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# EDUCATIONAL QUALIFICATIONS

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| **Year** | **Qualification** | **Institution** | **Performance** |
| 2023-2025 | M.S.E (Chemical and Biomolecular Engineering) | **Johns Hopkins University** | 3.7/4 |
| 2018 – 2022 | B.Tech (Chemical Engineering) | **Indian Institute of Technology(IIT-K) , Kanpur** | 3.2/4 |
| 2016 | Class 10th – CBSE Board | Puranchandra Vidyaniketan ,Kanpur | 9.4/10 |

# RESEARCH INTERESTS

Reaction Engineering , Material synthesis , Metal Organic Framework , Nanomaterials, Thin film deposition ,Carbon capture and utilization, Electrochemical engineering

# HONORS AND AWARDS

* Johns Hopkins University ChemBE Department Master's Fellowship (2023): Selective merit-based tuition award
* SURGE'22 Research Excellence Award, IIT Kanpur: First place among 230+ undergraduate research projects.
* Excellence in Community Service Medal, IIT Kanpur (Year): Highest institutional recognition for community engagement
* Distinguished Athlete Award, IIT Kanpur (Year): Honored for national-level soccer achievements.

# RESEARCH EXPERIENCE

**Nano-Porous Material for Sustainable Separation and Catalytic Processes Laboratory , Johns Hopkins University**

*Graduate student researcher , Supervisor: Prof Michael Tsapatsis* September’23-present

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| ***Objective*** | Amorphous Metal organic framework Thin film as metal containing resist in advanced Lithography |
| ***Strategy*** | * Synthesized and optimized metal-organic framework (MOF) thin films via solution-phase deposition techniques, including spin coating and continuous flow coating methodologies * Engineered and implemented an automated continuous flow reactor system for the synthesis of zeolitic imidazolate framework crystals through controlled metal salt-ligand interactions in aqueous media * Conducted systematic reaction kinetics studies to optimize heterogeneous nucleation parameters, achieving precise control over MOF film morphology and substrate coverage * Performed systematic investigation of MOF thin film growth mechanisms using various metal nodes (Sn2+, In3+, Cs+, Y3+) coordinated with 2-methylimidazole ligands, optimizing nucleation and growth through precise control of solution chemistry, precursor concentrations, and deposition parameters to achieve targeted film architectures * Performed comprehensive materials characterization using X-ray diffraction (XRD), atomic force microscopy (AFM), infrared spectroscopy (IR), and scanning electron microscopy (SEM) to elucidate film crystallinity, topography, chemical composition, and microstructure * Integrated experimental pH-metric titration data with computational speciation models to elucidate metal-ligand coordination equilibria, stability constants (log K) and identifying reactive precursor species critical to MOF film formation mechanism |
| ***Impact*** | Established systematic screening protocols for metal-ligand combinations to synthesize lithographically-compatible amorphous MOF thin films, culminating in the discovery and characterization of a novel tin-imidazolate framework exhibiting superior electron beam-induced structural modification properties for high-resolution patterning applications |

**SUSTAINABLE MODULAR AUTONOMOUS REACTOR TECHNOLOGY LABORATORY, IIT-KANPUR |**

*Undergraduate student researcher, supervisor: Prof Raghavendra Ragipani* sep’21-dec’22

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| ***Objective*** | ***“Mathematical modelling of carbon dioxide capture and mineralization using coal ash”*** |
| ***Strategy*** | * Developed an integrated kinetic model for carbon dioxide mineralization via aqueous absorption coupled with calcium extraction from coal combustion residuals, yielding precipitated calcium carbonate * Engineered a comprehensive mathematical framework by coupling: * Mechanistic dissolution kinetics for calcium ion extraction from coal ash under variable pH conditions * Multi-species CO2 absorption and aqueous carbonate speciation reaction networks * Advanced precipitation kinetics incorporating impurity-mediated crystal growth inhibition factors   Implemented numerical solutions for the coupled nonlinear ordinary differential equations system using stiff solver methodologies (MATLAB ODE15s), enabling precise prediction of mineralization pathways and product formation |
| ***Impact*** | Formulated an innovative kinetic model for carbon dioxide capture and mineralization, demonstrating precipitation-limited reaction pathways and elucidating the coupled effects of pH dynamics and CO2 partial pressure on overall process thermodynamics and conversion efficiency |

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| ***Objective*** | ***“Investigation of inhibiting effect of magnesium ions on the kinetics of calcium ion dissolution and carbonate precipitation for an integrated co2 mineralisation process”*** |
| ***Strategy*** |  Architected a comprehensive reaction kinetics framework for integrated CO2 mineralization, coupling multivariate mass action equations to simulate simultaneous absorption, dissolution, and precipitation phenomena using MATLAB   Developed a novel heterogeneous nucleation and crystal growth model for calcium carbonate formation, incorporating mechanistic understanding of impurity-mediated growth modification   Formulated advanced competitive adsorption algorithms to quantify magnesium ion interference in carbonate crystal formation, establishing structure-activity relationships governing inhibition mechanisms   Elucidated complex feedback mechanisms between precipitation inhibition phenomena and upstream process kinetics, including calcium dissolution and CO2 absorption dynamics |
| ***Impact*** | Computational analyses validated the tight coupling between dissolution-precipitation kinetics in integrated CO2 mineralization processes, demonstrating significant mechanistic impacts of magnesium-induced inhibition on overall reaction pathways |

**Electrochemistry And Transport For Design Of Energy System Laboratory, IIT-KANPUR |**

*Undergraduate student researcher, supervisor: Prof Lalit pant* feb’22-Dec’22

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| ***Objective*** | ***Multiphysics modelling of Polymer electrolyte Membrane Fuel Cell using COMSOL in 2D*** |
| ***Strategy*** | * Architected a multi-scale transport phenomena framework encompassing: * Maxwell-Stefan formalism for multi-component species transport through microporous transport layers * Darcy flow equations coupled with Navier-Stokes hydrodynamics for comprehensive treatment of mixed convective-diffusive transport in porous and channel domains * Electrochemical kinetics models integrating Butler-Volmer equations with Faradaic processes to quantify current generation and reaction dynamics" |
| ***Impact*** | Developed a comprehensive multi-physics model characterizing coupled transport phenomena and electro potential distributions across hierarchical PEM fuel cell architectures, encompassing gas channels, diffusion media, catalytic interfaces, and ion-conducting membranes |

**Bulk Solids and Complex Fluids Research Laboratory , IIT-KANPUR |**

*Undergraduate student researcher, supervisor: Prof Anurag Tripathi* July’22-Dec’22

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| ***Objective*** | ***Continuum simulation of the dense granular flow down an inclined chute in two dimension*** |
| ***Strategy*** |  Engineered a comprehensive Navier-Stokes solver incorporating Chorin projection methodology and μ(I) rheological constitutive relations to model granular flow dynamics through coupled transport-rheology frameworks   Performed high-fidelity numerical simulations of two-dimensional granular discharge phenomena between parallel plates, characterizing transient flow behavior from initiation through complete material evacuation   Implemented explicit finite difference discretization schemes for solving coupled nonlinear partial differential equations, with emphasis on granular flow physics and constitutive behavior   Optimized computational stability through advanced numerical methods addressing flow discontinuities and Courant-Friedrichs-Lewy (CFL) constraints |
| ***Impact*** | Pioneered a novel Python-based computational fluid dynamics implementation demonstrating an order of magnitude improvement in computational efficiency compared to traditional discrete element methods, while maintaining high-fidelity validation against experimental granular flow data |

# Work Experience

**Bharat Petroleum Corporation Limited(Oil&Gas) ,** Pipeline Engineer Kanpur,dec’19-march’20

* Engineered advanced pipeline configurations for next-generation fuel dispensing facilities.
* Performed computational fluid dynamics simulations using COMSOL Multiphysics to analyze single-phase fuel transport across diverse geometric configurations.
* Developed predictive models for pressure distribution and material integrity, implementing preventive strategies for corrosion mitigation and failure prevention.

# TECHNICAL SKILLS

**Lab Skills**: Wet Chemistry, organometallic synthesis, Flow chemistry, thin film synthesis, Nanomaterial synthesis, Analytical Chemistry, Atomic Force Microscopy, x-ray diffraction, Spin coating, Mechanical Testing (Charpy, tensile testing, hardness), Fourier-Transform Infrared Spectroscopy, Scanning Electron Microscopy, X-Ray Diffraction,

**Programming languages:** c/c++, python ,SQL, R ,HTML ,Julia ,Open foam, CFD programming

**SOFTWARE:** Comsol Multiphysics**,** Matlab, openFOAM **,** Ansys, Aspen plus, AutoCAD, Fusion360,CaRIne(crystallography software) ,DWSIM

## RELEVANT COURSEWORK & PROJECTS

* Interfacial science with application to Nanoscale system
* Advanced separation and purification
* Electroanalytical chemistry and energy conversion
* Advanced Thermodynamics
* Advanced semiconductor Devices
* Scanning electron microscopy
* Advanced chemical reaction engineering
* Material science of thin film
* Heat Transfer and its application

**Course Projects**

* + Dielectric behaviour of Barium Titanate
  + Visualization of crystal –structures using ***Carine crystallography software***
  + Literature review on ***sodium-ion batteries*** : working principle and future prospect

## Leadership and Entrepreneurship Experience

**HEAD OF PUBLIC RELATION|** *UDGHOSH , IIT Kanpur annual sports fest*  Jan’22-May’22

* Co-ordinating with a 20-member core team to administer the 18th edition of the hybrid model Udghosh with a budget of INR 10 Million

***Leadership*** • Spearheading 4 tier team of 100 members to conduct talks, workshops, panel discussions, and professional shows for sports festival

* Head in charge of decision-making and negotiation within the allocated budget of INR 4 million, the highest allocated to any cell Initiative
* Organized shows and events inviting over 25+ national & international artists gathering over 1+ Million eyeballs over digital media
* Responsible for contacting celebrities and arranging talks and shows for the main festival and pre-festival events with 50+ guests

### Initiatives

* Partnered with 10+ International Embassies to expand the reach outside India and execute that country’s guest personal affairs
* Initiated 1st online “Udaan”, a fitness competition to promote sports and wellness among Physically Challenged people in entire nation
* Devised an outreach publicity campaign resulting in a 1.7x increase to reach up to 30 million individuals over digital media in 8 months

***Impact***

* Modelled Festival structure to Hybrid mode (Online + Offline), India’s 1st sports festival to reform in dual mode - benchmark model

## EXTRA CURRICULAR

**Football(Soccer) Achievements**

* Two-time district team representative in AIFF state-level tournament.
* Selected for national trials for FIFA U-17 World Cup (2016).
* Three-time representative for IIT Kanpur in Inter-IIT Sports Meet (2018, 2019, 2022).
* Recipient of Best Football Player award at district-level tournament.

**Athletics Accomplishments**

* Silver medalist in state-level CBSE athletics meet (200m sprint, 25.10s), qualified for nationals.
* Participant in All India-level CBSE athletics meet, representing the state.
* Awarded "Overall Athlete Champion" trophy at school level (out of 2000 students).