights into the development of next generation photocatalysts as well as improves the efficacy of existing photocatalysts with congenial modifications such as doping/integration with carbaneous materials/other metal oxides. Further, this proposed work is of high significance, not only to the scientific world but also has great industrial, social and economic impact to the society.

Design of work (in months)	1-6	7-12	13-18	19-24	25-30	31-36
Comprehensive literature survey and synthesis of prominent heterogeneous photocatalysts (1-6 months)						
Characterization of synthesized catalyst						
Sampling and conduct of physico-chemical properties of waste water and spiked PPCPs in water (6 -12 months)						
Analysing the efficiency of the prepared nanocomposites and comparison with the parent photocatalysts in photodegradation.						

Final by-product analysis using thin-layer chromatography, gas chromatography, and High-pressure liquid chromatography mass spectroscopic technique and other spectroscopic and analytical techniques.						
Preparation of Detailed Project Report (DPR) and published outstanding results.						

g. Technical Details

a. TRL

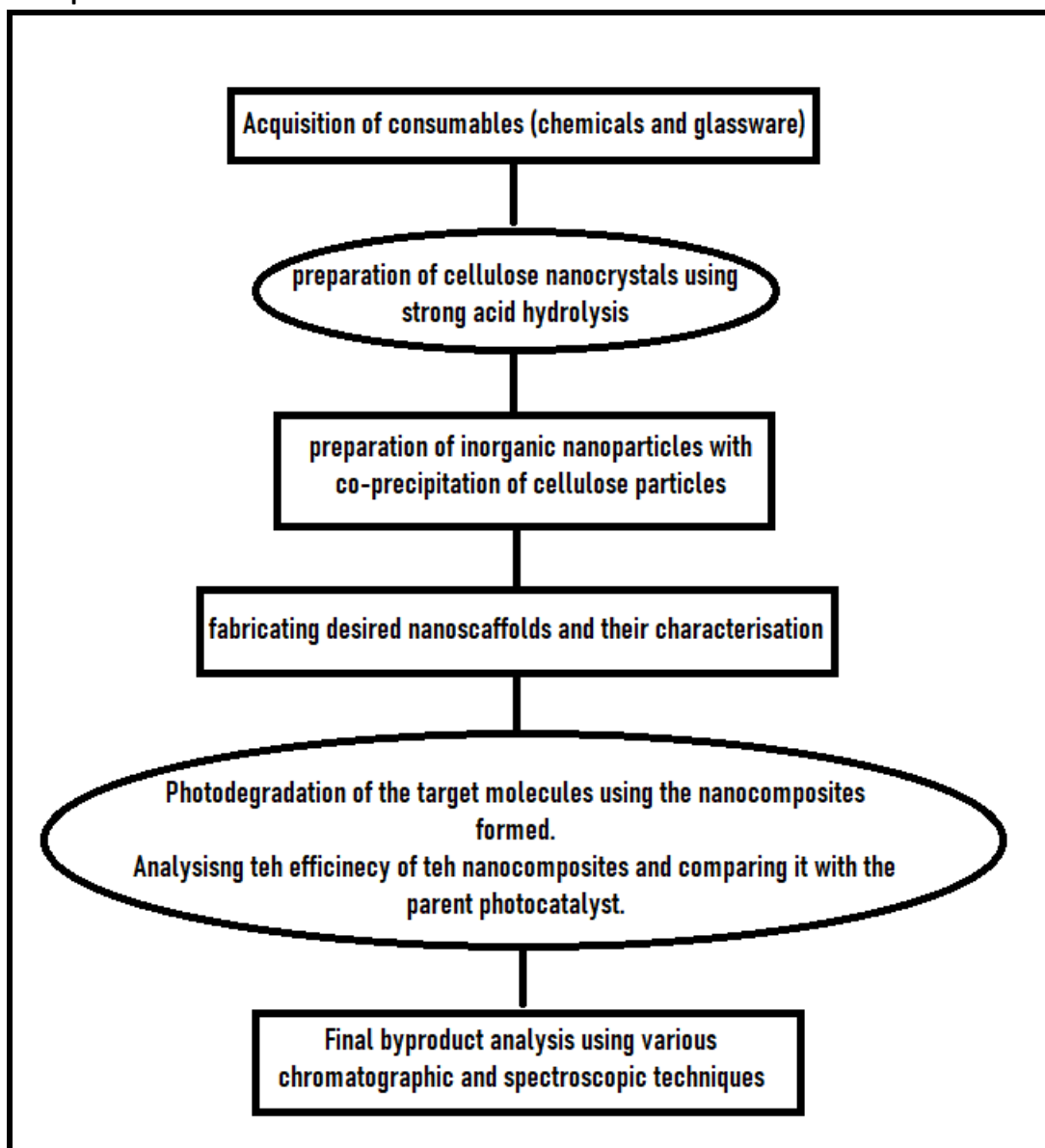
b. Methodology

- ❖ The facile synthetic procedures (co-precipitation, sol-gel, hydrothermal) will be employed to get the new solid phase materials from an aqueous medium through physical (temperature, agitation, and evaporation rate) or chemical (pH and ionic strength) transformations. To suit the target application, the obtained solid phase may require subsequent processing (aging, washing, filtration, drying, grinding, impregnation, mixing, and calcinations) to increase the catalytic activity. In order to enhance the performance of photocatalyst, chosen support materials will be impregnated through aqueous deposition of an active precursor on a support. Impregnation also allows for predetermination of final catalyst properties through careful selection of the support material. These methods facilitate the active metal deposition for the systems with weak or no support/metal interaction. By varying the solution properties (concentration, temperature, pH, and ionic strength) one can control the final supported catalyst attributes (particle size, dispersion, and amount). Using selected metal salts, bimetallic or trimetallic metal oxides will be designed to increase the acidic sites by impregnating different metals, graphene oxide and MWCNTs on it.

The following steps are involved in the proposed project:

- ❖ Synthesis of novel heterogeneous photocatalysts through facile preparation methods Prepared photocatalysts will be characterized by using PXRD, FTIR, TEM, SEM, ESR, BET surface area and other appropriate techniques. Advanced Oxidation methods will be conducted using photolight/ozoniser at controlled temperature flow conditions. The reactions involving heterogeneous catalysts will be studied in the specially designed reactors with pumps to circulate the reaction mixture.
- ❖ Organic components will be separated by GC-MS and HPLC and analysed by IR, LC-MS, ¹HNMR, ¹³C NMR techniques.

c. Design & development



d. Facilities and Instrumentation required:

- ❖ New and other catalyst materials will be characterized by using P-XRD, FT-IR, TEM, SEM-EDX, ESR, BET surface area and other appropriate techniques.
- ❖ Analysis of by-products by GC-MS or HPLC-MS techniques.
- ❖ Advanced Oxidation methods will be generated using an ozoniser/photolight and compressed oxygen at controlled temperature flow conditions.

e. Consumables (Scientific materials) :

Regular chemicals such as organic ligands, acids, bases, metal salts etc. No costly chemicals required.

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): **Immandhi Sai Sonali Anantha**

PAN: **AKBPI5629N**

Bank Account No. **37961755784**

Name of the Branch: **STATE BANK OF INDIA, MITHILAPURI COLONY BRANCH**

IFSC Code: **SBIN0016024**

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.