Department of Chemical Engineering

BIRLA INSTITUTE OF TECHNOLOGY & SCIENCE, PILANI
ज्ञानं परमं बलम्
BITS Pilani
Hyderabad Campus

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Contents

Department of Chemical Engineering

BITS Pilani
Hyderabad Campus

Message from Head of the Department

Welcome to the Department of Chemical Engineering, BITS Pilani Hyderabad Campus. At the outset, I wish to thank our faculty members for bringing out this nice brochure that is concise but comprehensive, giving an excellent bird's eye view of our young and vibrant department.

As a founding member of the department since Aug 2008, I am proud to say that our department has witnessed significant growth in the last few years across many aspects like adding state of the art infrastructure (teaching and research), putting best practices in place to maintain academic rigour and pedagogy, adopting a no-compromise approach in hiring human resources, having an excellent placement record for both UG and PG students besides vibrant industry connect.

Our department currently has 16 faculty members working broadly in the areas of energy and environment, catalysis and reaction engineering, materials modelling and simulation etc. The number of publications in highly reputed journals has been increasing every year, with 3-4 publications per faculty per year with an average impact factor of 4. We have been receiving funding of 1-2 crores per year from various agencies like DST, DBT, CSIR, DRDO, HBL Power Systems Ltd etc., for research and consultancy projects. There is still a great scope of improvement in this area, and we are moving in the right direction with a proper strategy.

Through our departmental association, "Association of Chemical Engineers (ACE)", our department has been hosting various events like invited talks from eminent speakers, workshops, seminars, conferences for much desired academic exchange, connect with industry besides gaining visibility. During the next few years, we sincerely aim to become one of the best Chemical Engineering Departments in the country in terms of critical metrics like teaching and pedagogy, research (academic and sponsored), academia-industry collaboration and placements besides producing young and dynamic chemical engineers with human values who can contribute to not only their growth but also that of the nation.

Head, Department of Chemical Engineering,
BITS Pilani Hyderabad Campus, Hyderabad

About the Department

Department of Chemical Engineering, BITS Pilani Hyderabad Campus, was established in Aug 2008 along with the campus. It has grown significantly in the last few years in teaching, research, infrastructure, and industry connect. The department runs UG (B.E. Hons.) and PG programmes (M.E. Hons. and PhD) besides involving in various minor programmes like Material Science and Engineering. We also actively engage in work-integrated learning programmes offered for working professionals.

The strengths of our department are well-qualified faculty, state of the art laboratories and classrooms, a wide range of analytical facilities, and most importantly, our meritorious, diligent, inquisitive and ambitious students. Our faculty team is a blend of young and experienced members who are passionate teachers and active researchers from diverse areas. The major areas of our research are process systems engineering, catalysis and reaction engineering, materials science, colloids and interfacial science, soft matter engineering, polymers, environmental chemical engineering, electrochemical engineering, petroleum and alternate fuels, modelling and simulation etc. Though the department is relatively young, our research outcomes, including publications in highly reputed journals, sponsored research and consultancy projects from various funding agencies like DST, DBT, CSIR, DRDO, HBL etc. are very good comparable with any other well-established department.

We have very good placement record for both UG and PG students due to the aggressive placement division in which we are also a part. Unique to BITS, we have a practice school programme offered to both B.E. and M.E. students where they spend 1-2 semesters in the industry working on the real-time problems taking the classroom to the industry! This not only gives exposure to an industrial environment to the students but also make them understand various complex problems encountered at a larger scale and how to solve them by applying the concepts learnt in the curriculum. This also facilitates our department and the institute to update the curriculum periodically to align with the needs of the industry. Since its inception, our department has produced alumni working at key positions in various industries, active researchers, and successful entrepreneurs.

Department at a Glance

Department of Chemical Engineering at BITS Pilani, Hyderabad campus is determined to develop new talents, leaders, researchers and entrepreneurs who can bring high level value addition to the Chemical and Allied industries. Our mission is to drive excellence in education and training for the creation of a common platform for connecting academia and industry.

Academic Programs
Bachelors | Master | PhD | Minor in Materials Engineering

Full time Faculty **15**

Area of Research
Reaction Engineering & Catalysis **|** Environmental & Energy Engineering **|** Materials & Surface Science **|** Nanotechnology **|** Polymer Science & Engineering **|** Electrochemical Engineering **|** Biomaterials **|** Petroleum & Petrochemicals **|**
Modelling, Simulation & Optimization

Undergraduate Enrolment **204**

Research Scholars and Fellows **18**

Funding Received in last 5 years (in Crores) **>2.6**

Research Papers Published (2020) **32**

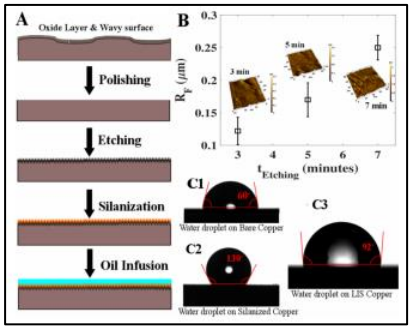
Funding Received from
DST **|** BIRAC (DBT) **|** CSIR **|** ABSTC Mumbai **|** DRDO **|** BITS Pilani

Departmental Activities
Conferences **|** Workshops **|** Expert interactions
Work Integrated Learning Program (WILP)

Areas of Research

Fiber reinforced polymers, 3D Printing
Surface modification, Layered materials
Superomniphobic surfaces

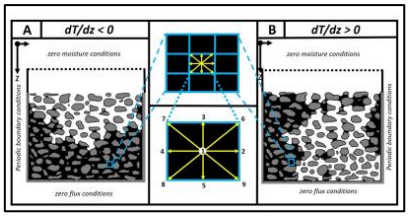
Polymer Science & Engineering



Membrane Separation
Heavy Metal Removal
Carbon Capture
Interfacial Engineering
Biomass Valorization

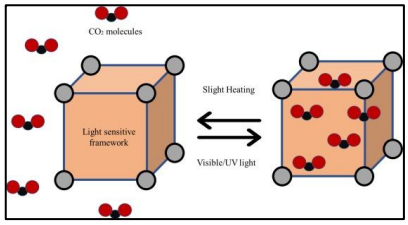
Nanotechnology

Materials & Surface Science



Fuel cells & Li-ion batteries
Alternative fuels
Endothermic fuel development
Heterogeneous Catalysis
Nanocatalysis

Environmental & Energy Engineering

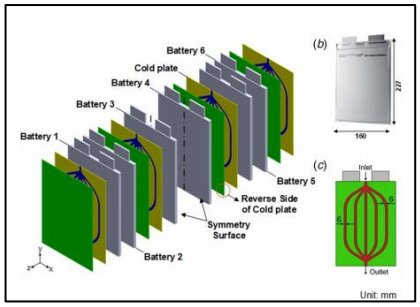


Electrochemical Engineering

Reaction Engineering & Catalysis

Reactive Transport Modelling
Lattice Boltzmann Methods
Process Optimization
Machine learning & Surrogates

Petroleum & Petrochemicals



Modelling, Simulation & Optimization

Faculty

Research Themes

Faculty	Polymer Science & Engineering	Nano-technology	Materials & Surface Science	Environmental & Energy Engineering	Electrochemical Engineering	Reaction Engineering & Catalysis	Petroleum & Petrochemicals	Modelling, Simulation & Optimization
Jaideep Chatterjee			●	●				
I. Sreedhar		●		●		●		
Srikanta Dinda	●			●		●	●	
Balaji Krishnamurthy				●	●			●
A. Ramesh Babu	●	●	●					
Karthik Chetan V	●	●	●					
Vikranth Kumar Surasani				●				●
D. Purnima	●	●	●	●				
Satyapaul Singh Amarthaluri		●		●		●		
Nandini Bhandaru	●	●	●					
Pankaj Kumar				●		●	●	
Arnab Dutta				●				●
Afkham Mir			●		●			●
Debirupa Mitra	●	●	●					
Iyman Abrar		●		●			●	
Ramendra K. Pal	●		●		●			

Dr. Jaideep Chatterjee

Professor

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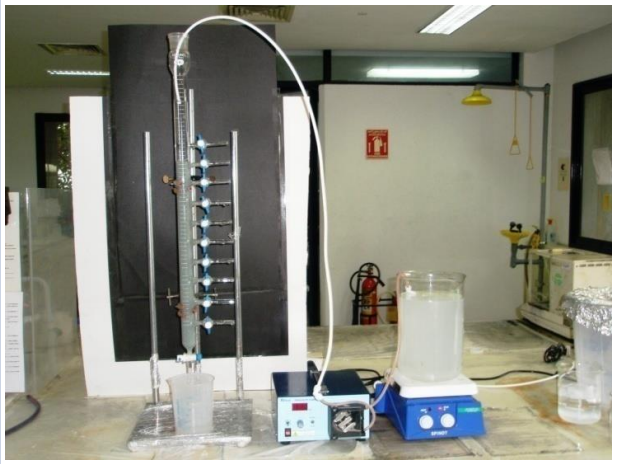
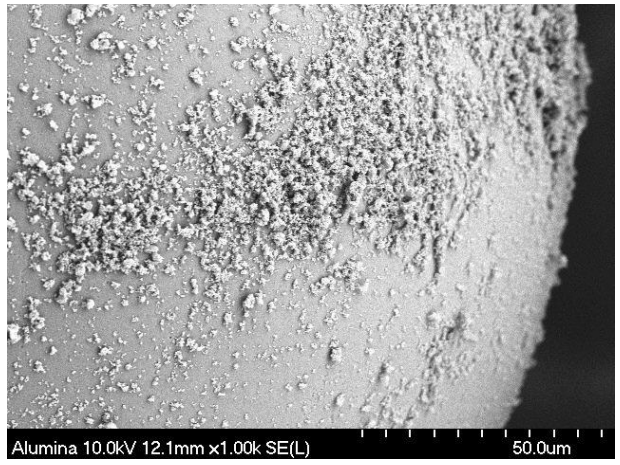
"Currently working on enhancing Recovery and Life of RO membrane systems."

Areas of Interest: Water Purification, Air Purification, Disinfection, Oil-water Interfaces, Capillary Phenomena

Reverse Osmosis based water purification has emerged as a front runner among water purification technologies. However, one of the drawbacks of RO technology is low pure water recovery and high water waste as "reject". This group is looking at the possible ways of significantly increasing the recovery of pure water from RO purifiers without compromising the life of the RO membrane.





Understanding Water Purification: Effect of electrolytes on filtration

Characterization of Water Filtration Products

Latest Publications:

- US 10710904, Device and a process for purification of grey water, 14/07/2020.
- US 10590015, Device and a process for recovering clean water and surfactant concentrate from grey water, 17/03/2020.
- Separation of anionic surfactant in paste form from its aqueous solutions using foam fractionation, 2017, Journal of Environmental Chemical Engineering, 5, 2, 1586-1598
- A comparative study of granular activated carbon and sand as water filtration media with estimation of model parameters, 2017, Advances in Environmental Research, 6, 1, 35-51

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> "Environmental sustainability is key to the growth of any nation. The efforts of our research group are always focused on exploring greener and energy-efficient options to the most common problems faced by society."

Areas of Interest: Environmental Chemical Engineering, Heterogeneous Catalysis, Reaction Engineering, Fluid Mechanics

My current research work is primarily focused on CO_2 capture and utilization, wastewater treatment using green methods, powder technology and drag reduction using polymeric additives. The objectives of the above-mentioned projects are to develop novel and cost-effective adsorbents viz., metal oxides, zeolites, MOFs to achieve high capture capacity and cyclic stability through the chemical looping method. As a part of CO_2 utilization, efforts are being made to develop transition metal-based nanomaterials for CO_2 methanation through novel synthesis protocols to achieve higher conversion, selectivity and stability. Development of green and efficient adsorbents based on biomass, biochar and polymers to remove heavy metals from industrial effluent effectively with simple regeneration techniques is also being done. Drag reduction to enhance the flow rate of aqueous and hydrocarbon systems using polymeric additives to reduce transportation costs, especially in the crude oil industry, is also focused on.

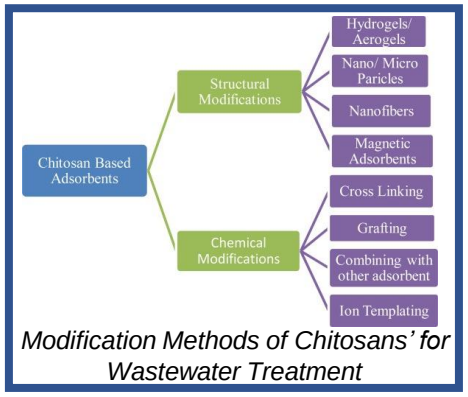
Carbon capture and Utilization using novel materials:

Carbon capture, a potential tool to mitigate global warming, has gained a lot of attention among researchers in the recent past. CO_2 utilization makes carbon capture even more economically viable. Our work primarily focuses on developing novel, cost-effective and efficient adsorbents based on metal oxides, zeolites, MOFs, industrial waste like coal fly ash that give high carbon capture capacity and cyclic stability. Regarding CO_2 utilization, novel highly stable catalysts based on M/NiO- MgO (M-Co, Cu, Fe) and M/La_2O_3 (M=Co, Ni and Fe) synthesized through different protocols have been deployed in CO_2 methanation by Sabatier reaction to achieve high conversion, selectivity and stability. Thermo-kinetic analysis is done to develop and validate suitable kinetic and thermodynamic models that explain the phenomena effectively.

Factors Affecting MOFs' Morphology for Carbon Capture

Wastewater treatment using green adsorbents

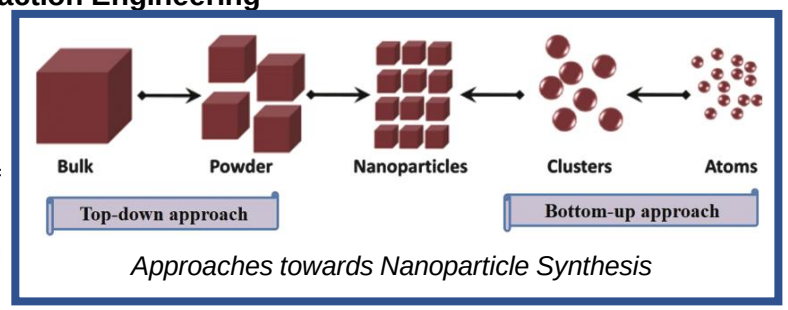
Our work in this area primarily focuses on heavy metal removal from industrial effluents using different classes of novel and cost-effective adsorbents viz., biomass-based materials, biochar and polymer-based materials like chitosan and alginates. The adsorbents were synthesized through cost-effective routes, and process standardization at macro and micro-levels is done using RSM to achieve highest metal removal efficiency. Regenerability and stability studies were also conducted to test the longevity and economic viability of the technology. Thermo-kinetic and simulation studies are done to gain deeper insight into the process.



Modification Methods of Chitosans' for Wastewater Treatment

Heterogeneous Catalysis and Reaction Engineering

There are various reactions like toluene nitration, vapour phase pyridine synthesis, triazole synthesis using Click reaction, aerobic oxidative synthesis of imines, C3-cyanation of indoles, synthesis of dimethyl-pyrazine from crude glycerol, chemo-selective reductive N-acetylation of nitrobenzene that have huge industrial importance. We have developed efficient and green catalytic routes to these reactions to promote selectivity, yield and conversions. Some catalysts deployed successfully in these reactions are zeolites, Cu-BTC MOFs, Cu/SBA 15, Cu/MgLaO, Zn modified $CuCr_2O_4$. Reaction engineering aspects are also studied in terms of mechanism, kinetics, reactor design and scale-up for these reactions.



Approaches towards Nanoparticle Synthesis

Latest Publications:

- V. M. Shama, A. R. Swami, R. Aniruddha, I. Sreedhar, B. M. Reddy, Journal of CO2 Utilization 2021, 48, 101507.
- S. S. Kolluru, S. Agarwal, S. Sireesha, I. Sreedhar, S. R. Kale, Process Safety and Environmental Protection 2021, 150, 323.
- U. Upadhyay, I. Sreedhar, S. A. Singh, C. M. Patel, K. L. Anitha, Carbohydrate Polymers 2021, 251, 117000.

Dr. Srikanta Dinda

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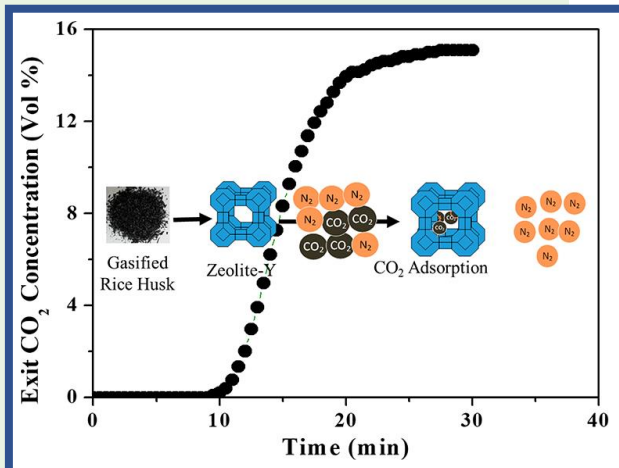
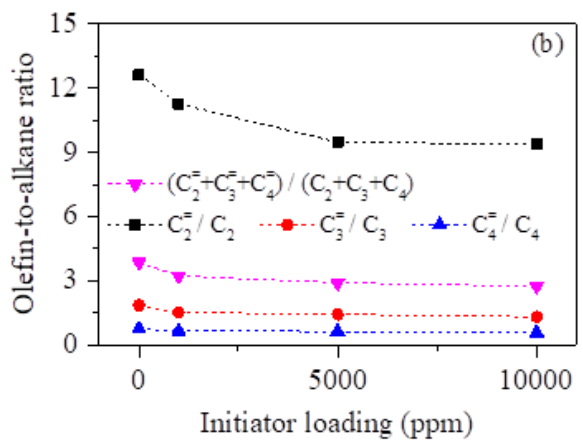
> "Current research group consists of four PhD scholars"

Areas of Interest: Heterogeneous Reactions and Catalysis, Synthetic and bio-polymer synthesis, CO_2 capture and CO_2 utilization, Hydrocarbon cracking

Development of endothermic fuel for hypersonic/supersonic application, conversion of CO_2 to value added chemical/fuels, Development of regenerable material for CO_2 capture. Development of biopolymer from nonedible vegetable oil, Development of resin for coating applications. Catalytic conversion of lignin to aromatics.



Absorbent from rice husk



Effect of initiator on gas distribution pattern.

On-going Research:

Development of endothermic fuel for hypersonic/supersonic application, estimation of cracking characteristics such as conversion, endothermicity, gas distribution patterns, and cracking kinetics. Development of catalyst for the conversion of CO_2 to value added chemical/fuels via hydrogenation route, Development of regenerable material for CO_2 capture. Estimation of CO_2 adsorption capacity, adsorption kinetics, Development of biopolymer from nonedible vegetable oil via epoxidation route for plasticizer application, Development of resin for coating applications. Catalytic conversion of lignin to aromatics.

Latest Publications:

- Kokkula Monika, Chanchal Chakraborty, Sounak Roy, Srikanta Dinda, Satyapaul A. Singh, Santanu Prasad Datta. Selection of an Ideal Coolant to Ward off the Thermal Runaway of Pouch Type Li-ion Battery Module, Journal of Electrochemical Energy Conversion and Storage, 2021, 18, 020913.
- Preetha C. Meenu, Santanu Prasad Datta, Satyapaul A. Singh, Srikanta Dinda, Chanchal Chakraborty, Sounak Roy, A compendium on Metal Organic Framework Materials and their Derivatives as Electrocatalyst for Methanol Oxidation Reaction, Molecular Catalysis, 2021, 510, 111710.
- Rojali Maharana, Seemarekha Das, Nabin Kumar Dhal, Srikanta Dinda, B.S. Manisha Singh, Characterization and Mechanisms of Biosolubilization of Rock phosphate by Microbes Isolated from Mahanadi Estuary, Odisha, India, International Journal of Environmental Research, 2021. 15, 335-348.
- Nithin B. Kummamuru, Angan Sengupta, Srikanta Dinda, Molecular Simulation Study of CO_2 Adsorption in Carbon Slit Pores at High Temperature and Pressure Conditions, Bulletin of Materials Science, 2020, 43, 296.

Dr. Balaji Krishnamurthy

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"My research group currently focusses on experimental and theoretical study of electrochemical systems."

Areas of Interest: Electrochemical Engineering, Batteries, Fuel cells

The research comprises of modelling and simulation of electrochemical systems. We are also working on developing electrodes for enzymatic glucose fuel cells and other electrochemical systems.

On-going Research Activities:

Currently research is focussed on two main areas:

a) *Simulation of lithium ion battery systems and fuel cells.*

b) *Development of novel electrode materials for enzymatic glucose fuel cells.*

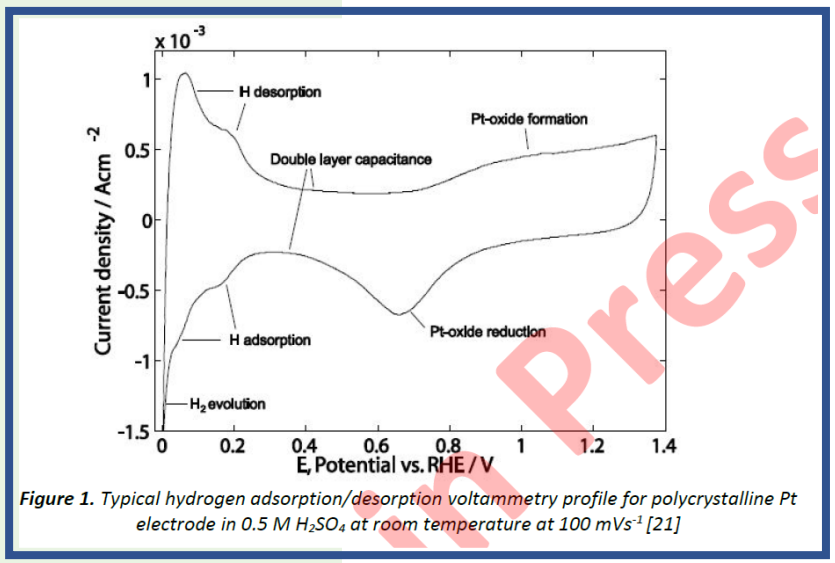

Figure 1. Typical hydrogen adsorption/desorption voltammetry profile for polycrystalline Pt electrode in 0.5 M H_2SO_4 at room temperature at 100 mVs^{-1} [21]

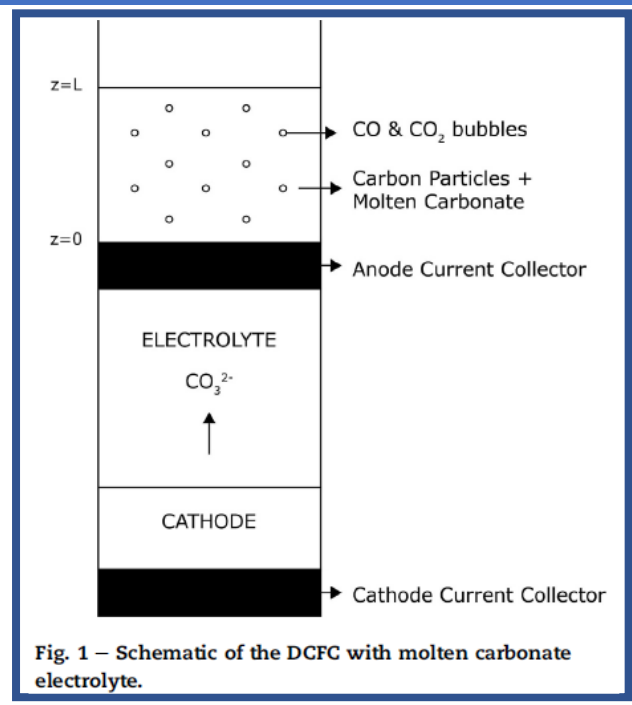

Fig. 1 – Schematic of the DCFC with molten carbonate electrolyte.

Latest Publications:

1. *Pencil graphite electrodes as anodes for enzymatic bio fuel cells, M.Bandapati, S. Goel and B. Krishnamurthy, Journal of Electrochemical Science and Engineering, http://dx/doi.org/10.5599/jese.807*
2. *Modeling the effect of GDL porosity on high temperature fuel cells , V. Jha, R. Hariharan and B. Krishnamurthy, Internatational Journal of Heat and Mass transfer, 161,(2020), 120311.*
3. *Modeling the effect of rib width and channel dimensions on the performance of high temperature fuel cells, V.Jha and B. Krishnamurthy, DOI: https://doi.org/10.5599/jese.907.*
4. *Modeling the performance of DC SOFC-Anode Supported configuration, S.Raj, S.Gnanasundaram, B.Krishnamurthy, Journal of Electrochemical Science and Engineering, http://dx.doi.org/10.5599/jese.933(2021)*

Dr. Ramesh Babu Adusumalli

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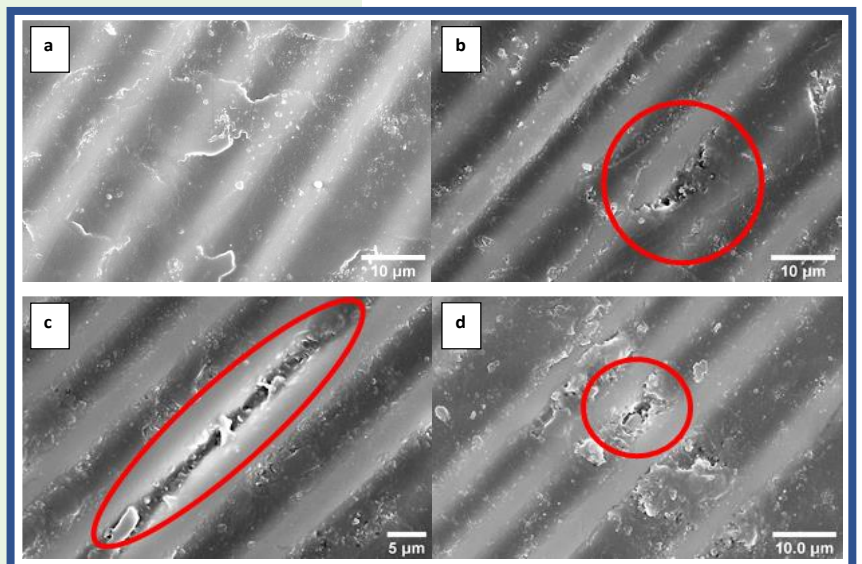
> "We take a synergistic approach to develop novel processes and tuned polymer composites for advanced applications."

Areas of Interest: Polymer Composites; Fibres; Pulp and Paper; Nanomechanics

Research Theme

1. Processing of polymer composites using compression molding, injection molding and 3D printing.
2. Processing of wood pulp using digester, beater and processing of nano cellulose fibrils using ultrafine grinder.
3. Testing of fibre including carbon, glass, and jute and hair fibres. Single fibres tests like diameter, tensile testing and nanoindentation are carried out on longitudinal and transverse sections respectively to understand the structure –property relations at micro and nano level.
4. Testing of pulp (FTIR, TGA, SEM, chemical analysis) and nanocellulose sheets and testing of polymer composite specimens using tensile testing, impact testing, flexural testing, fibre-matrix bonding and SEM fractography.



SEM images of thermoset polymer composite samples (a) – before conditioning (b), (c), (d) - after thermal shock test

On-going Research:

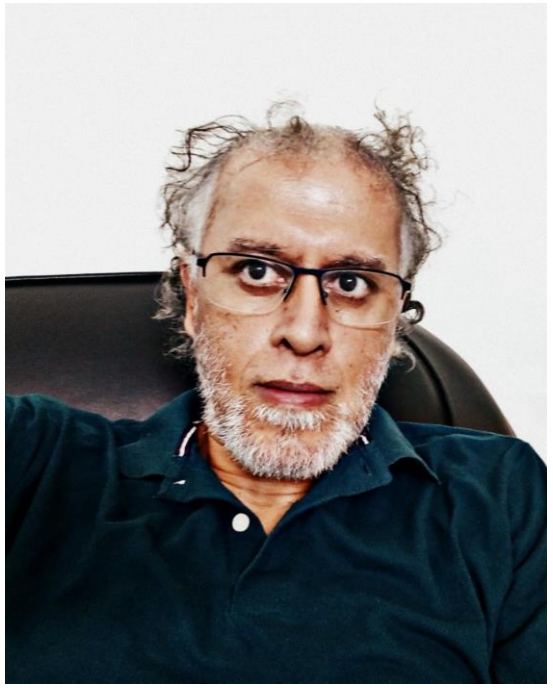
Currently working on processing and characterization of nanocellulose sheets from wood. Using high temperature digester, wood is converted to pulp and pulp is converted to nanocellulose slurry using ultrafine grinder. These nanocellulose sheets can be used to capture dust particles of particulate matter $PM_{2.5}$ thereby checking the air quality index. These sheets are fully biodegradable and possess high wet strength due to high aspect ratio of nanocellulose fibres.

Currently working on thermoset resin-based polymer composites. Initially these composites are subjected to thermal shock (-40 °C to 100 °C), Solar radiation, fluid contamination, humidity (85 % RH), Salt spray, blowing rain and rain erosion cycles. After applying the polyurethane-based coating, these composites are again subjected to above mentioned environmental conditioning tests and damage of coating or substrate (if any) is analysed using microscopy (OM/SEM), thermal and electrical conductivity, pull-off adhesion, and scratch resistance-based coating evaluation methods.

Currently working on processing and characterization of 3D printed glass/carbon fibre-based nylon-based polymer composites. Here filaments of fibre and matrix are fed continuously to print the required shape of composite (programmed in computer) and it is tested using universal testing machine equipped with tensile, ILSS, three-point bending and high temperature chamber.

Latest Publications:

- S. Mishra, C. Kunchi, K. Venkateshan, R. C. Gundakaram, R. B. Adusumalli, J Mater Sci 2016, 51, 10191.
- M. Pydimalla, R. Adusumalli, Nord. Pulp Pap. Res. J. 2020, 35 (2), 161–171
- S. Aparna, D. Purnima, R. B. Adusumalli, Polymer Composites 2020, 41, 5167.
- J. Santo, P. K. Penumakala, R. B. Adusumalli, Polymer Composites 2021, 42, 3231.



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"The main intent is to learn, investigate, innovate and provide solutions in a holistic and interdisciplinary manner for scenarios involving product development and materials troubleshooting in defence, aerospace, biomedical and environmental applications."

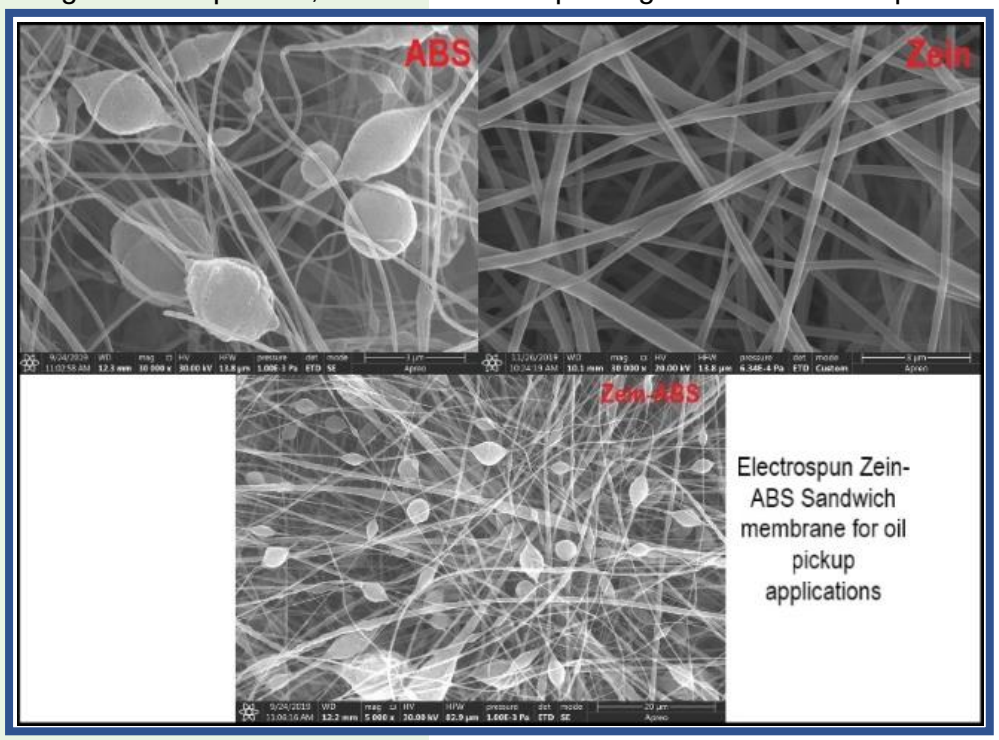
Areas of Interest: Advanced composites, value-added products from biomaterials, relaxation behaviour in amorphous materials, nanoscience, microencapsulation and materials characterization

Research Theme

The research theme of our group is to develop prototypes for niche applications in defence, pharmaceutical, energy and environmental fields.

A few examples over the past few years are the following: i) developing novel biomaterial filaments for 3d printing in biomedical, pharmaceutical and food applications, ii) developing sizing agent for improved interfacial compatibility in composites for defence applications, iii) developing nanomats for microencapsulation of pharmaceuticals.

The protypes involve materials such as, polymers, fibres and biomaterials. The processes that are employed are electrospinning for nanomats, liquid-based formulations for coatings or sprays, sol-gel for composites, extrusion for 3D-printing and other techniques.



Indigenization of core-shell nano rubber modified epoxy for defence applications

Epoxy network polymers comprising of aromatic rings (Bis-Phenol A) are wonderful in regards to curing kinetics, freedom of using various curing agents and exhibiting useful mechanical strength and thermal stability properties. The downside of this family of polymers has been brittleness and lack of significant mechanical toughness due to the presence of aromatic rings in the crosslinked architecture.

We are employing physical dispersion (ex-situ) of rubber (silicone, polybutadiene etc.) particles/colloids uniformly in the reacting epoxy monomer medium with appropriate grafting to attain compatibilization between the cured epoxy and rubber particles in the final product. With this, there is a higher possibility of attaining mechanical toughness without sacrificing mechanical strength and modulus and thermal stability.

Development of electrospun hybrid sandwich-type membrane for niche oil-water separation applications

Oil-water separation in nano or micron sized emulsions which are present in abundance in niche industry, environment and energy locations has been a major challenge.

We are developing a hybrid electrospun sandwich-type membrane based on both biomaterial as well as synthetic polymer. The goal is to make the membrane as super hydrophobic as possible in facilitating a substantial and guaranteed removal of quantity of oil per gram of the membrane. The other goals are to have these membranes reusable, biofriendly and cost feasible.

Latest Publications:

- S. Patra, P. Thakur, B. Soman, A. B. Puthirath, P. M. Ajayan, S. Mogurampelly, V. K. Chethan, T. N. Narayanan, RSC Adv. 2019, 9, 38646.
- C. Kunchi, K. C. Venkateshan, R. B. Adusumalli, Fibers Polym 2019, 20, 1538.
- C. Kunchi, K. C. Venkateshan, N. D. Reddy, R. B. Adusumalli, International Journal of Trichology 2018, 10, 204.

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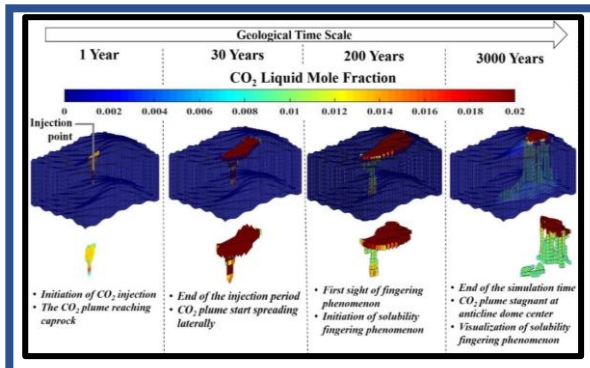
"Multiscale modelling of multiphase flow in porous media."

Areas of Interest: Transport in Porous Media

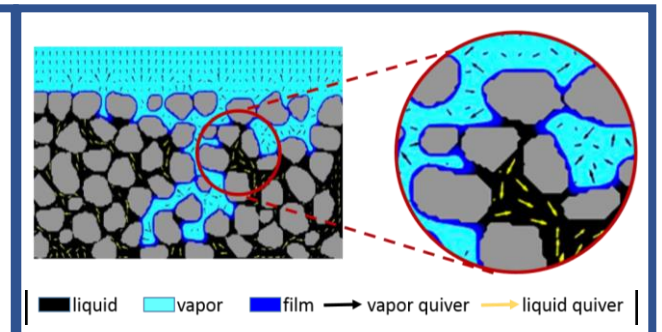
The demanding challenge to secure access to clean water sources and provide sufficient energy for a growing population while coping with the threats of climate change is still baffling the scientific community. Technologies such as enhanced oil recovery, fuel cells are explored as a possible solution. All these technologies have a common foundation of coupled mass and heat transfer through porous media. Other classical examples of coupled mass and heat transfer with either single or multiphase flows in porous media are CO_2 geological sequestration, geothermal energy extraction, contaminant transport in aquifers, drying of porous media, adsorption and catalysis applications in process engineering. Our research group focus on multiscale models to understand the micro-macro interactions during the multiphase flow through porous media.

On-going Research Activities

Immiscible displacements during multiphase flow in porous medium play a major role in determining the maximum sweep efficiency of CO_2 in carbon geological sequestration, favourable drying rates in food, pharmaceuticals etc., and improving the efficiency of electrolyzers. The coupled heat and mass transfer in porous media play a major role in drying of capillary porous media, determining process parameters for CO_2 sequestration, and water and thermal management in fuel cells and electrolyzers. In any event, the understanding of the phenomena is contingent upon how the fluid flows in porous media. We build our research stature in the numerical modelling of drying of porous media using multiphase Lattice Boltzmann Method (LBM). Further, we share an appreciable contribution to non-isothermal coupled Pore Network Model (PNM) techniques for drying of porous media. Additionally, perquisite knowledge in the reactive transport modelling enhances our group as a versatile research group for the development of complex numerical techniques. We aim to reconcile PNM and LBM as a computationally efficient pore-scale modeling technique and develop coupling techniques to bridge multiphase flows with convection-diffusion problem like heat transfer and reactive transport. At present, we are developing a parallelized LBM for the application of drying of porous media and the requirement of parallel computing devices such as HPCs is demanding.



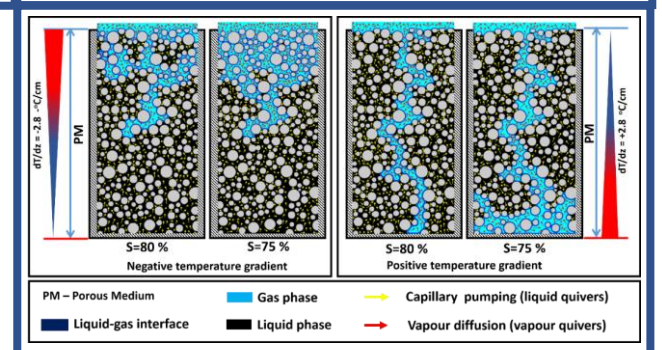
CO_2 Geological Sequestration of Deccan Trap Province



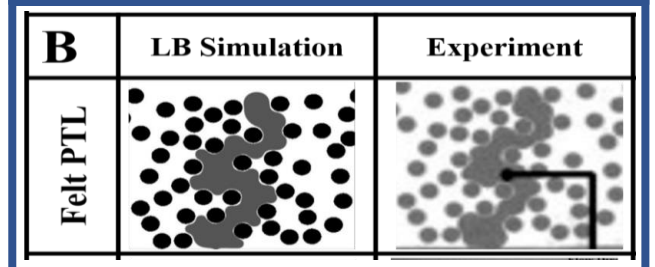
Multiphase flow phenomena during drying in capillary porous media using LBM simulation

Latest Publications:

1. ***D. Panda, S. Paliwal, D. P. Sourya, A. Kharaghani, E. Tsotsas, V. K. Surasani, Physics of Fluids 2020, 32, 122116.***
2. ***D. Panda, B. Supriya, A. Kharaghani, E. Tsotsas, V. K. Surasani, Chemical Engineering Science 2020, 220, 115634.***
3. ***S. Paliwal, D. Panda, S. Bhaskaran, N. Vorhauer-Huget, E. Tsotsas, V. K. Surasani, International Journal of Hydrogen Energy 2021, 46, 22747.***
4. ***P. R. Punnam, B. Krishnamurthy, V. K. Surasani, International Journal of Chemical Engineering 2021, 2021, e7762127.***
5. ***G. T. Zachariah, D. Panda, V. K. Surasani, Chemical Engineering Science 2019, 196, 310.***



Influence of thermal gradient on invasion patterns during drying of granular porous medium



Invasion patterns during of O_2 in anodic PTL of PEM water electrolyser, comparison with experiments.

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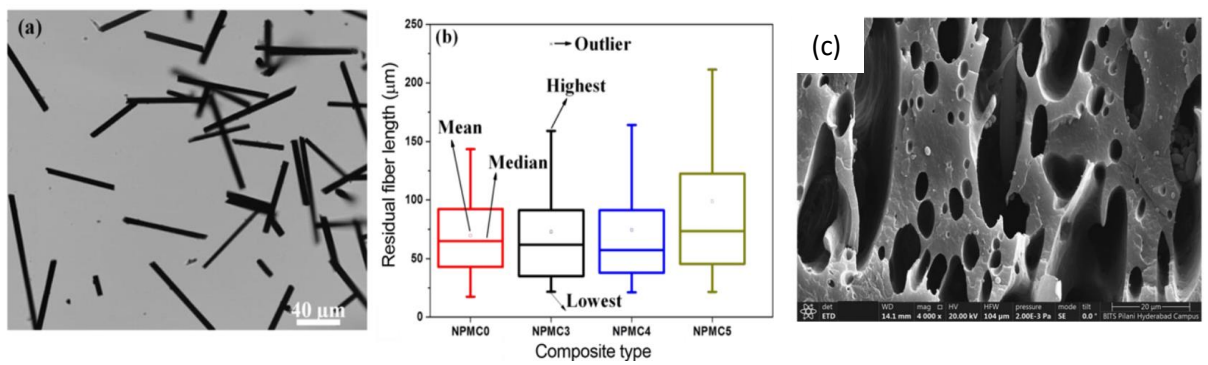
"The group aims to use environment-friendly approaches to improve interfacial adhesion in polymers, production of nanomaterials, and waste management, with special emphasis on biomass and fly ash."

Areas of Interest: Polymer Blends and Composites, Surface modification of materials and interfacial adhesion, Nanomaterial Synthesis from Agriculture residue, Heavy metal removal using agricultural and industrial waste.

Plastic, agricultural, and industrial waste contribute to environmental pollution. They also pose problems such as land management, fire accident, toxic gas releases etc. The use of recyclable polymers is one solution to address the concerns of plastic waste, which is one of our research interests.

Agricultural waste management, along with value addition, is an important issue. We are currently exploring ways to use agricultural waste in bulk and turn it into valuable nanomaterials and polymer composites using green processes. Towards this end, we employ green, biological processes such as enzyme-based delignification.

The presence of heavy metals in water is of great concern. Our group is also researching the capabilities of agricultural and industrial waste such as fly ash in heavy metal removal .



(a) Distribution of carbon fibre in PA6/PP/SCF (b) Residual fibre length of carbon fibre with different grafted polymer content (c) Showing impact morphology of PA6/PP blend after etching out PP the holes represent the PP and indicate the size of PP in the blend

Latest Publications:

S. Ramesh, P. Doddipatla, S. Pamidipati, Biomass Conv. Bioref. 2021, DOI 10.1007/s13399-021-01306-2.

T. S. Ghanta, S. Aparna, N. Verma, D. Purnima, Polymer Engineering & Science 2020, 60, 1717.

S. Aparna, D. Purnima, R. B. Adusumalli, Polymer Composites 2020, 41, 5167.

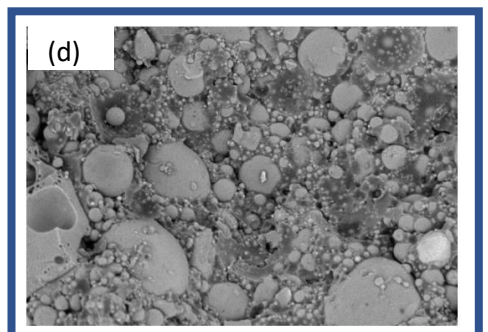
A. Sridhar, P. Doddipatla, Journal of Applied Polymer Science 2019, 136, 47690.

On-going Research

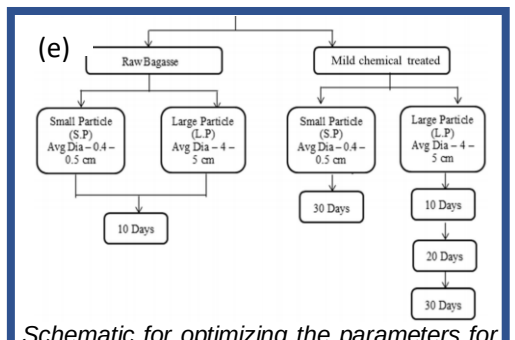
Thermoset polymer with carbon fibre reinforcements are used in various industrial applications such as space, automobile industries. Recycability is one of the issues with these. Thermoplastic polymers have been looked for as alternative matrices. PA6 is one such polymer. However, hydrophilicity is one of its drawbacks, which is overcome by blending with hydrophobic PP. PA6/PP-blends were reinforced with carbon fibre. Residual length plays an important role in determining the final properties of the composites made, which was studies and depicted in figure (a) and (b). Morphology of the blend plays a vital role in determining its properties, such as interfacial adhesion. The PA6/PP blend morphology is depicted in figure (c).

The use of industrial waste in fly ash is beneficial as it will solve the management problem of fly ash waste. Fly based composites with PP were made. Dispersion of fly ash in PP is crucial for getting good properties of the composites. Effect of various treatments studies. Figure (d) shows the spherical fly ash particles.

Value addition of agricultural mass by turning them to nanomaterials such as nanocellulose is of great interest. The use of chemo-biological routes is an emerging area of interest. Our research group is working on using enzymes and fungal treatment of biomass for lignin removal. Figure (e) represents the optimization of parameters like size and days for fungal treatment used to produce nanocellulose.



Fly ash in polymer composites



Schematic for optimizing the parameters for treatment of biomass using fungi

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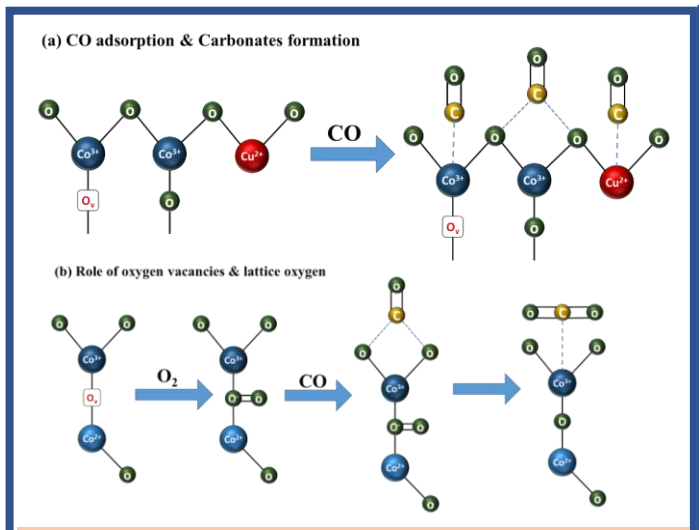
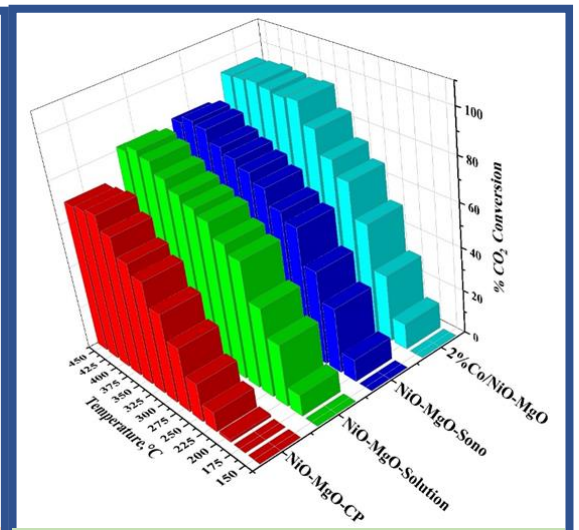
"Our focus is to explore novel materials synthesis and its catalytic pathways to tackle energy & environmental challenges."

Areas of Interest: Heterogeneous Catalysis, Reforming, Photocatalysis, CO_2 Sequestration, CO abatement, Reaction Mechanism & Microkinetics, Computational Fluid Dynamics, Process Simulation, Kinetic Monte Carlo (kMC)

The global challenges that we are facing are related clean water, energy and environment. We are addressing these challenges by catalytic means. As a part of CO_2 utilization, my group primary focus is on synthesizing stable and active catalysts to generate fuels such as CH_4 and CH_3OH. The development of low temperature catalysts for CO, SO_x and NO_x abatement is a challenging task due to its catalytic poisoning nature. However, these toxic gases removal is crucial in versatile nature of applications like three way catalytic converters equipped with IC engine and removal of CO and NO_x in H_2 rich feed for proton exchange membrane fuel cell (PEMFC). We also focus on developing photo-(electro)-catalysts for water purification and green H_2 generation using sun light.



Possible CO oxidation and PrOx mechanism on Cu/Co_3O_4 catalysts



NiO-MgO catalysts performance for CO_2 methanation

Catalysts for CO abatement

Cu incorporated cobalt oxide spinel matrix exhibits excellent selectivity and conversion towards both CO oxidation and preferential CO oxidation. The *in situ* FTIR experiments under PrOx conditions showed the presence of carbonates, formate and carboxyl species. Surface carbonates are observed even at low temperatures of 50°C, indicating its significant role in the rate controlling mechanism.

Photocatalysis for water purification and H_2 generation

We focus on defect and bandgap engineering to improve the photocatalytic efficacy of a catalyst for water purification application. Using advanced materials such as graphene, C_3N_4, Z-scheme heterojunctions, the utilization of e^- and h^+ pairs can be enhanced. Such a mechanism will not only facilitate the degradation of organic pollutants, but also enhances the reaction rates of water splitting at room temperature. A successful design of continuous H_2 generator using sunlight will be a game changer in clean energy production.

CO_2 utilization to synthesis fuels

CO_2 conversion to CH_4 is achievable between 300-400°C, however, water gas-shift and catalyst reduction in presence of stringent feed conditions restricts the available active sites. We developed M doped NiO-MgO catalyst and it is found to be highly effective than commercial Rh based catalysts. Our objective is to synthesize low-cost catalysts for the applications of human space flights and biogas quality improvement.

The CH_3OH synthesis by CO_2 hydrogenation has excellent prospect in addressing global issues of fossil fuel diminishment, and global warming. However, it is challenging to design a catalyst that can lower the activation energy barrier at low temperatures to meet thermodynamic limits. The typical pathways of CO_2 hydrogenation are formate, reverse water gas-shift (RWGS) and trans –COOH mechanisms, which is again subject of exploration.

Latest Publications:

- Y. Varun, I. Sreedhar, S. A. Singh, Int. J. Hydrogen Energy 2020, 45, 28716.
- N. K. R. Eswar, S. A. Singh, J. Heo, J. Mater. Chem. A 2019, 7, 17703.
- S. A. Singh, S. Mukherjee, G. Madras, Mol. Catal. 2019, 466, 167.
- N. K. Veldurthi, N. K. Eswar, S. A. Singh, G. Madras, Appl. Catal. B: Environ. 2018, 220, 512.

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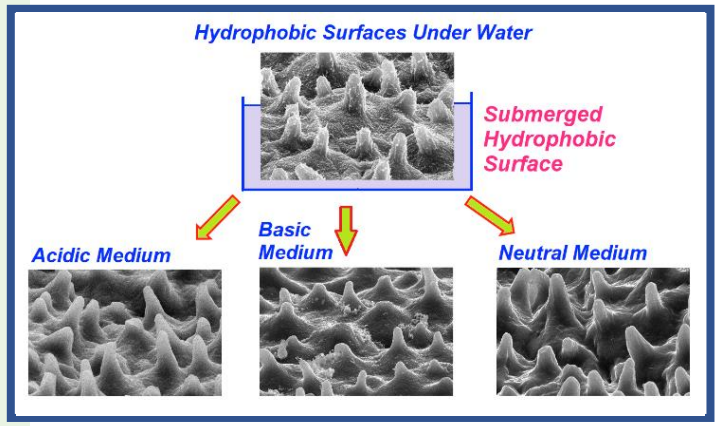
"Our work focuses on fundamental aspects, design and applications of soft materials with nanoscale structures in the areas of wetting, nanofabrication and microfluidics."

Areas of Interest: Dynamics of Ultra-thin Films, Self-assembly at the Nanoscale, Soft Lithography, Superhydrophobicity, Functional Surfaces.

Our research group mainly focuses on the nanofabrication and nano-manipulation of polymeric structures combining the concepts of soft-lithography and thin film instability. The work explores fundamental aspects related to confinement induced instability, morphological evolution and pattern formation in multi component ultra-thin film systems with detailed analysis using various microscopy techniques. We also explore different applications in materials and surfaces, where nano-structuring plays an important role such as special wettability surfaces, microfluidics, biological scaffolds and self-assembly of peptides

Development of superomniphobic surfaces and their long term durability studies

Superhydrophobic surfaces provide unique surface properties for prevention of the adhesion, self-cleaning applications, reduction of frictional drag, prevention of microbial growth to name a few. In this regard we are currently pursuing the development of alternative methods for fabricating superomniphobic surfaces, based on the concept of generating re-entrant nanostructures on a Soft-Lithography platform.



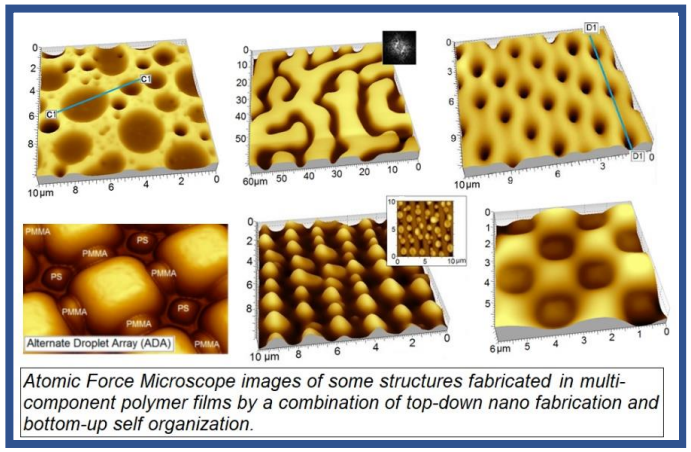
The key novelty will be to control the self-organization utilizing instabilities active at the meso-scale with the help of soft lithographic routes to achieve patterns that possesses re-entrant geometry, without using etching. We are also look into the long-term durability of these surfaces in different practical scenarios, including when submerged under water for prolonged duration of time.[1]

Latest Publications:

1. S. M. Varughese, N. Bhandaru, Soft Matter 2020, 16, 1692.
2. N. Bhandaru, Bull Mater Sci 2020, 43, 180.
3. N. Bhandaru, A. Das, N. Salunke, R. Mukherjee, Nano Lett. 2014, 14, 7009.
4. N. Bhandaru, G. Kaur, A. Panjla, S. Verma, Nanoscale 2021, 13, 8884.

Stability and morphology modulation of multi-component Polymer thin films

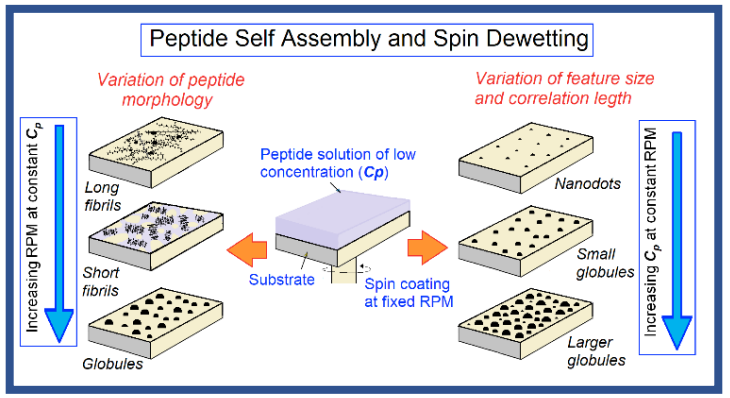
Ultra-thin films (thinner than 100 nm) tend to become unstable due to various meso scale interactions such as van der Waal's forces, rupture spontaneously and dewet on a non-wettable surface. While such instability is undesirable from the stand point of a thin coating, it is a viable non lithographic route to engineer meso scale structures. With this project, we are looking into some advanced experimental issues related to instabilities in multi component thin film systems and combine the important concepts of top down and bottom-up fabrication approaches.[2,3]



Atomic Force Microscope images of some structures fabricated in multi-component polymer films by a combination of top-down nano fabrication and bottom-up self organization.

Controlled Self-assembly and spatial organization of biomolecules

Controlling the morphology and nanostructure of self-assembled biomolecules is of fundamental importance to chemistry and material science due to their bioactivity in both in vivo and in vitro settings, hybrid supramolecular assembly, possible detection and treatment of diseases and so on. With this work, we investigate the effect of nature of wetting and deposition parameters on the self-assembly of diphenylalanine peptide and its variants on a surface. Our experiments also reveal the different hydrodynamic effects on the peptide assembly.[4]



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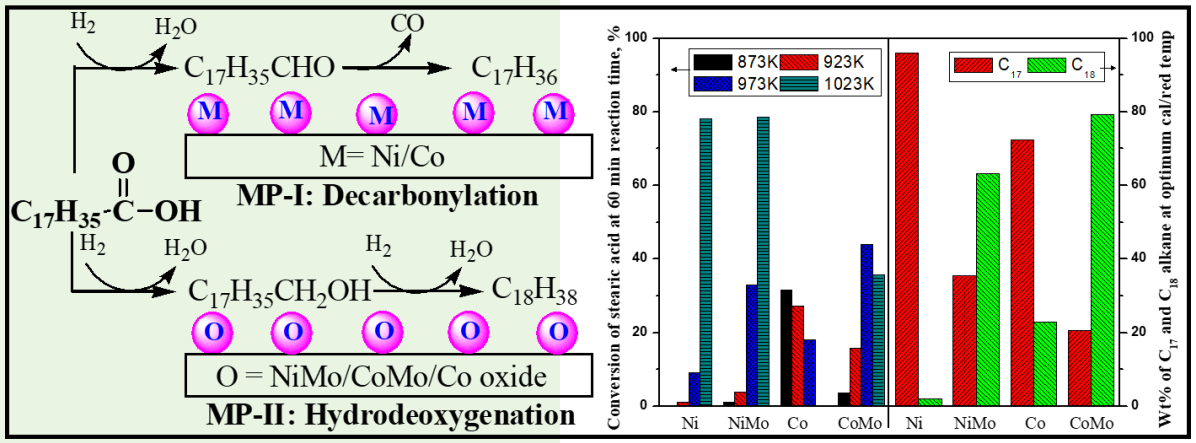
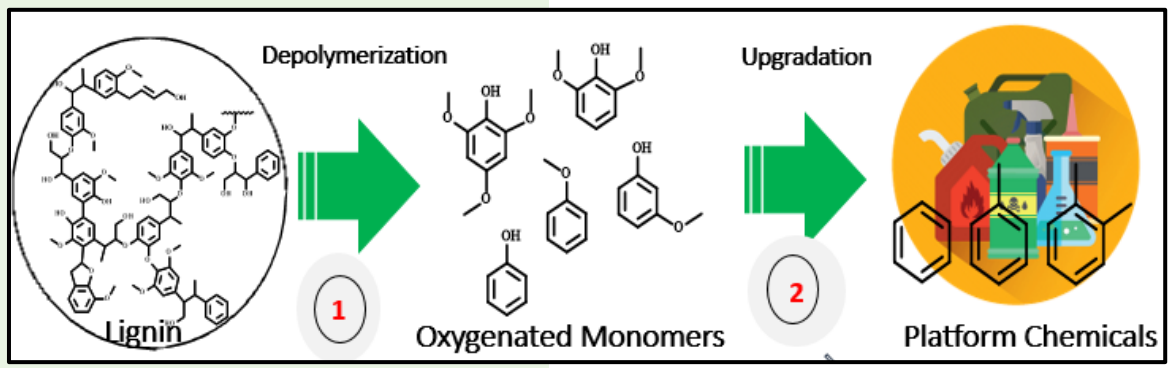
> Our research mainly focuses on the process development for the production of hydrocarbon biofuels (transportation fuel) and chemicals from biomass in the hydrocarbon biorefinery.

Areas of Interest: Biofuels, Biorefinery, Heterogeneous Catalysis, Reaction engineering

We are currently working with the broad theme of biorefinery with special emphasis on heterogeneous catalysis, reaction engineering, process design and techno-economic analysis using Aspen plus/Hysys. In the past few decades, considerable attention has been devoted to the production of biofuels to reduce dependency on finite fossil fuels. These efforts are intended to achieve energy security and preserving a healthy environment. Transportation fuels are the prime energy-consuming sector with about 28% of the world's energy. Our research is thus focused on producing biofuels in a sustainable manner.



Mechanism of HDO of stearic acid over mono-metallic (Ni and Co) and bi-metallic (NiMo and CoMo) catalyst and Effect of calcination temperature on the catalytic performance of both mono and bi-metallic catalysts.



Depolymerization of lignin to chemicals

Hydrodeoxygenation (HDO) of Stearic Acid Over Supported Metal Catalysts for the Production of Green Diesel:

The hydrodeoxygenation (HDO) of fatty acids derived from vegetable and microalgal oils is a novel process for the production of liquid hydrocarbon fuels well-suited with existing internal combustion engines. This technology produces green diesel with a high yield and minimal carbon loss. HDO is a catalytic process and carried out in the presence of hydrogen over supported metal catalysts. The catalyst thus plays a vital role in this process. Hence, the work is mainly focused on:

- The selection of suitable supports and development of supported transition metal catalyst for the selective conversion of stearic acid.
- Elucidate the underlying reaction mechanism and kinetics of HDO over supported metal catalysts.
- Role of calcination temperature on the performance of supported metal catalysts.
- Role of molar ratio of individual metals in bimetal catalysts.

Techno-economic evaluation of the processes for production of biofuels:

Techno-economic analysis is essential to identify the primary cost drivers and the feasibility of the processes. It is also an economically most attractive way to check the sustainability of the new developed process before commercialization can be undertaken. Hence, our research work focuses on process design and economic analysis for the production of biofuels.

Production of fuels and aromatics from lignocellulosic biomass: an integrated bio-refinery approach:

Lignin is a carbon-neutral renewable and rich source of aromatics. The idea of a bio-refinery is an alternative to the existing petroleum refinery for the production of fuels and chemicals. Hence, sustainable technology can make it feasible for an integrated biorefinery process to produce chemicals from lignin sources. The development of highly active, selective, and stable catalysts and optimal process conditions for depolymerization of lignin and hydro-deoxygenation (HDO) of a lignin-derived oxygenated compound is a scientific challenge with technological impact. Hence, our research work focuses on the same challenges and looking sustainable approach for producing fuels and chemicals from lignin.

Latest Publications:

- P. Kumar, S. R. Yenumala, S. K. Maity, D. Shee, Applied Catalysis A: General 2014, 471, 28.
- P. Kumar, P. Kumar, P. V. C. Rao, N. V. Choudary, G. Sriganesh, Fuel 2017, 199, 339.
- P. Kumar, S. K. Maity, D. Shee, ACS Omega 2019, 4, 2833.
- P. Kumar, S. K. Maity, D. Shee, Chemical Engineering Communications 2020, 207, 904.

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"Our research group focusses on using computational techniques for a sustainable and healthier tomorrow with applications spanning across energy to biological systems."

Areas of Interest: Process Synthesis & Simulation, Optimization, Machine Learning, Process Monitoring, Technoeconomic Analysis, Energy & Biological systems

The key focus of our research is to develop computational frameworks that will aid in decision-making. Our application domain ranges from energy to biological systems. On the energy front, we focus on process synthesis, simulation, and optimization to investigate the technoeconomic feasibility of different sustainable processes for a greener tomorrow. This will enable policymakers to judiciously decide our future energy landscape. On the other hand, we use both data-based and knowledge-based frameworks to unveil different attributes of biological systems. This has the potential to aid experimentalists in designing effective experiments, thus saving both time and resources and advancing towards a healthier tomorrow.

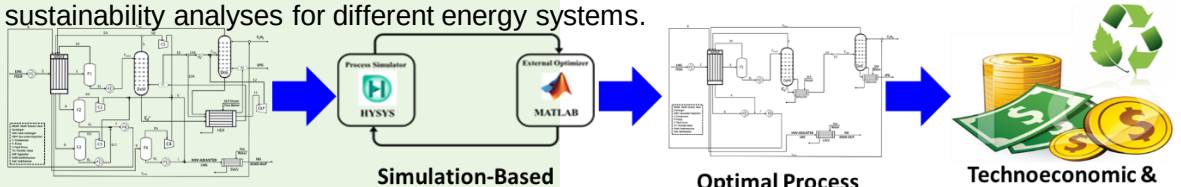
Natural gas value chain | | CO_2 Capture & sequestration | | CO_2 utilization | | Renewable energy resources

SYSTEMS ANALYSIS

Data Mining | | Feature Extraction | | Supervised & Unsupervised Algorithms | | Model Explainability

Simulation-based Optimization

Simulation-based optimization (SBO) framework enables seamless interfacing of process simulators like Aspen HYSYS with external environment like MATLAB. Although simulators come with inbuilt thermodynamic packages and modules for different unit operations, they lack efficient optimization solvers. To overcome this limitation, the SBO paradigm integrates commercial simulators with external programming platform where we can implement a plethora of optimization algorithms. The SBO methodology is used in optimizing process superstructures incorporating various design topologies and operating conditions to obtain optimal design configuration along with optimal process operating conditions. This allows us to perform technoeconomic and sustainability analyses for different energy systems.



Process Superstructure | Simulation-Based Optimization Paradigm | Optimal Process Configuration | Technoeconomic & Sustainability Analysis

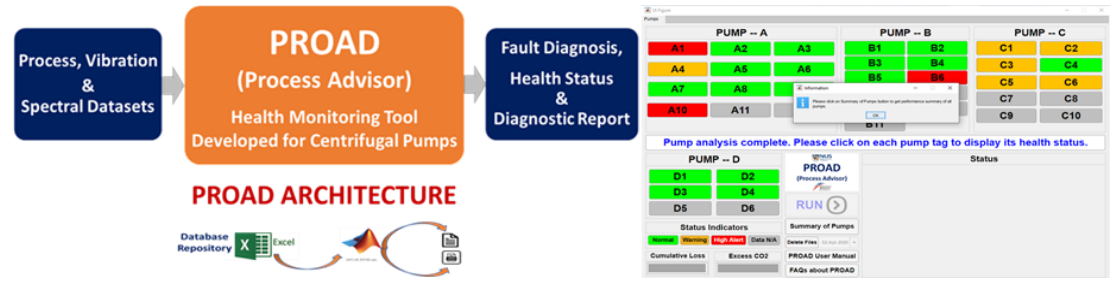
Machine Learning-assisted Predictive Modelling

In the era of internet of things and our quest for digitalization, it is pertinent to develop data-based predictive modelling frameworks. We use supervised as well as unsupervised machine learning algorithms to develop predictive models for different systems. The objective here is to unveil structure-property relationships that can aid in predicting different properties for a system which otherwise would be resource intensive to evaluate via wet lab experiments.

We are actively working in collaboration with Dr. Debirupa Mitra to develop different predictive models that can complement experimental methods of antimicrobial discovery. We also use explainable machine learning concepts to extract insights from our developed models and validating them with experimental insights, thus further enhancing the reliability of our models. We are also working with Dr. Mitra to develop models that can aid in understanding the disease progression of Covid-19 and explain the effect of various treatment options.

Machine Learning-based Prototype: Aiding in the digitalization of chemical processes

PROAD (Process Advisor), a data-driven GUI-based tool was developed in collaboration with National University of Singapore that can perform health monitoring and diagnostics of centrifugal pumps. PROAD has been handed over to our industrial partner for its implementation within plant.



Latest Publications:

1. A. Dutta, I. A. Karimi, S. Farooq, ACS Sustainable Chem. Eng. 2018, 6, 10687.
2. A. Dutta, I. A. Karimi, S. Farooq, Ind. Eng. Chem. Res. 2019, 58, 963.
3. A. Dutta, S. Farooq, I. A. Karimi, S. A. Khan, Journal of CO2 Utilization 2017, 19, 49.
4. A. Dutta, I. A. Karimi, S. Farooq, AIChE 2020 Annual Meeting, San Francisco, CA, USA

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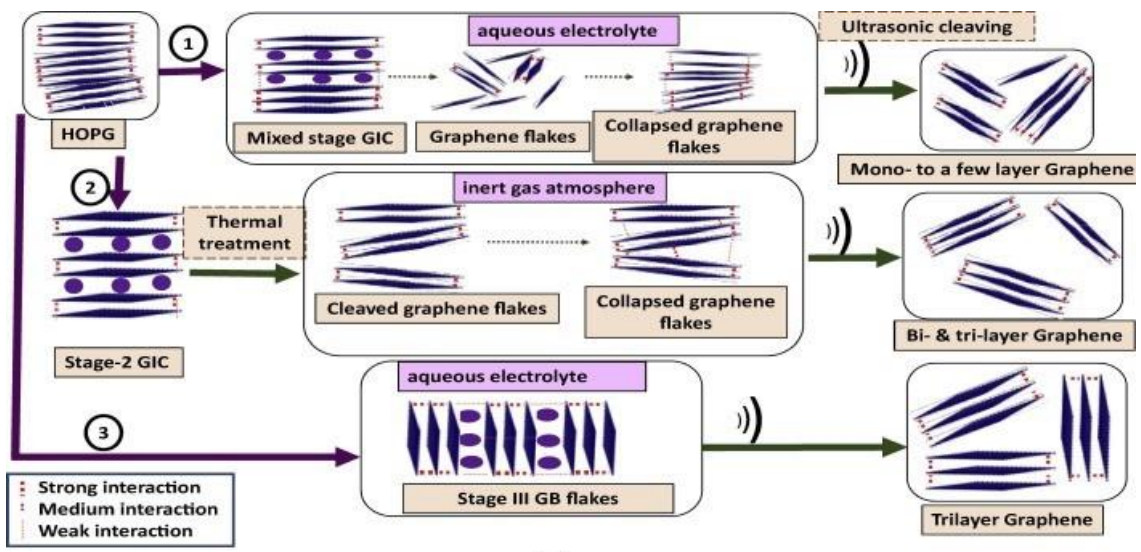
> "We conduct multifaceted research on 2D layered materials with a goal of discovering new phenomena and applications, that can be translated into high impact products."

Areas of Interest: Layered Materials, Energy storage devices, graphene, electrochemical engineering, supercapacitors

Our research focuses on exploring approaches for the synthesis, self-assembly, and scalable processing of 2D materials with exceptional electrochemical properties for energy harvesting and storage applications. We explore fundamental electronic and electrochemical phenomena of novel materials, with a current particular emphasis on graphene and other 2D materials (e.g. phosphorene, MoS2), to prepare advanced new generations of hybrid materials with unprecedented materials attributes, and devices based on them especially those pertinent to energy harvesting and storage applications.



A schematic of the graphene synthesis processes involving formation of GIC intermediates. Path 1: electrochemical exfoliation of graphite to graphene in an aqueous electrolyte solution via multistage GICs yields graphene with different number of layers. Path 2: graphene synthesis using a stage-pure GIC intermediate. Path 3: the scheme used in this work. The intermediate product is stage III GB which has low strength at intercalation planes. The GB is selectively cleaved at the intercalation planes in a dispersion favourable solvent by ultrasonic agitation to give a completely trilayer graphene suspension.

On-going Research

Layered materials are stacks of host sheets loosely bonded by van der Waals interactions. The extraordinary properties of these materials are layer dependent and the key to harnessing these superior properties is to develop a bulk, cheap, facile technique having a good control on the layer number of the synthesized material. We employ electrochemically facilitated exfoliation as a promising route for mass-production of 2D-layer sheets due to its fast, smooth and benign operational conditions.

Current projects include

1. **Electrochemical synthesis of layered materials.**
2. **Fabrication and analysis of doped graphene for energy storage applications.**
3. **Molecular models and simulations of layered materials.**
4. **DFT guided design to improve the charge capabilities of layered materials.**
5. **Graphene based materials for antimicrobial applications.**
6. **Applications of layered materials as Electrochemical Actuators**

Latest Publications:

A. Mir, G. N. Abhilesh, R. M. Tamgadge, A. Shukla, J Solid State Electrochem 2019, 23, 2281.

A. Mir, A. Shukla, Materials & Design 2018, 156, 62.

A. Mir, D. K. Singh, A. Shukla, Materials Chemistry and Physics 2018, 220, 87.

A. Mir, A. Shukla, Applied Surface Science 2018, 443, 157.

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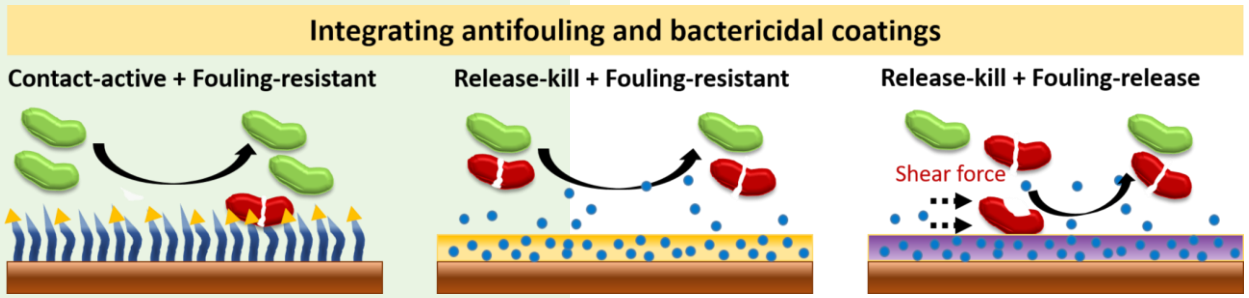
> "We are an interdisciplinary research group actively looking for developing products and processes to detect, prevent, and control infections."

Areas of Interest: Surface modification for healthcare application, Antimicrobial coatings & hydrogels, Modelling of biological systems

The overall goal of our research group is to apply chemical and material science engineering principles to understand, detect, prevent, and control infections. Current focus is in the experimental design of antimicrobial materials and coatings that can potentially be used to inhibit the transmission of microbes via frequently-touched surfaces, to prevent the occurrence of biomaterial-associated infections, and to facilitate the healing of infected wounds. There is also modelling-based collaborative research to understand viral growth dynamics in humans, and to assist in computational antimicrobial discovery.

Multifunctional polymeric coatings

Surface-modification of materials using polymers offer a versatile platform to introduce a multitude of functionalities such as antimicrobial, antifouling, hemocompatible, anti-thrombotic, etc. Our research focusses on the development of multifunctional antimicrobial coatings as well as stimuli-responsive antimicrobial coatings for application in catheters, wound healing dressings, implants, etc.

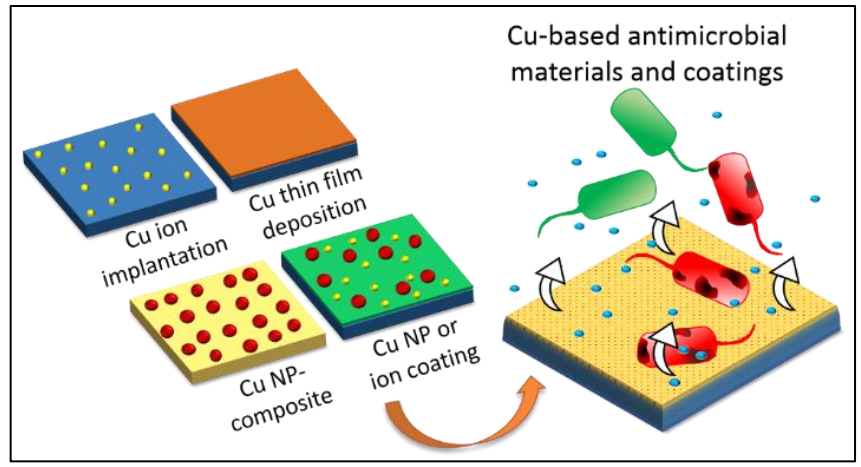


Latest Publications:

1. D. Mitra, M. Li, E.-T. Kang, K. G. Neoh, ACS Appl. Mater. Interfaces 2019, 11, 73.
2. D. Mitra, E.-T. Kang, K. G. Neoh, ACS Appl. Mater. Interfaces 2020, 12, 21159.
3. D. Mitra, E.-T. Kang, K. G. Neoh, ACS Appl. Polym. Mater. 2021, 3, 2233.

Copper-containing antimicrobial coatings

Copper's antimicrobial properties have been known since ancient times. Copper demonstrates rapid and high microbicidal efficacy against pathogens in close contact under ambient indoor conditions, making it highly suitable as an anti-infective surface to inhibit surface-assisted pathogen transmission in hospitals, clinics, frequently-touched public facilities, etc. Our current research focusses on the development of facile techniques for the preparation of copper ion-impregnated and copper nanomaterial-based antimicrobial coatings.



Modelling of biological systems (In collaboration with Dr. Arnab Dutta)

Mathematical modelling is a powerful tool to study viral growth kinetics. One of our research involves the study of SARS-CoV-2 growth dynamics at a single organism scale, using kinetic models, in an effort to understand the disease progression of Covid-19 and quantitatively rationalize the effect of various treatment options. In another collaborative work, we are looking at antimicrobial peptide classification and property prediction using machine learning-based models, in an effort to understand structure-activity relationships and complement experimental methods of antimicrobial discovery.

Dr. Iyman Abrar

Assistant Professor

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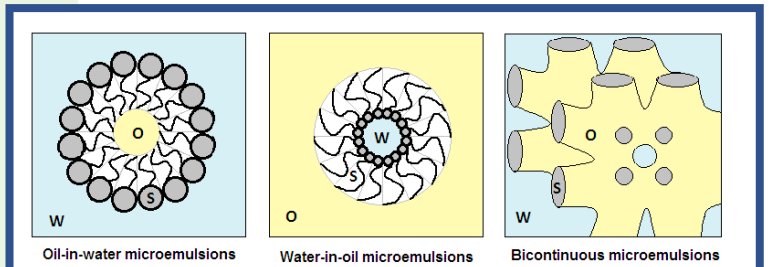
> "All of us hold the potential to revolutionize how we remedy the non-renewable environment around us. Our research group focuses on problems related to the energy sector and we are looking for sustainable alternative fuels."

Areas of Interest: Emulsions and Microemulsions; Sustainable Alternative Fuels; Performance Evaluation of IC engine; Interfacial Engineering

The key focus of our research is on developing sustainable alternatives to petroleum-based fuels. Our research revolves around interdisciplinary areas of chemical, petroleum and mechanical engineering.

It draws on the applications of interfacial engineering to formulate microemulsions and emulsions that can serve as an alternate to petroleum-based fuels. Micro-emulsions are thermodynamically stable and optically isotropic colloidal dispersions of polar phase and non-polar phase, stabilized by a surfactant.

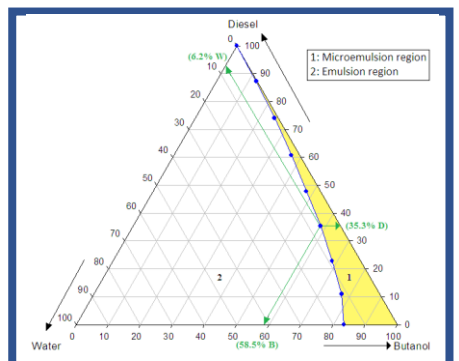


Structures of oil-in-water, water-in-oil, and bicontinuous microemulsions, where, W represents water, O represents oil, and S represents surfactant

They could be directly used in the engine without any modification. These alternative fuels are also tested in engines for their performance evaluations. Our work has been proven through papers and patents, and we are actively working on collaborations with different institutes.

Surfactant-free microemulsions

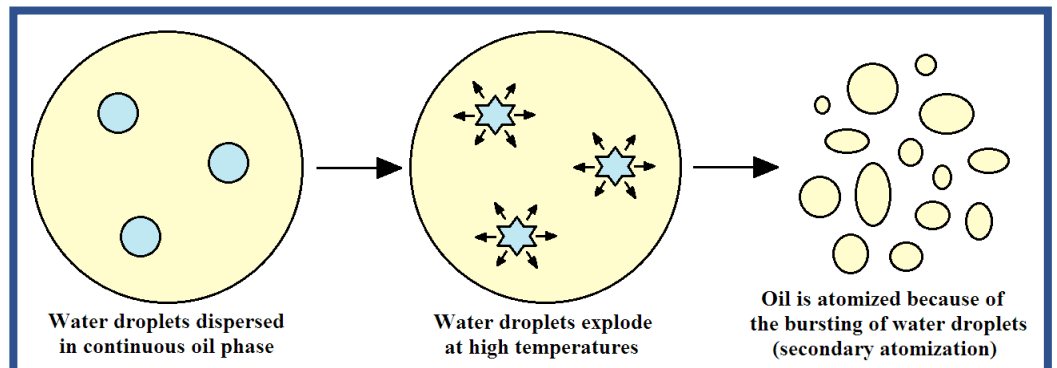
One of the major limitations of using the microemulsions includes the high percentages of surfactant (~10%) required for its formation, which restricts their sustainable use. At present, very limited data is available on surfactant-free microemulsion fuel and their characteristics. Thus, the ongoing research is focussed on formulation of surfactant-free microemulsions, wherein an amphi-solvents serve as a replacement for surfactant. An amphi-solvent is used in place of a surfactant in these microemulsions to reduce the interfacial tension and the cost of fuel. These microemulsions are expected to be economically viable and cleaner alternatives to petroleum-based fuels.



Ternary plot for butanol-diesel-water system used to represent emulsion and microemulsion region

Water-in-oil based fuels

Addition of a small amount of water in the fuel is desirable as it improves the combustion characteristics. The water droplets are dispersed in a continuous phase of fuel in cases of both emulsions and microemulsions. As the temperature inside the combustion chamber increases, the water droplets evaporate rapidly as the boiling point of water is much lower than that of fuel. These microexplosions of water droplets result in breaking up of fuel films into finer droplets, leading to secondary atomization of the fuel inside the combustion chamber, with an increased specific surface area, and hence are readily combustible. The microexplosions also increase the turbulence, which improves the air-fuel mixing and further enhances the combustion and reduce the exhaust gas emissions.



Secondary atomization of fuel caused by microexplosions of water droplets dispersed in the continuous oil phase.

Latest Publications:

- I. Abrar, A. N. Bhaskarwar, Sustainable Energy Technologies and Assessments **2021**, 47, 101414.
- I. Abrar, A. N. Bhaskarwar, Environmental Progress & Sustainable Energy **2020**, 39, 13422.
- I. Abrar, A. N. Bhaskarwar, Fuel **2019**, 257, 115944.

Dr. Ramendra K. Pal

Assistant Professor

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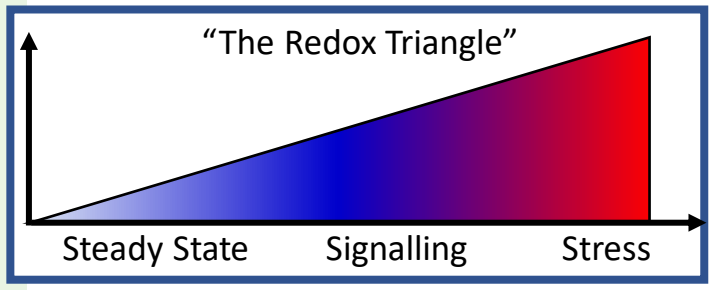
> "We take a multidisciplinary approach to innovate solutions and seek answers to the fundamental questions related to human health and the environment."

Areas of Interest: Biomaterials; Biochemical sensors; Soft electronics; Plasma medicine; Cold Plasma-based disinfection of pathogens

"Life is nothing but an electron looking for a place to rest." Albert Szent-Györgyi (*The Nobel Prize in Physiology or Medicine 1937*).

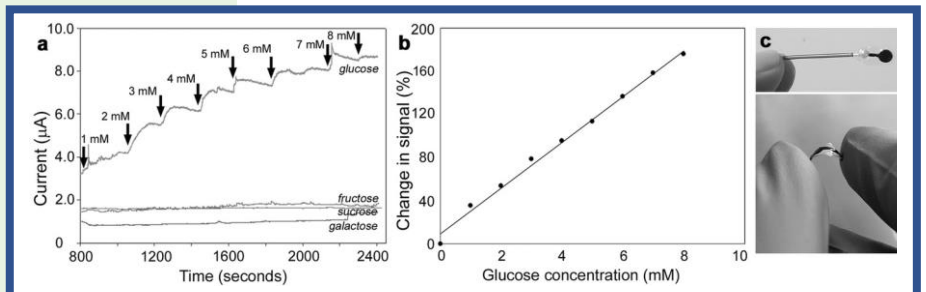
Cells use oxidation and reduction (redox) reactions to produce energy and communicate. Redox communication among cells often shows *three* redox states of a cell. Measurement and analysis of these states are crucial to understanding various disease states and tuning these redox processes can provide a personalized approach to therapeutics .

Our broad vision is to gain a deep understanding of redox processes, develop devices that generate redox species, and probe biological processes using redox methods for monitoring human health and the environment.



Electrochemical sensors for physiological and environmental monitoring

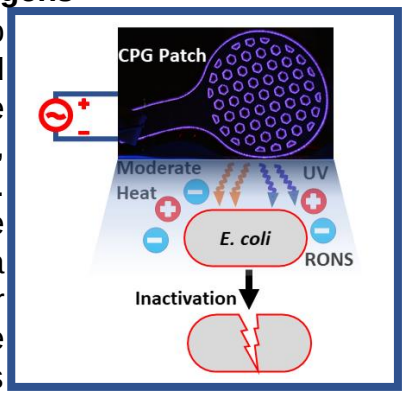
Electrochemical biosensors probe specific biomolecules in multi-analyte systems. Application of electrochemical sensors includes clinical and medical diagnostics, environmental and health monitoring, and food industries. These sensors allow miniaturization, fast read-out, online monitoring, and simultaneous sensing capabilities. This research effort investigates the anti-biofouling modifications of biosensor surfaces and smart integration of nanomaterials to improve selectivity and sensitivity of electrochemical sensors.



Glucose-specific electrochemical sensor

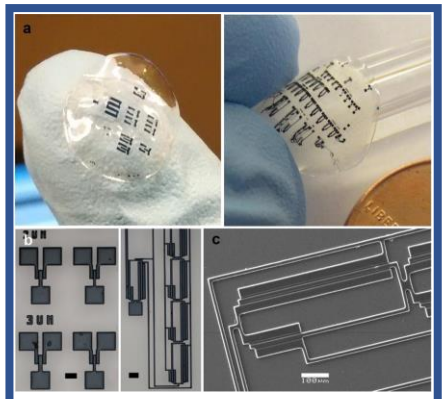
Cold plasma-based therapies and inactivation of pathogens

Cold plasma, the fourth state of matter, refers to partially ionized gas consisting of charged species, excited atoms and molecules, and high-energy photons. The novelty of this technology lies in its non-thermal, economical, versatile, and environmentally friendly nature. The reactive species produced during plasma produce oxidative stresses on biological moieties. The plasma medicine field explores the application of cold plasma for therapeutic purposes. My research aims to understand the specific redox processes occurring in biological systems when exposed to cold plasma and tune the exposure to achieve therapeutic outcomes.



Natural polymer-based bioelectronics

Natural polymers are biocompatible, biodegradable, bio-conformable, and sustainable. They also provide biorecognition, self-repair, and stimuli response. Bioelectronics employs the principles of electronics to monitor and stimulate biological activities. Natural polymers are material for choice for integration of electronics for biological applications. My research involves developing natural polymer-based functional materials and hybrid microfabrication processes to create biocompatible and biodegradable electronics.



Conductive micropatterns on flexible silk fibroin sheets

Latest Publications:

- R. K. Pal, S. C. Kundu, V. K. Yadavalli, ACS Appl. Mater. Interfaces 2018, 10, 9620.
- R. K. Pal, A. A. Farghaly, M. M. Collinson, S. C. Kundu, V. K. Yadavalli, Advanced Materials 2016, 28, 1406.
- R. K. Pal, A. A. Farghaly, C. Wang, M. M. Collinson, S. C. Kundu, V. K. Yadavalli, Biosensors and Bioelectronics 2016, 81, 294.

Staff

Mr. P. Somi Reddy
Sr. Technical Assistant

Mr. P. Appala Reddy
Technician

Mr. N Bhaskara Raju
Technician

Mr. Mudassir Khan
Technician

Mrs. P Himabindu
Jr. Office Assistant

Current PhD Scholars & Project Fellows


Mr. Premnath


Mr. Y. Varun


Mr. Kalyan Vuchuru


Mr. Punnam Pradeep Reddy


Mr. P. Saikiran


Mr. Ravi Kiran


Mr. Aniruddha R


Mr. Suresh K.


Mrs. Sadamanti


Mr. D. Prabhat


Ms. D Shruthi Keerthi


Ms. Sowmya


Mr. K. Sundaraiah


Ms. Gulipalli Pallavi


Ms. G Sirisha


Mrs. C Jhansi


Ms. Malayanur Srilekha

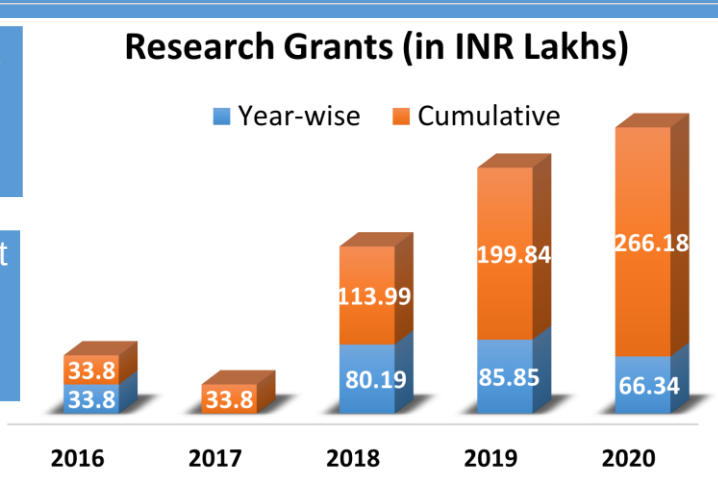

Ms. Madhushmita Sahoo


Mr. Madahavaiah

Sponsored Research

>INR 2.6 crores worth externally funded research grants received in the last 5 years

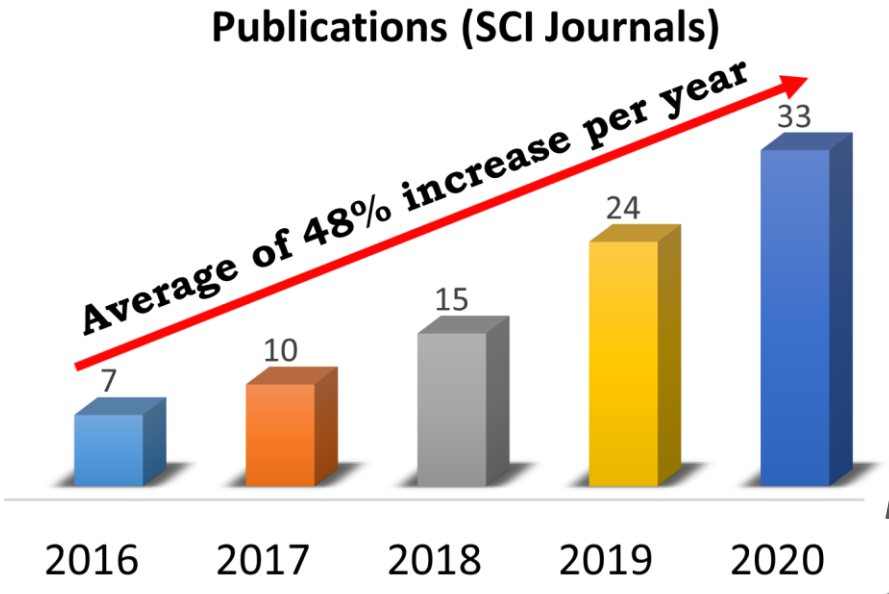
Consultancy projects received in last 5 years: INR 87 lakhs from DRDO, HBL Power Systems Limited, Ardee Hytech

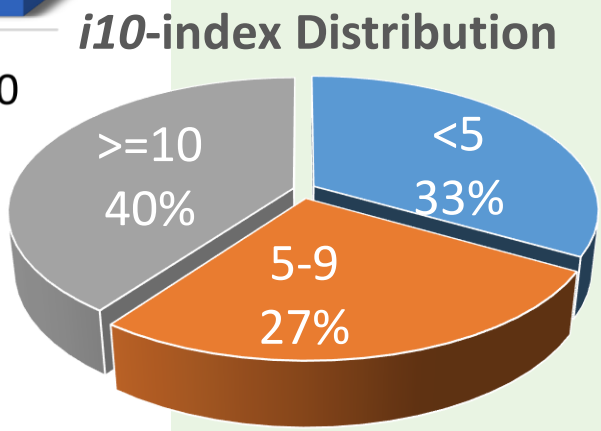


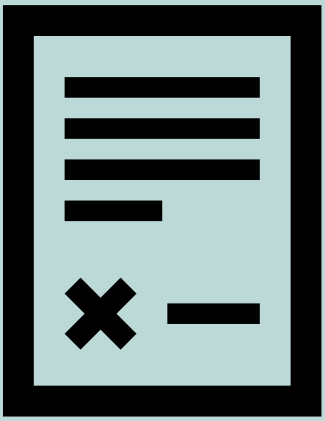
Project Name	PI &(Co-PI)	Funding Agency	Amount (lakhs)	Start date/ duration
Development of superomniphobic surfaces for self-cleaning and antimicrobial applications	Dr. Nandini Bhandaru	DST INSPIRE	28 (total **35** lakhs & first year was spent at IITK)	April 2017 5 years
Reactive transport modeling & simulation of CO2 sequestration in deccan volcanic province	Dr. Vikranth K.Surasani (Dr. B. Krishnamurthy)	DST	21.7	April 2018 3 years
Development of cost effective adsorbents for heavy metal removal from industrial effluent generated at HBL	Dr. I. Sreedhar	HBL Power Systems Ltd	5.04	March 2019 1 year
Underwater superoleophobic surfaces for oil/water separation	Dr. Nandini Bhandaru	BITS-Pilani	9.5	Sept. 2019 2 years
Synthesis of core-shell nanoparticles for photocatalytic reforming	Dr. Satyapaul A. Singh	BITS-Pilani	10	Sept. 2019 2 years
Modeling the capacity loss in lithium ion batteries during cycling	Dr. B. Krishnamurthy (Dr.Vikranth K.Surasani)	CSIR	23.4	Nov. 2019 3 years
Waste Minimization and Carbon Capture with Coal Flyash Doped Sorbents- A Two Edged Sword	Dr. I. Sreedhar	CSIR	19	Nov. 2019 3 years
Developmental Studies on Environmental Conditioning of QCE Composite Materials - DRDO (PI)	Dr. Ramesh Babu	DRDO	24.9	Dec 2020 1 year
Development of endothermic fuel for supersonic vehicle applications	Dr. Srikanta Dinda	DST	36.4	Dec 2020 3 years
Modeling the performance of DET and MET based enzymatic glucose fuel cells	Dr. B. Krishnamurthy	DBT	32.16	2021-2024

Research Accomplishments

Publications in esteemed journals like Renewable & Sustainable Energy Reviews Journal of Chemical Engineering, Journal of Materials Science, Carbohydrate Polymers, Langmuir, Chemical Engineering Science, Journal of Cleaner Production, Journal of CO_2 Utilization, Catalysis Science & Technology, Journal of Power Sources , Drying Technology, etc.







Patents Granted /issued

S. Goel, P. Rewatkar, M. Bandapati and **B. Krishnamurthy**, A system and method for electric power and process thereof for manufacturing the system, 2018 Indian Patent application, 201711046160.

S. Dinda, P. K. Chinthala, A. Gohel, A. Yadav, S. Mandal, G. Ravichandran and A. K. Das, Process and composition of catalyst/additive for reducing fuel gas yield in fluid catalytic cracking (FCC) process. **2017**, Pat. No: US 9783743B2.

G. Ravichandran, P. K. Chinthala, T. Doshi, A. Gohel, A. Arusu, S. Mandal, A. K. Das, **S. Dinda,** A. Parekh, Fluid Catalytic Cracking (FCC) additive and catalyst preparation method, **2016**, CN10381856B.

S. Dinda, P. K. Chinthala, A. Gohel, A. Yadav, S. Mandal, G. Ravichandran and A. K. Das, Process and catalyst compositions / additive, for reducing the fluid catalytic cracking (FCC)process in the fuel gas yield. **2016**, CN103703105 B.

G. Ravichandran, P. K. Chinthala, T. Doshi, A. Gohel, A. Arusu, S. Mandal, A. K. Das, **S. Dinda,** A. Parekh, FCC catalyst additive and a method for its preparation, **2015**, US9067196 B2.

S. Dinda, P. K. Chinthala, A. Gohel, A. Yadav, S. Mandal, G. Ravichandran and A. K. Das, Process and composition of catalyst/additive for reducing fuel gas yield in fluid catalytic cracking (FCC) process. **2015**, Pat. No: EP 2729553 A4.

S. Dinda, P. K. Chinthala, A. Gohel, A. Yadav, S. Mandal, G. Ravichandran and A. K. Das, Process and composition of catalyst/additive for reducing fuel gas yield in fluid catalytic cracking (FCC) process. **2014**, Pat. No: US 20140116923 A1.

A Device And A Process For Purification Of Grey Water, Sep 30, 2014. EP 3055044 B1,

A Device And A Process For Purification Of Grey Water, Sep 30, 2014. AU 2014/334011 B2,

Multi Phase Systems Lab

Aniruddha is using coal fly ash doped sorbents for carbon capture and waste minimization

Mixed and Fluidized Bed Reactor

Vacuum oven

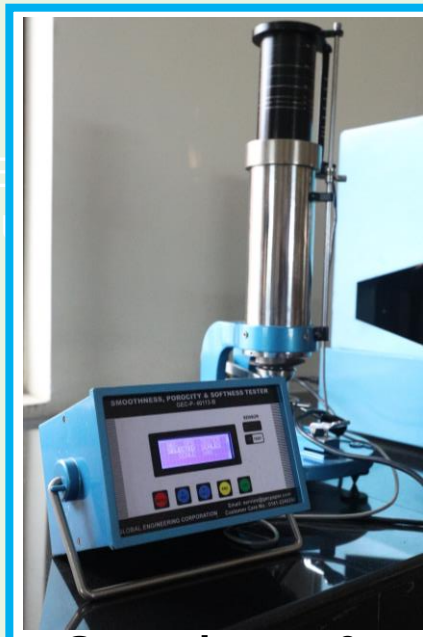
Chemical Reaction Engineering Lab

Research Equipment

Batch Reactor

PFR

Rotary Digester



Smoothness & Softness Tester

CSTR & PFR

Student is digesting lignocellulosic biomass

Brightness and Colour Tester

Environmental Lab

Research Activities

Laminar Air Flow Hood

Orbital Shaker

Sireesha is working on heavy metal removal using agriculture waste

Trey Fermenter

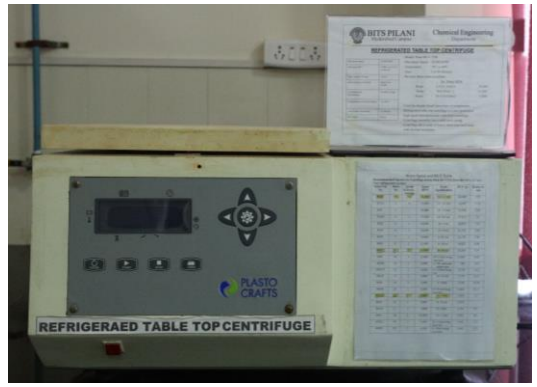
B.O.D. Incubator

Ravi Kiran is exploring higher water recovery from RO

Instrumentation Lab

Research Activities

BET Surface Area Analyser



Refrigerated Centrifuge

Mudassir is analysing a gas sample

Jhansi is working on layered materials

Gas Chromatographer

Distillation Analyser

UV/Vis Spectrophotometer

Ultrasonic Cleaner

Potentiostat & Galvanostat

Probe Sonicator

Rotary Evaporator

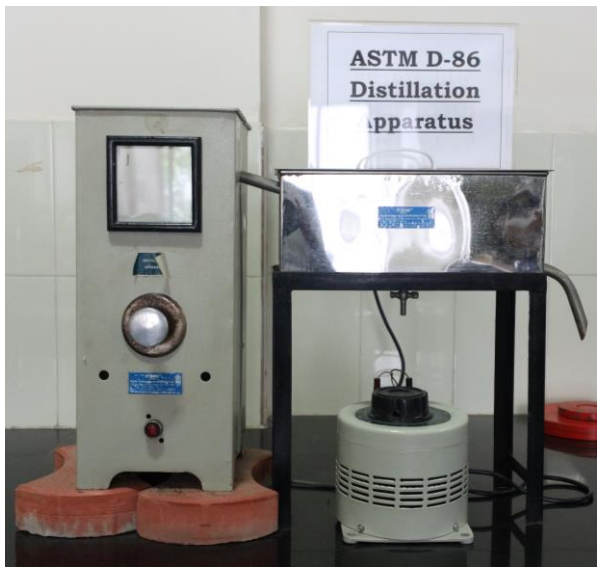
Petroleum Lab

Research Activities

Cracking Reactor

Viscometer

Madhavaiah is developing an endothermic fuel for supersonic vehicle applications



Distillation Apparatus

Flashpoint Apparatus

Kalyan is studying decomposition kinetics of endothermic fuels

Selected Chemical Engineering Operations Lab

Fluidized Bed Dryer

Batch Crystallizer

Centrifugal Pump Setup

Free & Forced Vortex

Critical Heat Flux

Ball Mill

Granulator

Emissivity Monitor

Selected Chemical Engineering Operations Lab

Tray Dryer

Double-effect Evaporator

Plate & Frame Filter Press

Fluid Mixer

Rotary Drum Filter Press

Heat through Composite Wall

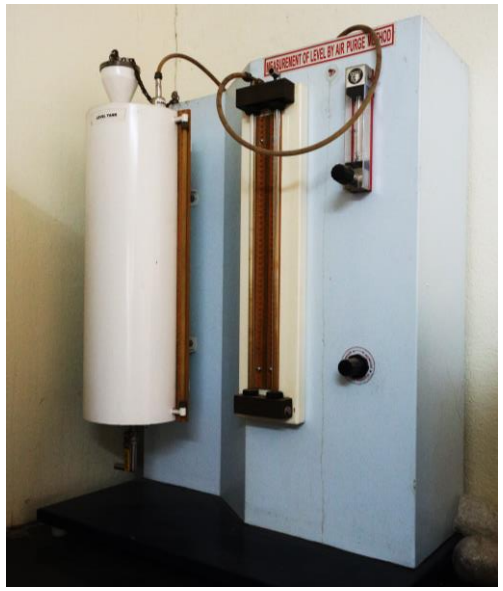
Muffle Furnace

Dust Sampler

Selected Chemical Engineering Operations Lab

Sedimentation Unit

Water Cooling Tower



Level Measurement by Air Purge Method

Research Activities

Super mass Colloider

Ahmed is testing stability of composites in simulated ocean environment

Lab Valley Beater

Pallavi is measuring thickness of nanocellulose sheets

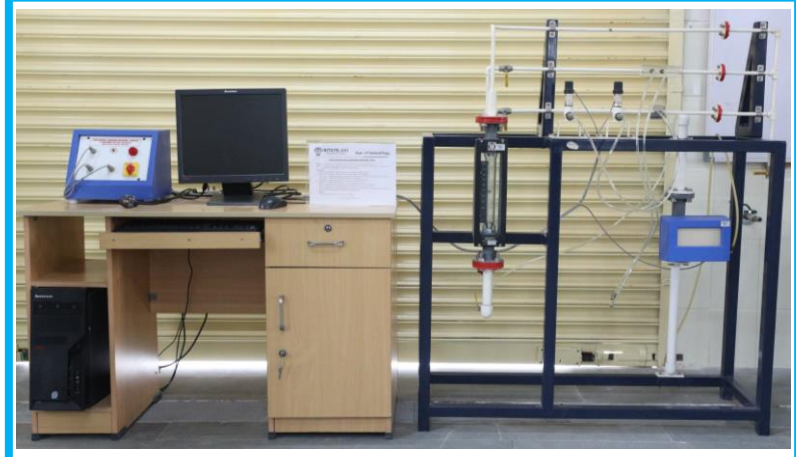
Transport Phenomena Lab

Bernoulli's Theorem Apparatus

Drop wise & Film wise Condensation

Extraction Columns

Fixed and Fluidized Bed Apparatus



Venturi & Orifice Meters

Fluid Friction Apparatus

Reynold's Apparatus

Vapor in Air Apparatus

Double Pipe Heat Exchanger

Transport Phenomena Lab

Heat Exchanger

Plate & Frame Heat Exchanger

Thermal Conductivity of Metal Rod

Thermocouple Calibrator

Bubble-cap Distillation Column

Forced Convection Apparatus

Natural Convection Apparatus

Thermal Conductivity of Liquids

Shell & Tube Heat Exchanger

Materials & Interfacial Science Lab

Research Activities

Laminar Flow Hood

Sai Kiran is studying the morphology of polymer blends

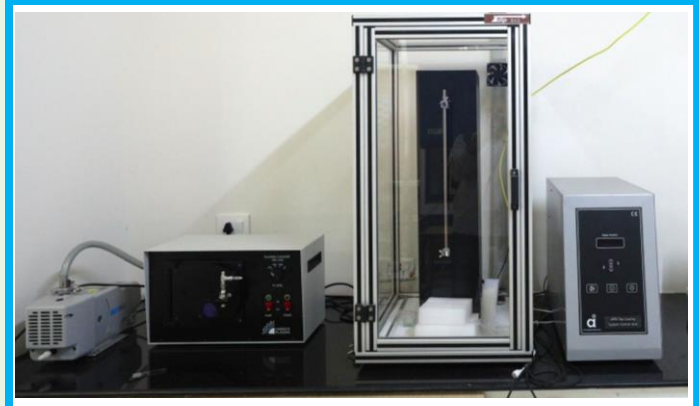
Varun is developing nanomaterials for waste to energy applications

Sirisha is using interfacial engineering for efficient combustion of alternative fuels

Mayuri is studying underwater superoleophobic surfaces for oil-water separation

Madhushmita is investigating material chemistries required for antibacterial surfaces

Avinash is working copper nanoparticle-based antibacterial coatings



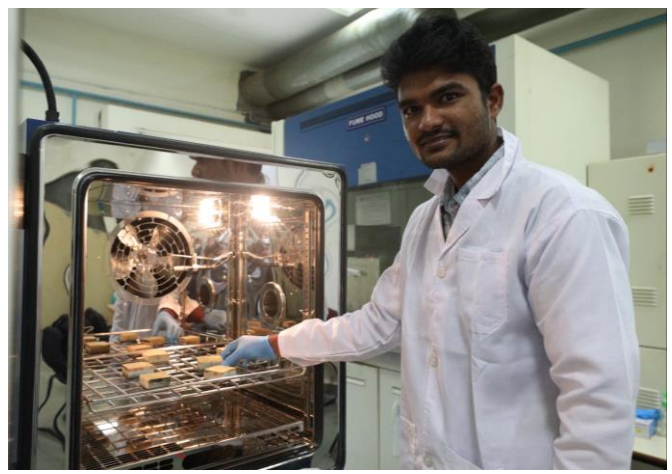
Plasma Cleaner

Polymer Science & Engineering Lab

Research Activities

Compression Moulding Machine

Polymer Extruder



Karthik is testing material composites in an Environmental Chamber

Injection Moulding Machine

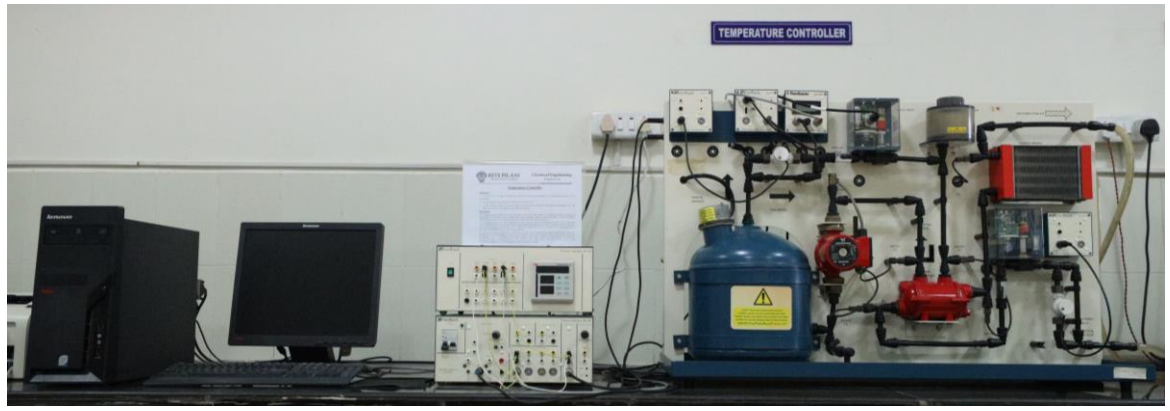
Melt Joint Making Machine

Melt Flow Index Tester

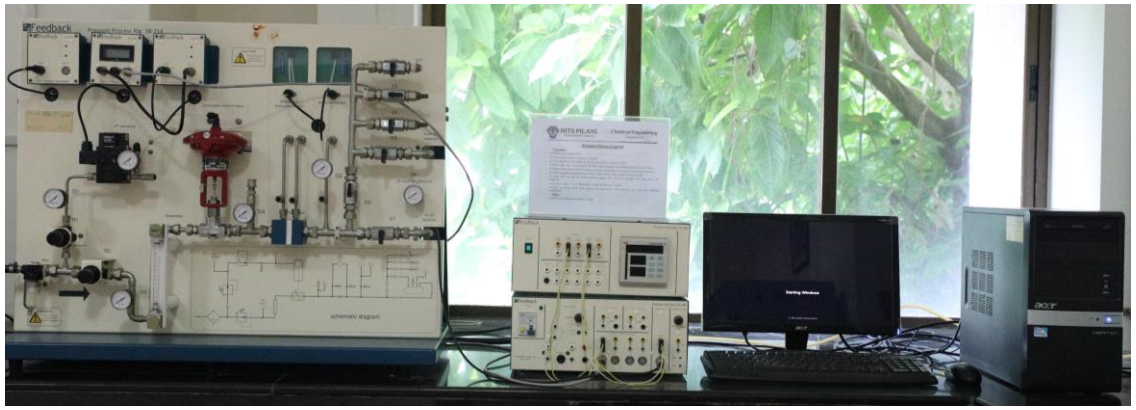
Izod Impact Tester

Process Control Lab

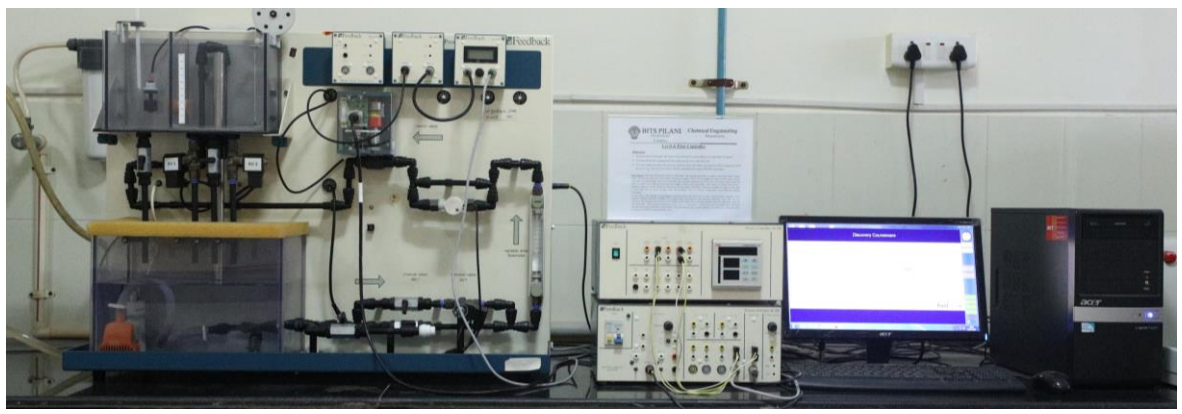
Research Activities



Temperature Controller Unit



Pressure Controller Unit



Level Control Unit

Electrospinning Unit

Microtome

pH Control Unit

Kaushik is investigating environmental conditioning of quartz-cyanate ester composites for RADOM applications

Advanced Separation Lab

Reverse Osmosis Plant (Capacity:)

Autoclave

Research Lab

High pressure reactor setup

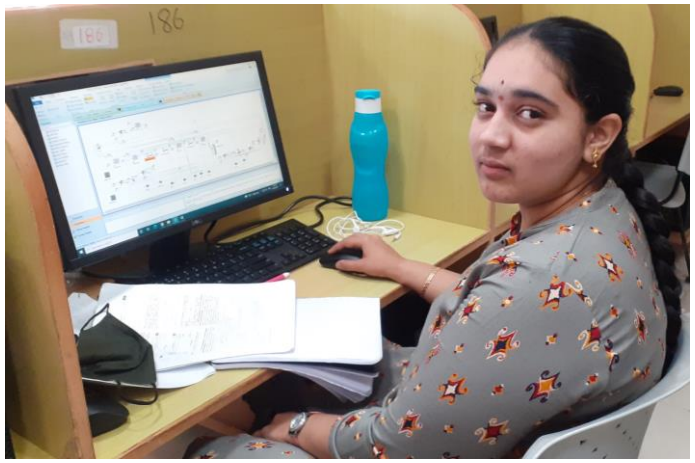
Suresh is working on turning CO_2 to value-added products

Computational Research Lab

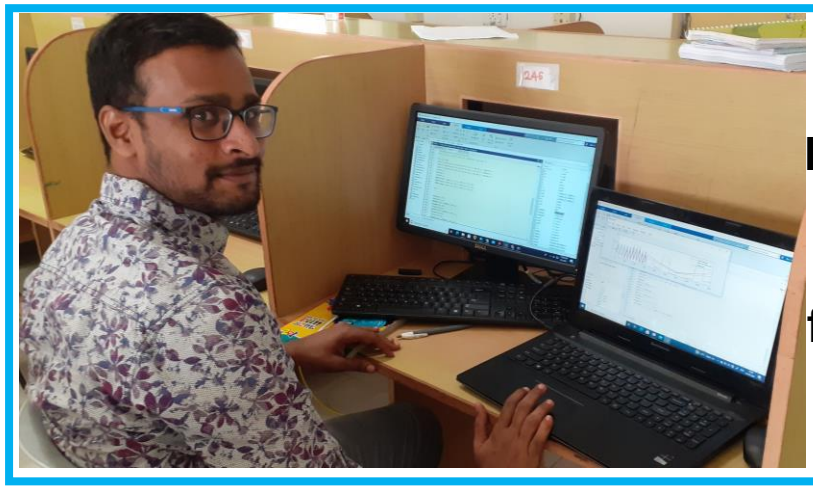
Research Activities

Pradeep Punnam is a PhD student working on Reactive Transport modelling and simulation of CO_2 Geological sequestration.

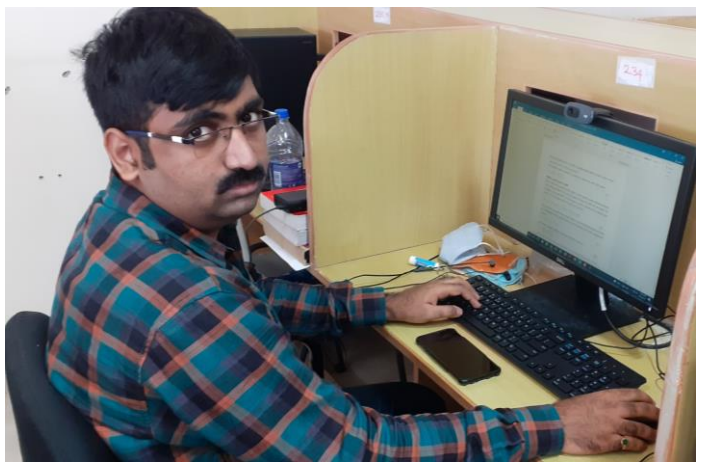
Kaviya is working on experiments and modelling of multiphase flow phenomena in Porous Transport Layer in PEM elelctrolyzers.



Srilekha is investigating simulation-based optimization strategies for chemical processes



Baru is working on strategies for surrogate-based fault detection and diagnosis



Dasika Prbhat is investigating on multiphase flow phenomena in porous media using Lattice Boltzmann Method.

Mr. Vikalp Jha is working on modeling of capacity loss of lithium-ion batteries under cycling

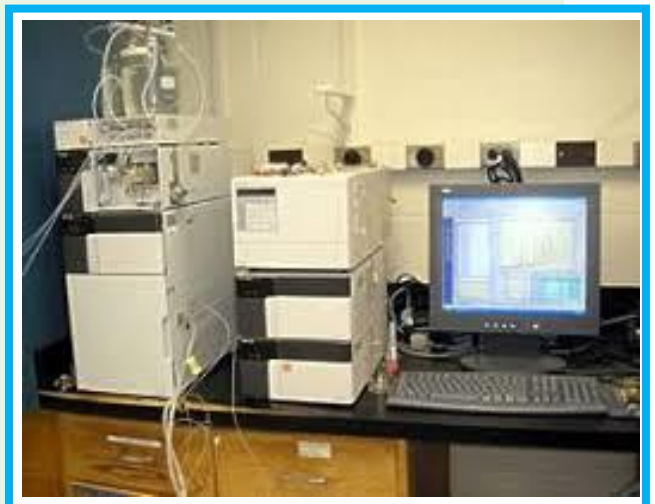
Institute Facilities

Impedance /Gain-Phase Analyzer

Universal Testing Machine

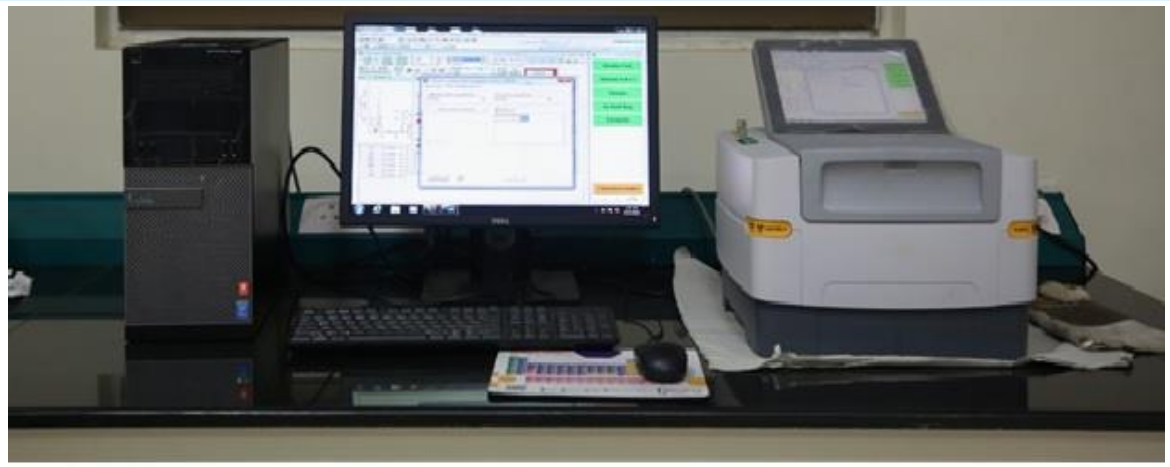
Atomic Absorption Spectroscopy

X-ray Photoelectron Spectroscopy



High Performance Liquid Chromatography

Field Emission SEM



Energy Dispersive XRF

Goniometer

BET Surface Analyzer

Thermal Gravimetric Analysis

Institute Facilities

Thermogravimetry-Differential Scanning Calorimetry (TG-DSC)

Small/Wide Angle X-ray Scattering (SAXS/WAXS)

NMR

Cell Sorter

Differential Scanning Calorimeter

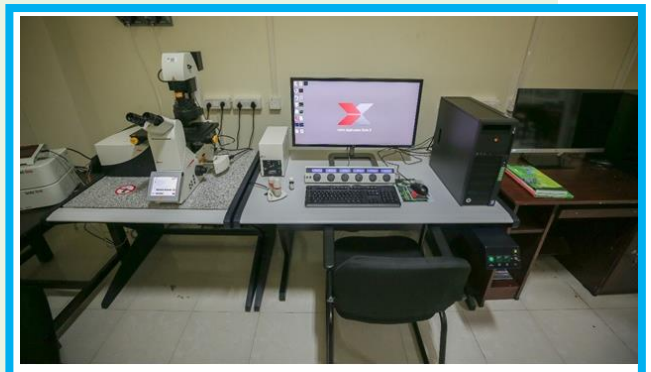
Atomic Absorption Spectroscopy

Fast protein liquid chromatography (FPLC)

Energy Dispersive XRF

Differential Thermogravimetric Analysis

Institute Facilities



Confocal Microscope

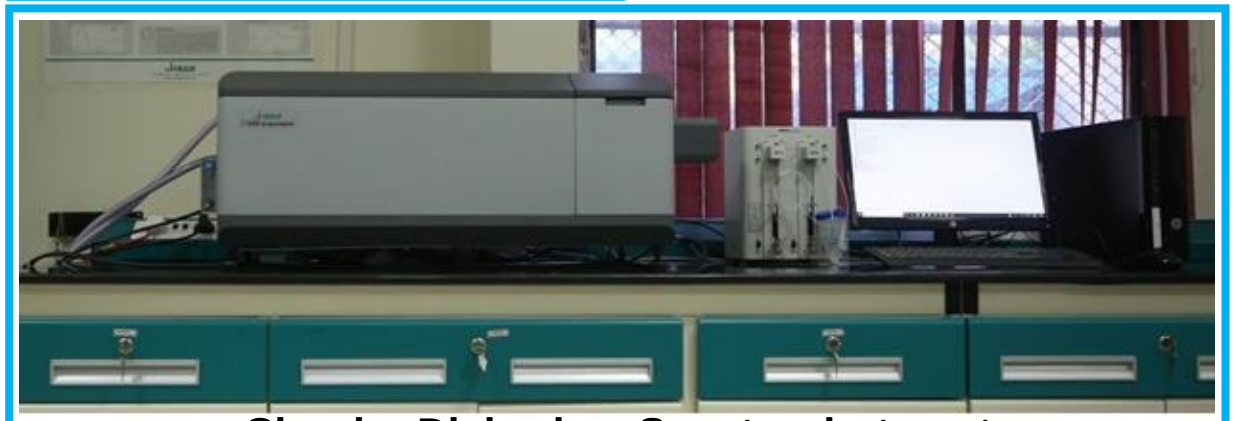
Single Crystal XRD

Powered XRD

Liquid Chromatography/ Mass Spectroscopy

Gas Chromatography

Time Correlated Single Photon Counting Fluorescence (TCSPC)



Circular Dichroism Spectrophotometer

HPLC-2

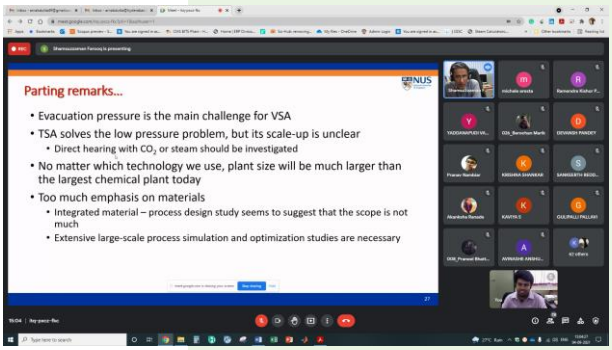
Thermal Gravimetric Analysis

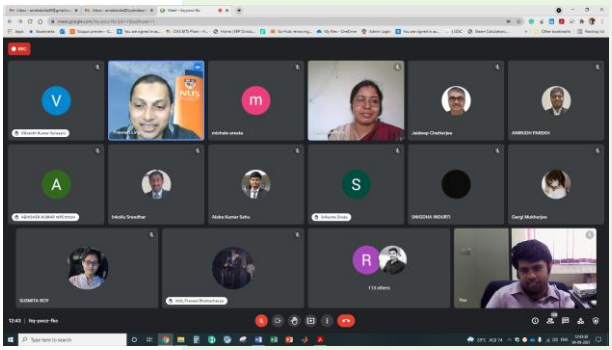
Webinars/Invited Talks during 2020-21

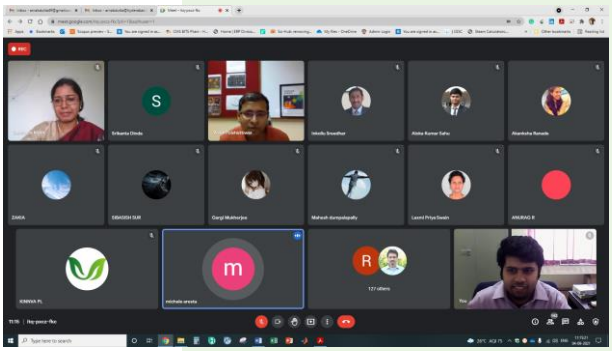
- **Guest Lecture**: "*Artificial Intelligence in Chemical Engineering and Materials Science-Past, Present and Future*" by Prof Venkat Venkatasubramianian, Department of Chemical Engineering, Columbia University, New York
- **Webinar**: on "*Carbon Capture, Sequestration, Storage and Utilization for Greener Tomorrow*"

Speakers:

- Prof. Vivek Polshettiwar, Tata Institute of Fundamental Research, India
- Prof. Praveen Linga, National University of Singapore, Singapore
- Prof. Farooq Shamsuzzaman, National University of Singapore, Singapore
- Prof. Michele Aresta, University of Bari, Italy







B.E. in Chemical Engineering

UG	Program Type First Degree	Total number of courses in seven semesters	43

Breakup

Common Courses	Disciplinary Core	Disciplinary Electives
23 (including 3 humanities and 5 open electives)	15 courses spread over 2nd and 3rd year	5 courses spread over 3rd and 4th year

- Single degree students generally do practice school (**PS-1** and **PS-2**)
- Dual degree students generally do thesis (16 units) or thesis + electives (9+6 units) and PS-2 in 09th and 10th semesters.
- Out of 5 discipline electives **3** can be project type courses like Study oriented project (SOP), Lab Oriented project (LOP), Design oriented Project (DOP).

Discipline electives pool: Environmental Pollution Control, Transport Phenomena, Process Plant safety, Modelling and Simulation in Chemical Engineering, Chemical Process Technology, Biochemical Engineering, Corrosion Engineering, Petroleum refining and petrochemicals, Polymer technology, Paper and Pulp technology, Alternate energy resources, Electrochemical Engineering, Introduction to Nanoscience

Minor in Material Science and Engineering

Courses: 5 (min), Units: 15 (min)

3 Core Courses

2 Elective Courses

Core Courses:

- CHE F243 / ME F213/MF F213: Materials Science and Engineering 3 0 3 (2 0 2)
- MST F331: Materials Characterization 3 1 4 (3rd year first semester)
- MST F332: Materials Processing 3 0 3 (3rd year second semester)

Electives Pool

CHEM F336: Nanochemistry
CHEM F326: Solid State Chemistry
MST F339: Polymer Materials
CHEM F223: Colloidal and Surface Chemistry
BITS F416: Introduction to Nanoscience
PHY F414: Physics of Advanced Materials
PHY 416: Soft Condensed Matter Physics
ME F452: Composite Materials and Design
CHE F433: Corrosion Engineering
MST F334: Materials for Catalytic Applications
MST F336: Glass Technology
MST F335: Coating and thin film technology
MST F338: Metals and Alloys
MST F337: Materials for Energy Applications
MST F333: Introduction to Biomaterials

M.E. Programme Structure

Year	Semester I	Units	Semester II	Units
I	Advanced Chemical Engg. Thermodynamics	5	Reaction Engineering	5
	Mathematical Methods in Chemical Engineering	5	Advanced transport phenomena	5
	Elective I	*	Research Methodology	5
	Elective II	*	Elective III	*
	Total	16 (min)	Total	16 (min)
	Semester III		Semester IV	
II	Elective IV to VII	16 (min)	PS/Dissertation	16/20
	OR Elective IV and V and Dissertation (9 Units)	16 (min)		
	OR Dissertation (16 units)	16		
	Total	16 (min)	Total	16/20

PhD Programme

Programme Type	Programme Name	Total Number of Courses
First Degree (UG)	B.E. in Chemical Engineering	43 courses in seven semester
Breakup		
Common Courses	Disciplinary Core Courses	Disciplinary Electives
23 (including 3 humanities and 5 open electives)	15 courses spread over 2nd and 3rd year	5 courses spread over 3rd and 4th year

- Single degree students generally do practice school (**PS-1** and **PS-2**)
- Dual degree students generally do thesis (16 units) or thesis + electives (9+6 units) and PS-2 in 09th and 10th semesters.
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Practice School

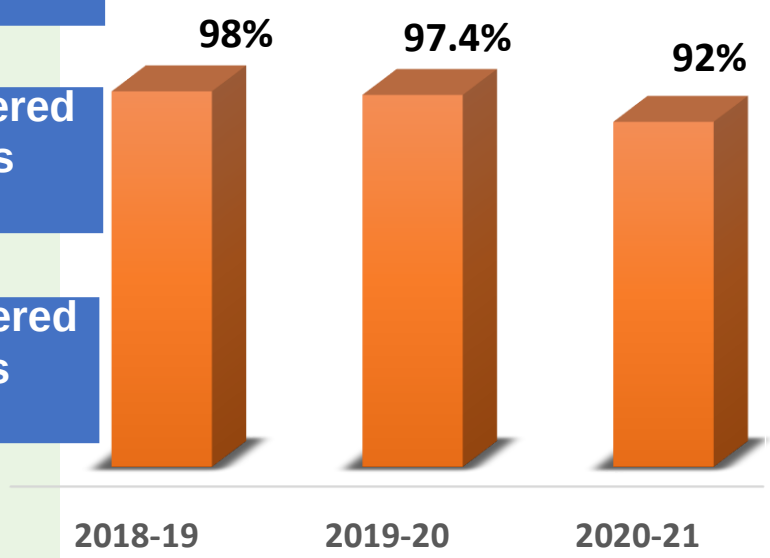
Practice School is an educational innovation seeking to link industry experience with university instruction. The objectives of PS are to (i) meet the rapidly changing needs and challenges of a professional workplace, (ii) enable students to acquire learning by applying the knowledge and skills they possess, in unfamiliar, open-ended real life situations, and (iii) bear an economic relevance to society. These objectives are achieved by bringing the reality of the world of work into the process of education. PS creates the required setting for experiential and cooperative learning and education, by providing students with an opportunity to work on relevant assignments, under the guidance of professional experts and under the supervision of faculty. Consequently, Practice School serves as a platform that facilitates and promotes partnership and intellectual exchange between academia and industry.

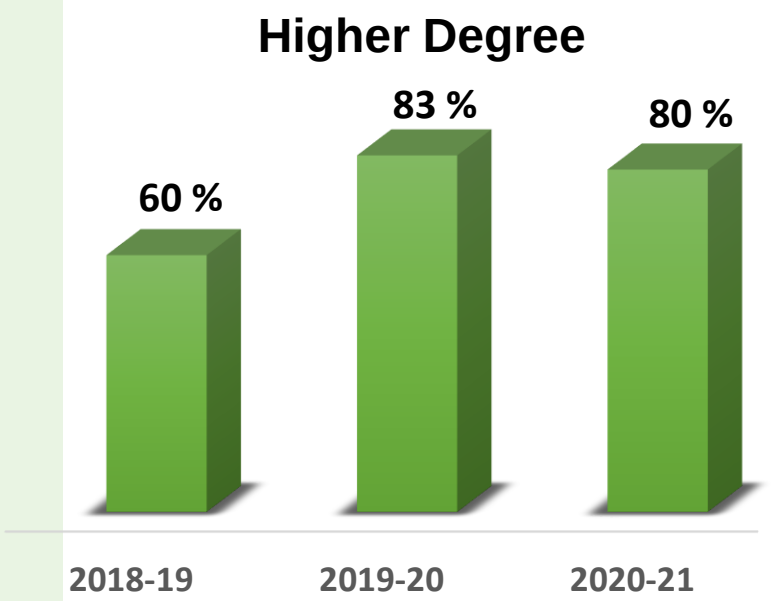
List of Top Chemical Engineering Stations for PS

Placements

- 2020-21 placement process is ongoing
- Highest Salary offered in the 2020-21 is 22 Lakhs
- Average Salary offered in the 2020-21 is 10.3 Lakhs

Last Three Years' Placements





Past Recruiters

ExxonMobil, Capgemini, Reliance Industries Limited, Biocon, Jarvis, AEQUS ecosystems of efficiency, JPMorganChase, Futures First, REFLEXIS, Credit Suisse, merilytics, PUBLICIS SAPIENT, BYJU'S, EPSILON, freshworks, Flipkart, MedPlus, POSTMAN, indusinsights, Aizant, BloomchemAG, LOWE'S, NOMURA, Sai, Orbees, BLEND COLOURS Powered by Innovation, Mopedo Electric, TATA TRUSTS, SMARTANALYST INTELLIGENT INSIGHTS. SMART RESULTS., Goodera, UBS, Deutsche Bank, ZS, IMPACT ANALYTICS, ATOTECH, REPORTGARDEN, POKARNA LIMITED

Alumni Testimonials

Dr. Nikunj DUDANI

Post-doc at the Laboratory of Atmospheric processes and their impact (LAPI), at EPFL, Lausanne, Switzerland

"*Positive and motivated. That is what walking down the Chemical Engineering Department at BPHC made me feel. The faculty was extremely supportive, warm and encouraging. At the same time, the level of expertise in even the most complex subjects was commendable. It has, no doubt, been pivotal in all my research undertakings where it always made me feel full of ideas and we'll informed*."

Mr. Vaidhiswaran Ramesh

PhD Student, Imperial College London

"*The Department of Chemical Engineering at Hyderabad campus is a wonderful establishment, featuring state of art research facilities and a diverse faculty, with strong experience in research and industry. I thoroughly enjoyed my time there as a student. The teaching and the degrees offered were rigorous but highly flexible to accommodate the student's varied interests. This flexibility both in the degree and in the range of core chemical engineering courses offered to us allowed me to carefully tailor and shape my understanding of the subject and my research direction. The opportunity to pursue a practice school internship or research is again one such example of the great flexibility that the department offers. The student cohort at BITS and more so in the department is (was) equally strong - always encouraging and supportive. And these interactions with fellow students and faculty is something I treasure most dearly*."

Dr. Sai Darshan Adloor

Consultant at Siemens Process Systems Engineering

"*I have some really fond memories of my time as a student at the Department of Chemical Engineering in BITS Pilani-Hyderabad. The faculty are very friendly and knowledgeable. My time as an undergraduate in the department laid a strong foundation for me to pursue my Ph.D. at the University of Cambridge and eventually a job in Siemens Process Systems Engineering in London, U.K.*"

Ms. Ankita Agarwal

Senior Executive at Biocon Biologics

"College is the only place where the student is fostered to deal with the world. What kind of person he/she will be is decided in the college.

Having spent the last two years in this esteemed institution, I have witnessed a tremendous change in my life may it be on the academic front or even on a personal level. The campus, provides an ideal platform for growth and improvement leading to the formation of bright young individuals determined to make an impact in the coming future. My teachers made the learning experience valuable. The placement cell of the college also works tirelessly to provide the students with numerous opportunities in the industry that allows them to step into the professional world seamlessly. BPHC community fostered me to find and do things I enjoyed and led me to take the best direction based on what I liked. BPHC has left a huge impact in my life!."

Mr. E. Mallikarjun

R&D Battery Engineer at Mopedo Electric

"My overall experience to date has been amazing, and the college is having an amazing infrastructure. Chemical engineering department has provided me with a number of opportunities to grow and explore my skills. The emphasis on sports along with education always helped me a lot. I have always found a positive and healthy Environment and the faculty are highly supportive. Most of my doubts were cleared after the classes get over. It has added a number of values to my life."

Dr. Suresh Pathi

OE Lead-FTO3 at Dr. Reddy's Laboratories Limited

"It gives me an immense pleasure to say that I have completed my highest degree PhD from very reputed university BITS-Pilani. As an alumnus of BITS-Pilani-Hyd campus, Chemical Engineering Department, I had the opportunity to be taught by experts of the research area making whole process so easy with their expertise and wisdom. Especially I would like to thank my Guide Dr. I Sreedhar and Co-Guide Dr. Vikrant for their continuous support during the journey, without which my dream of PhD would not have been possible. I am currently working with Dr.Reddys Laboratories Ltd, and earlier was associated with reputed companies like Granules India Ltd, Neuland Labs, GVK Bio and Hetero Drugs. Though I had multi- functional experience in various organization, PhD from BITS- Pilani has added value to carrier path, improved my innovative thinking ability and enhanced courage to face the challenges of professional life."