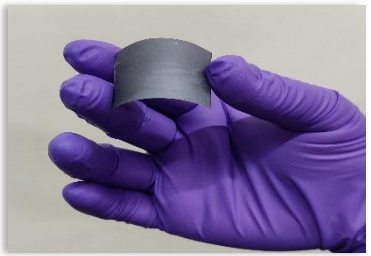
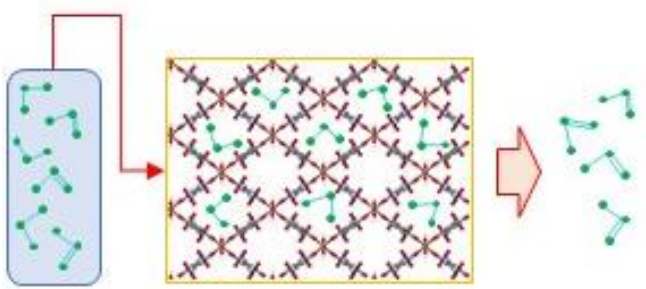
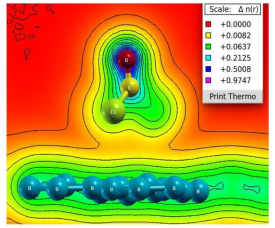
Department of Physical Sciences, P D Patel Institute of Applied Sciences, Charotar University of Science and Technology

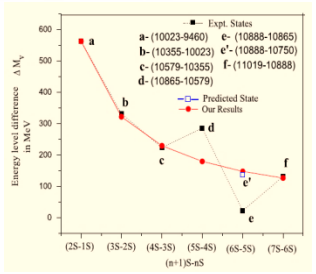
Research Areas



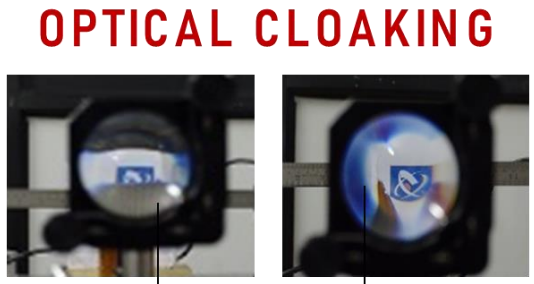
Engineering of Nanomaterials

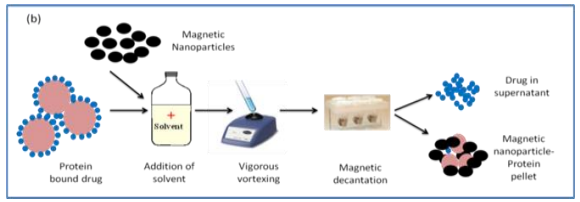




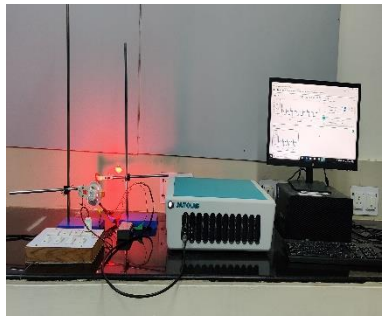


Theoretical Physics (Condensed Mater and High Energy Physics)





Optics and applications of nanoparticles and magnetic fluids



Characterization facilities

Research Areas: Engineering of Nanomaterials: Applications, devices and systems

Nano Materials

2D-Materials
Transition metal dichalcogenides, Graphene

Nano Particles
Transition metal oxides, Transition metals

Thin films
Transition metal dichalcogenides

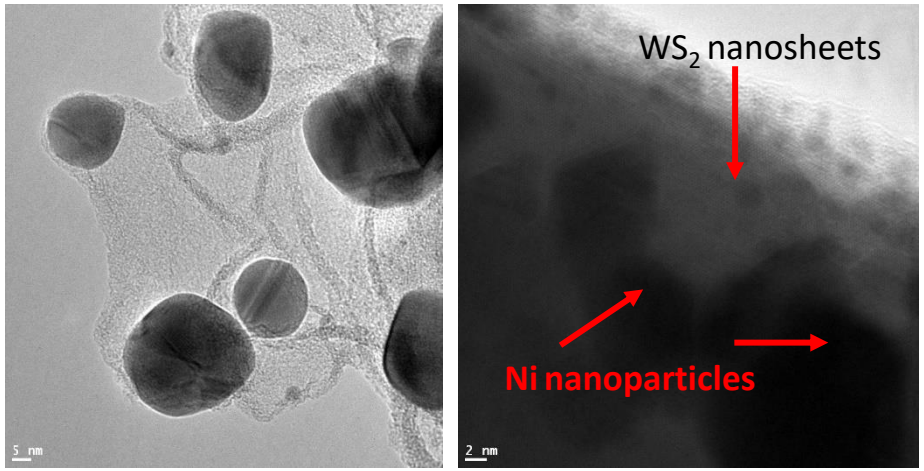
Heterostructures
TMDC/TMO, TMDC/TM

Dr. C. K. Sumesh & group

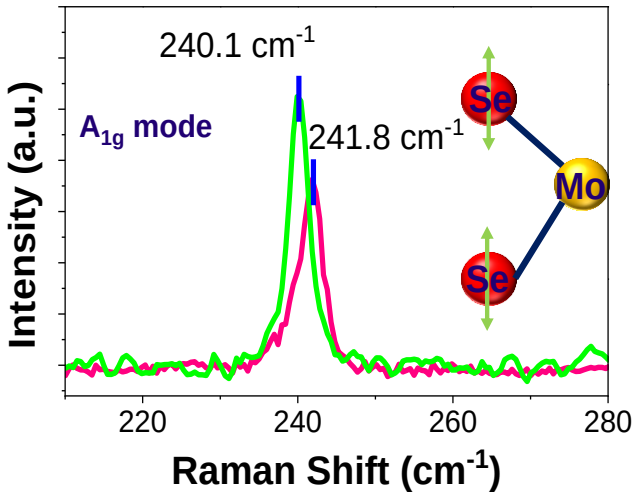
Our expertise:

- **Synthesis of size and morphology tuneable Nano-heterostructures for multifunctional applications (Optoelectronic, electrochemical applications, antimicrobial activities).**

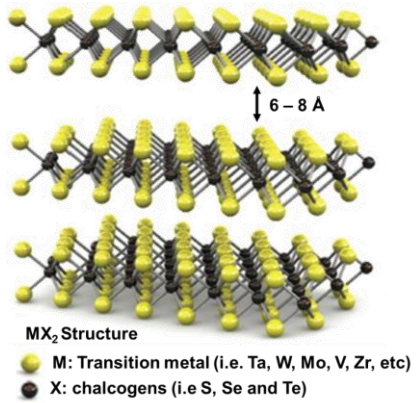
Analysis of nanomaterials by HR-TERM



Raman spectra of $MoSe_2$ nanosheets



2D TMDC and analogous materials



Quality Parameters:

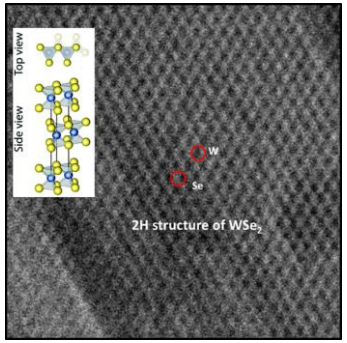
- Tunable optical bandgap
- High surface area
- Easy to functionalize
- complementary material to graphene

Transition metal dichalcogenides (TMDC) *(eg. MoS_2, WS_2, and WSe_2)*

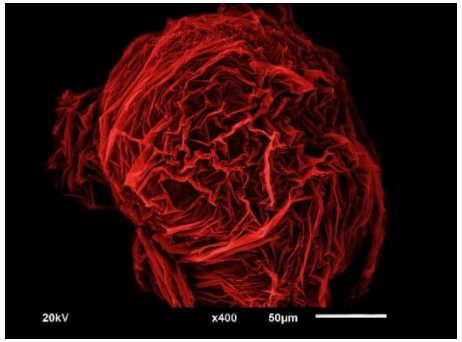
Transition Metal Oxides (TMO) (eg. MoO_3, WO_3, Cu based Oxides)

Graphene family	Graphene	hBN 'white graphene'	BCN	Fluorographene	Graphene oxide
2D chalcogenides	MoS_2, WS_2, $MoSe_2$, WSe_2	Semiconducting dichalcogenides: $MoTe_2$, WTe_2, ZrS_2, $ZrSe_2$ and so on		Metallic dichalcogenides: $NbSe_2$, NbS_2, TaS_2, TiS_2, $NiSe_2$ and so on	
				Layered semiconductors: GaSe, GaTe, InSe, Bi_2Se_3 and so on	
2D oxides	Micas, BSCCO	MoO_3, WO_3	Perovskite-type: $LaNb_2O_7$, $(Ca,Sr)_2Nb_3O_{10}$, $Bi_4Ti_3O_{12}$, $Ca_2Ta_2TiO_{10}$ and so on	Hydroxides: $Ni(OH)_2$, $Eu(OH)_2$ and so on	
	Layered Cu oxides	TiO_2, MnO_2, V_2O_5, TaO_3, RuO_2 and so on		Others	

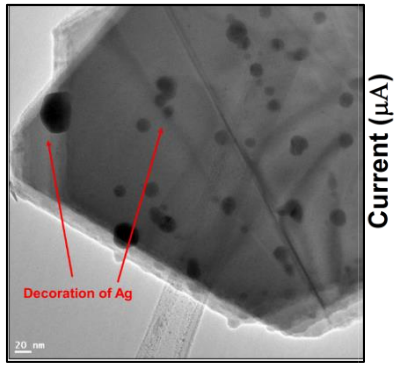
Results



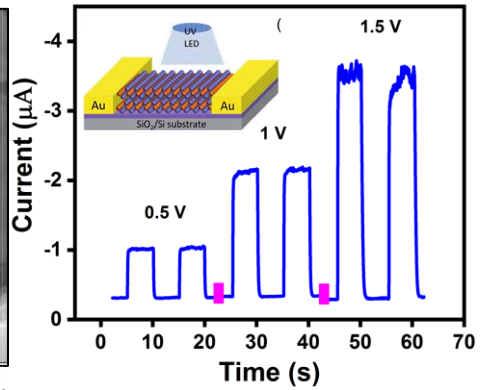
HRTEM image of the WSe_2 nanosheet represents the honeycomb structure Prepared by



SEM Image of WO_3 nanoflowers Prepared by chemical route method



Clusters/ bulk powder of WS_2 is uniformly exfoliated in to thin and isolated-sheets of WS_2 nanosheets with an average lateral size of sheets are the size of ~ 1 µm are obtained with decoration of Ag particles



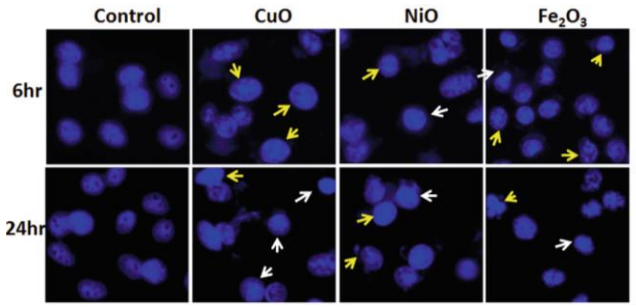
I-T curves of WSe_2 nanosheets photodetector with and without illumination

Synthesis Methods

- Chemical Route
- Solvo/Hydro-thermal
- Microwave
- Direct Vapour Transport
- Vacuum deposition, etc

Main features

- Easy synthesis methods
- Possibility to fabricate heterostructure
- Optimization in various properties such as optical, electrical, etc
- Contemporary device fabrication such as photodetectors, gas sensors, electronic devices, bio-sensors



Scope for collaboration

- **Anti-cancerous & biological activities using various metal oxides**

Dr. Nilesh Pandey, CIPS

- **Corrosion testing**
- **Photocatalysis**

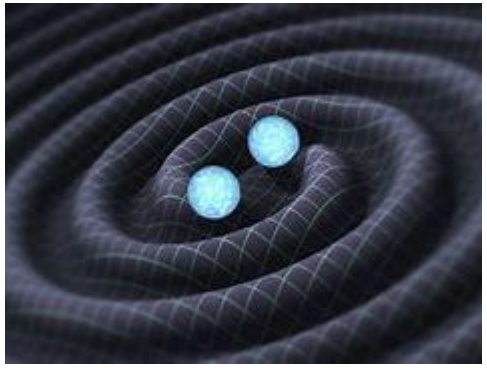
Dr. Kamlesh Chauhan, CSPIT

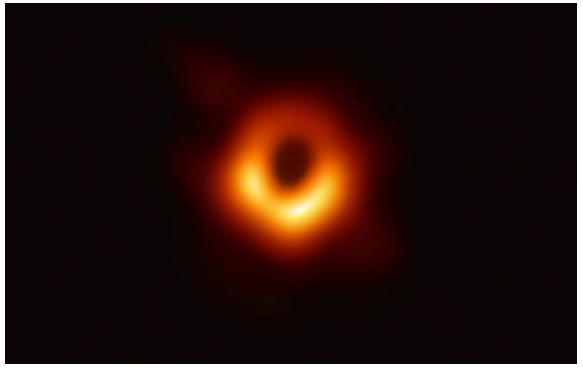
Dr. Sanni Kapatel

Research in Theoretical Physics

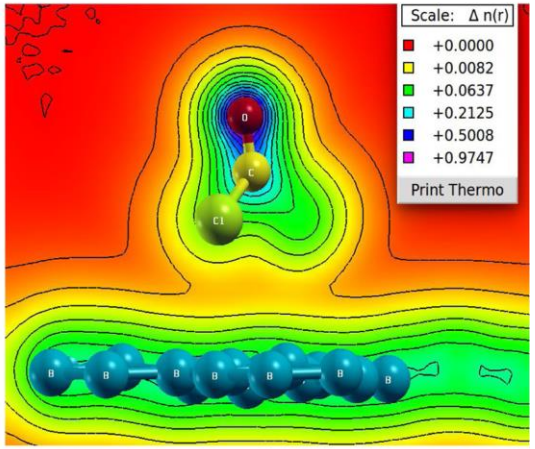
Research Areas : Astrophysics and Cosmology

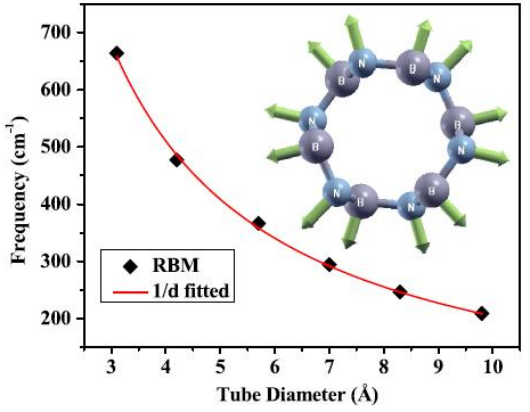
- Black-hole Physics
- Small scale structure formation
- Gravitational Wave
- Digital Image Processing
- Gravitational collapse of stars
- Gravitational lensing and shadows
- Astrometry
- Engineering applications in the field of cosmology





To investigate properties of materials at Nanoscale..



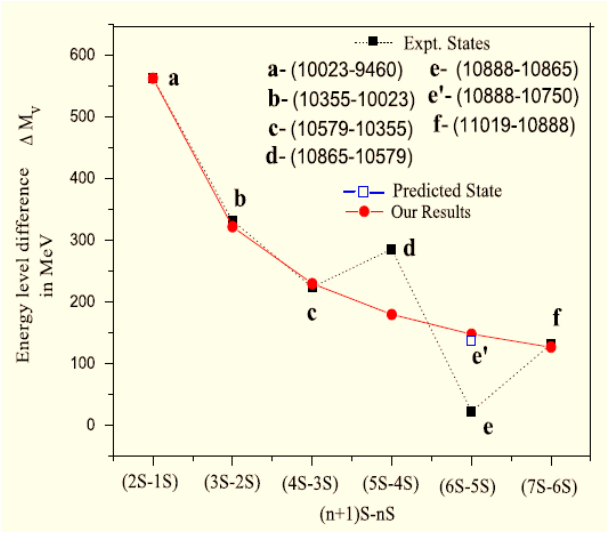


Dr. Shweta Dabhi

Theoretical High Energy Physics, Hadron Physics

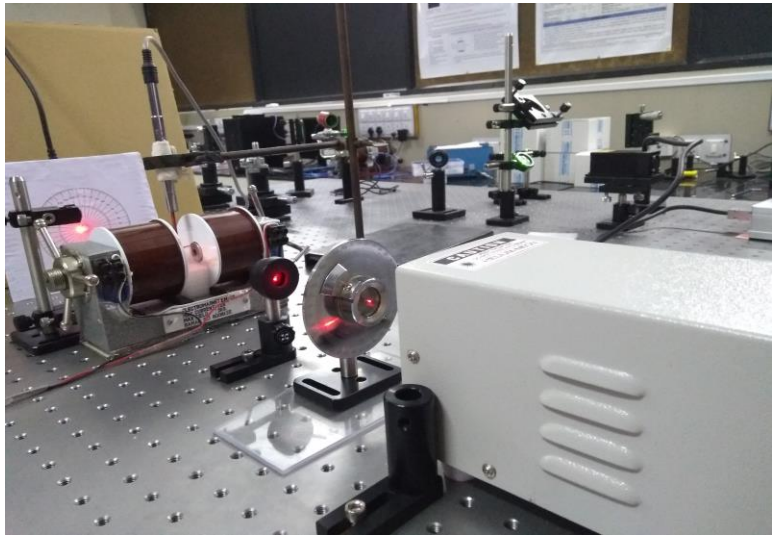
Area of Interest :

- Mass spectra of Meson
- Decay properties of Meson
- Exotics states
- Masses of tetraquark states in the hidden charm sector



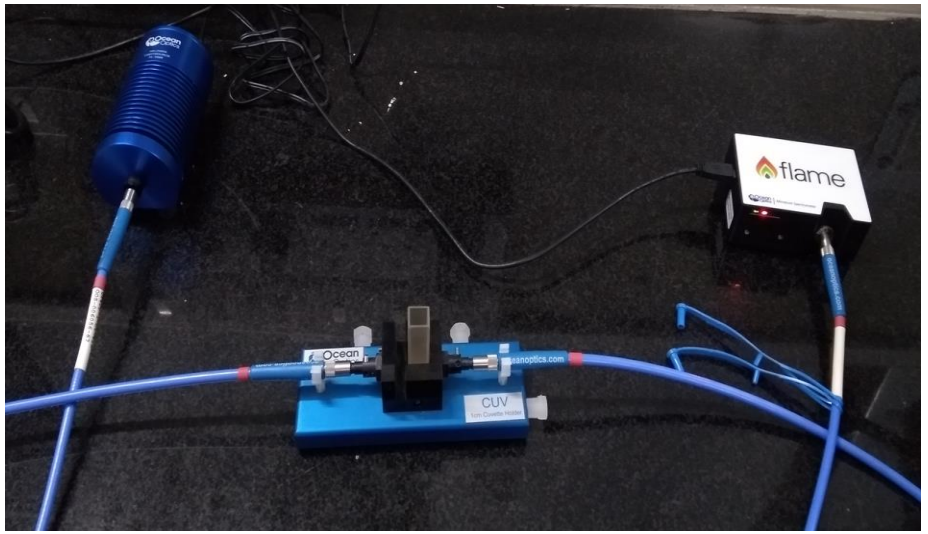
Dr. Manan Shah

Optical Characterization Facility



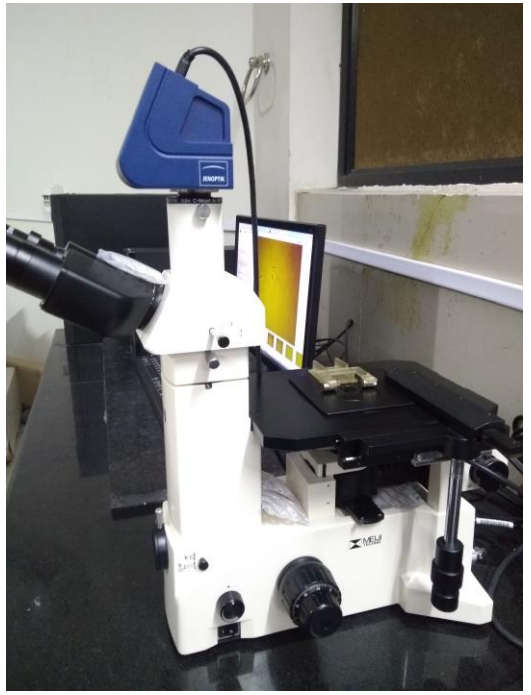
Lasers:

- **He-Ne Red laser (632 nm, 5mW)**
- **Diode Green laser (532 nm, 30mW)**
- **He-Cd laser (442 nm, 30mW)**



Portable spectrophotometer (Make: Ocean optics)

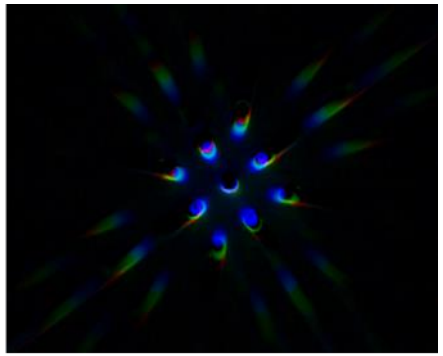
- **FLAME-S-XR1-ES Spectrophotometer, detection range, λ= 200nm-1100nm,**
- **Tungsten Halogen Source,HL-2000-LL, wavelength Range, λ=360nm-2000nm**
- **400µm UV/VIS optical fibre and cuvette holder**



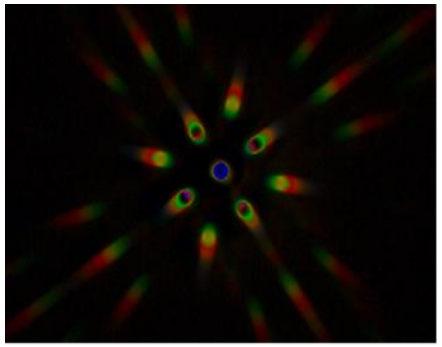
- **Inverted Metallurgical Microscope (Make: Meiji, Japan- IM7200)**
- **Calibrated Scale**
- **Polarizer**
- **Color CCD camera (make: Jenoptik, German, Resolution: 2080×1542 pixel)**

PI: Dr. Rucha P Desai, DST-SERB/002278 Project

Magnetic Fluid based Tunable Diffraction Grating



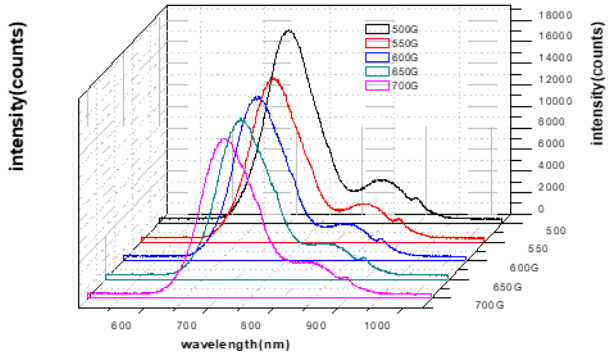
H= 0 G



H=370G, T=240sec

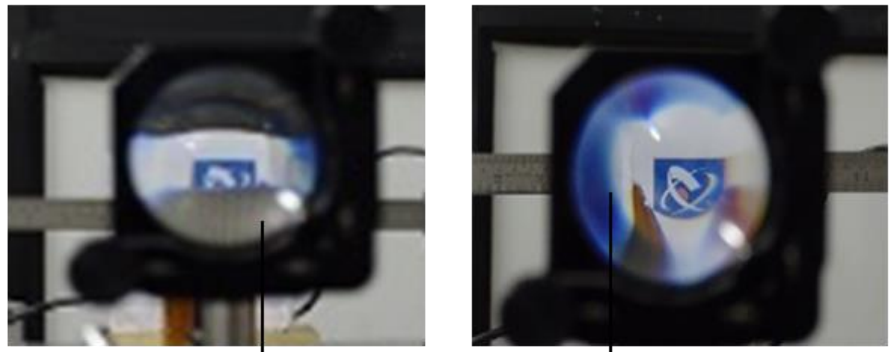
Field off H=0,T=30sec

Magnetic field induced chain formation – Microscopic image

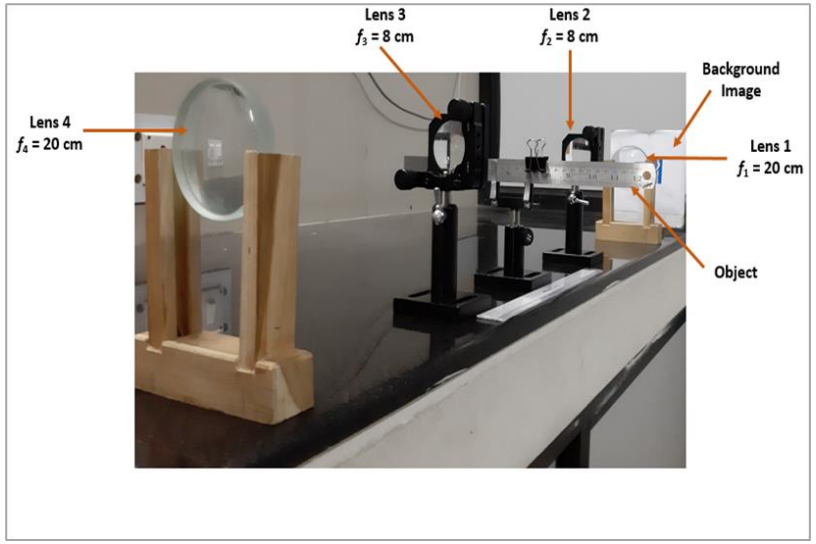


White light spectroscopy – MF as monochromator

OPTICAL CLOAKING

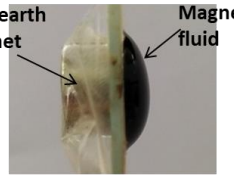


Turning "visible" to "invisible"

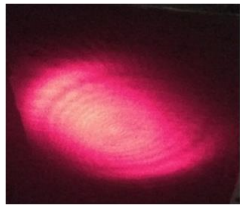


- One-way cloaking
- Two-way cloaking

Magnetic Fluid Mirror



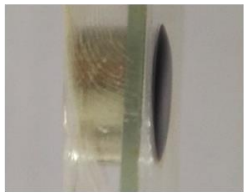
Ms ~ 280 G
H = 750 G



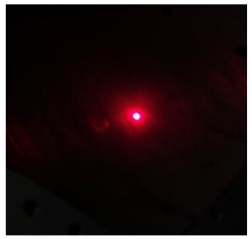
Reflected diverged Beam (without focusing lens (2))

Reflected focused beam (with focusing lens(2))

Reflection due to the spherical curvature in the mirror leads to diverged the reflected beam. External lens is needed to focus the beam.



Ms ~ 70 G
H = 750 G



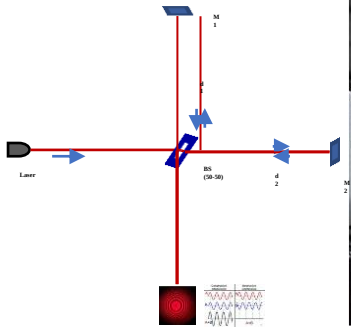
Incident light

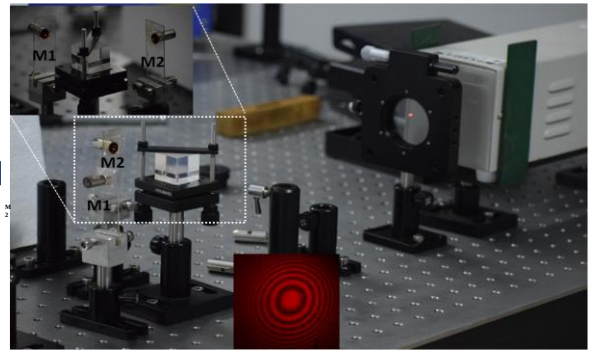
Reflected Beam

Reflection due to the plane surface of the mirror leads to focused beam (without lens).

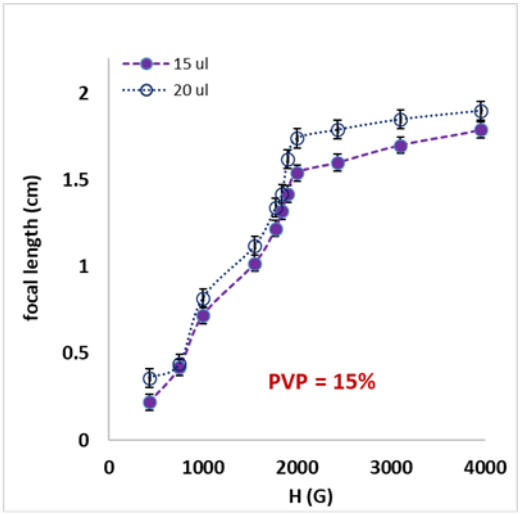
Michelson Interferometer: An application

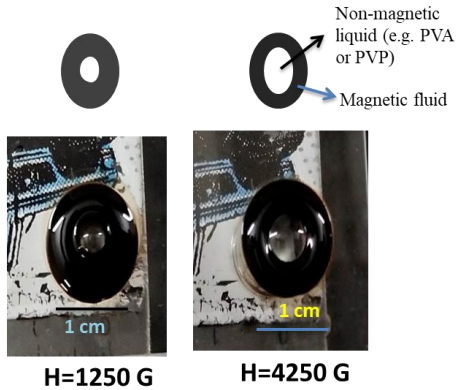
Michelson Interferometer





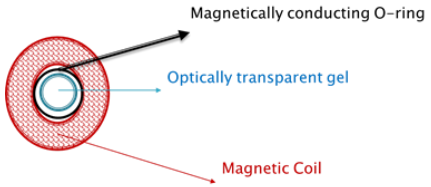
Adaptive Liquid Lens





H=1250 G
H=4250 G

Magnetic fluid=40µL



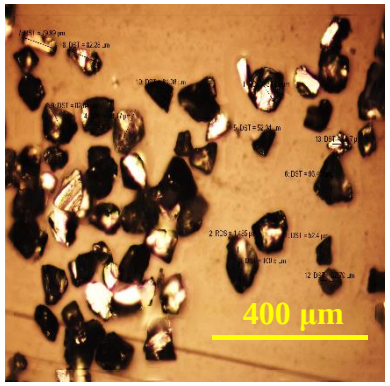
Side view of Curvatures at different magnetic fields

H= 1000 G
H= 750 G
H= 430 G

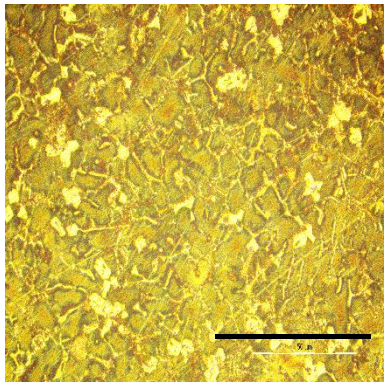
Scope for collaboration

- to interface magnetic field and full set-up.
- Feedback and control loop
- Simulation of the experiment
- To prepare miniaturized fully automated device

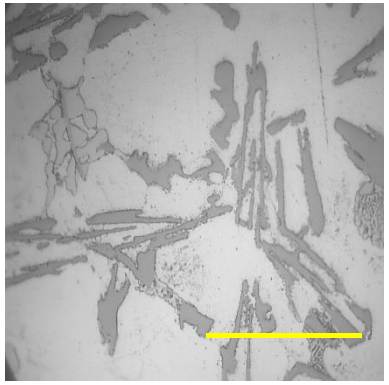
Inverted Metallurgical Microscope – University users



Al Particles



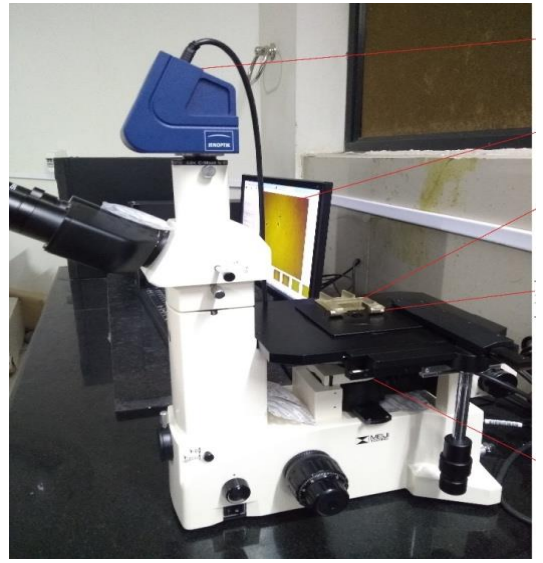
Al - Composite



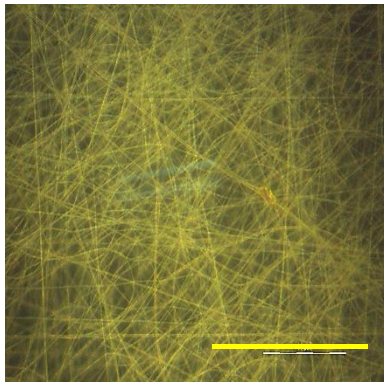
Material Surface

Dr. Mayur Sutaria & Group, Mechanical Engineering, CSPIT, CHARUSAT

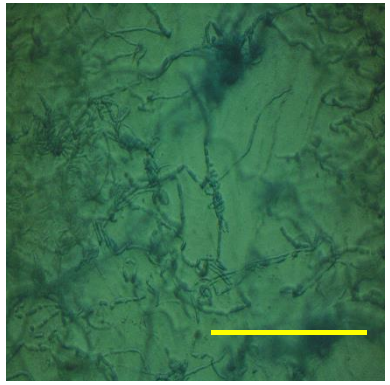
Variable Polarization



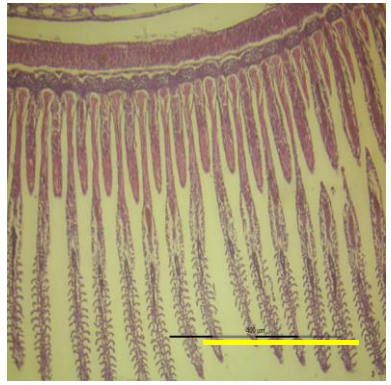
Inverted Metallurgical Microscope (Make: Meiji, Japan- IM7200) equipped with CCD camera (make: Jenoptik, German, Resolution: 2080×1542 pixel)



Fiber Dimensions

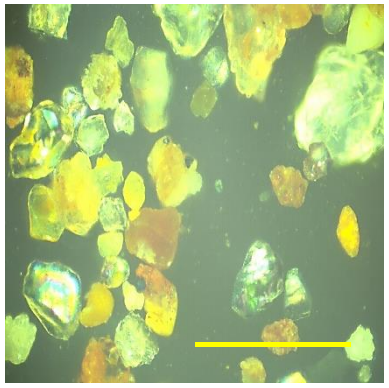


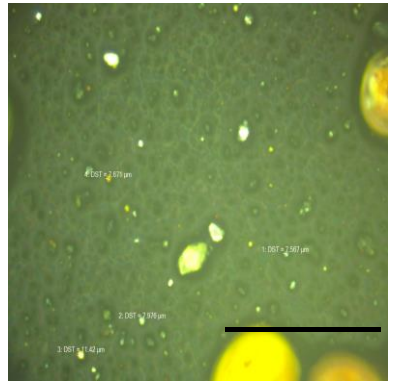
Hyphae Fungus



Fish Bone

Dr. Vaibhav Patel, PDPIAS Dr. Kiran Patel, PDPIAS Dr. Chirayu Desai, PDPIAS

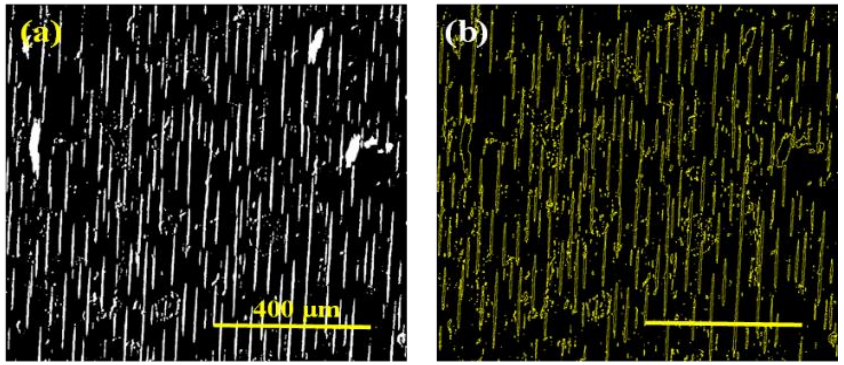




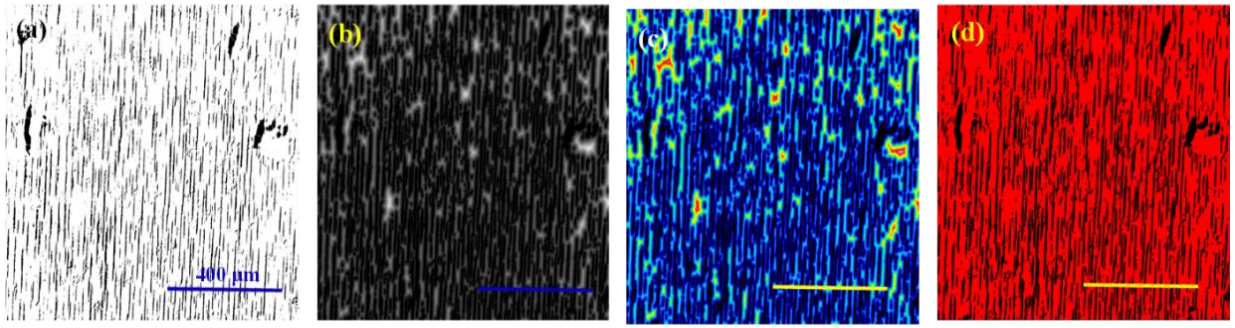
Sand Particles

Dr. Prabin S. Civil Engineering, CSPIT, CHARUSAT

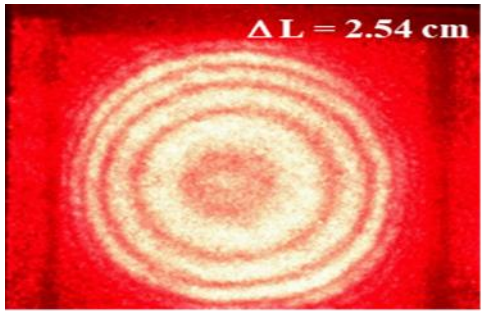
Image Analysis



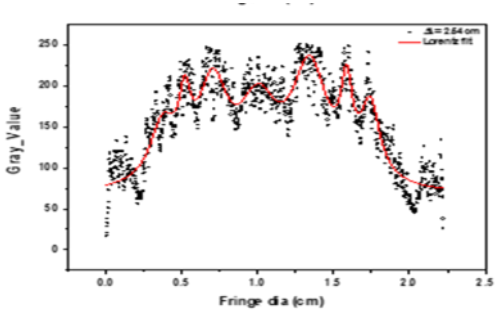
Structure identification



Inter-chain distance determination



Video of interference pattern



Time dependent data extracted from the video

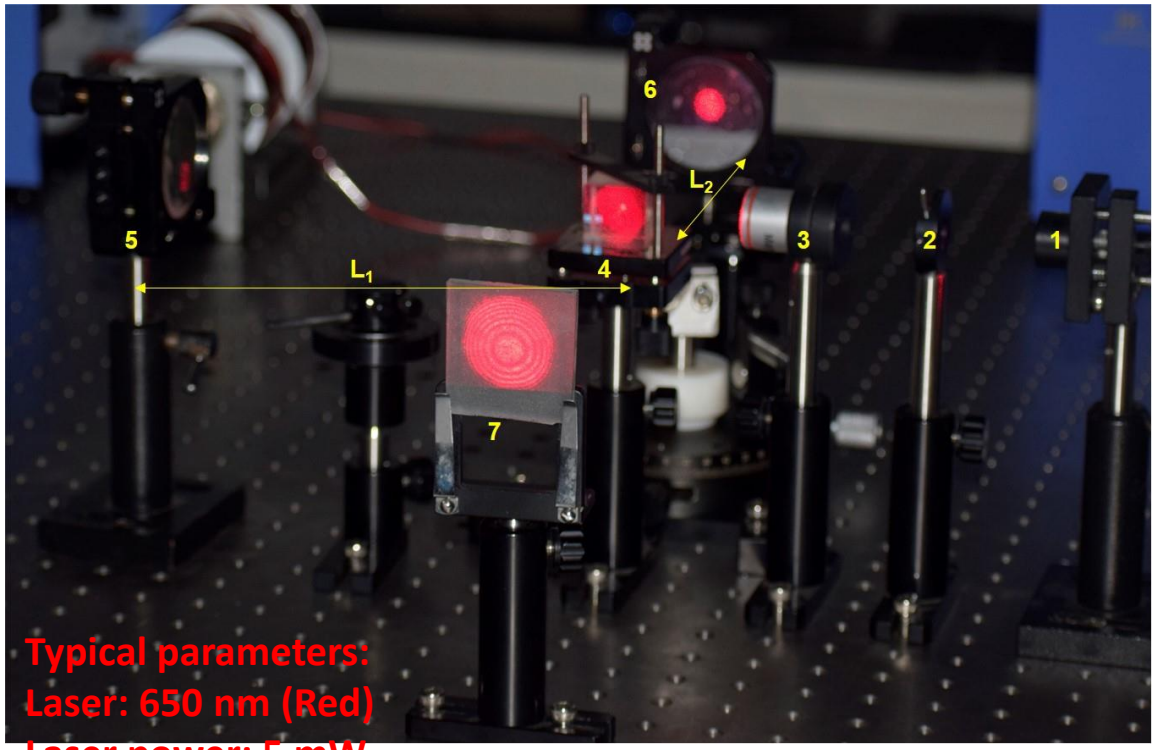
- Analysis of images using ImageJ software – Java based script
- Method developed for the analysis of structure identification & inter-structure distance . The method will be submitted to github, and hence can be added as plug-in in the ImageJ software

Scope for collaboration:

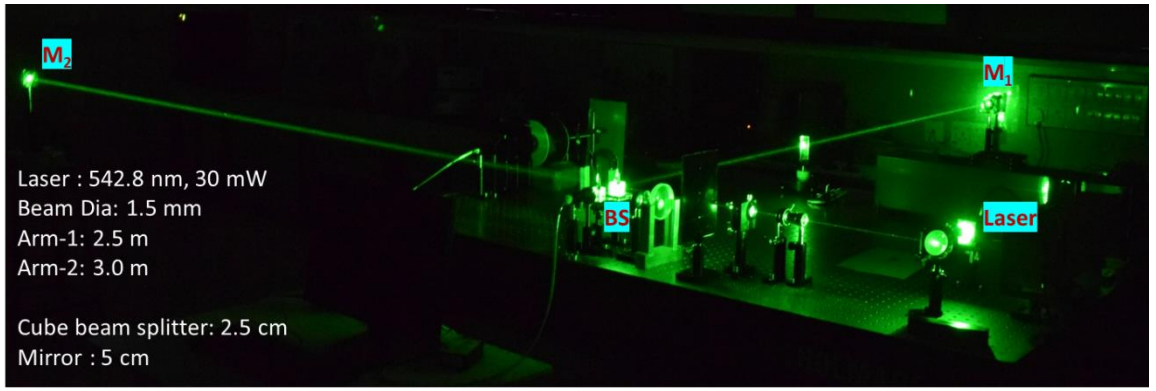
- Interest to explore different types of structure (particle shape, size, distance) identification …..
- Study internal cell structure and subsequently analysis of various parameters

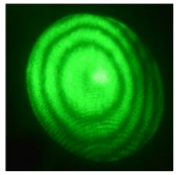
Urvesh Soni et al

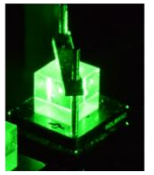
Michelson Interferometer

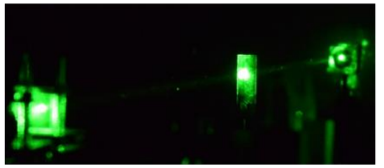


Typical parameters:
Laser: 650 nm (Red)
Laser power: 5 mW
Beam diameter: 0.3 cm



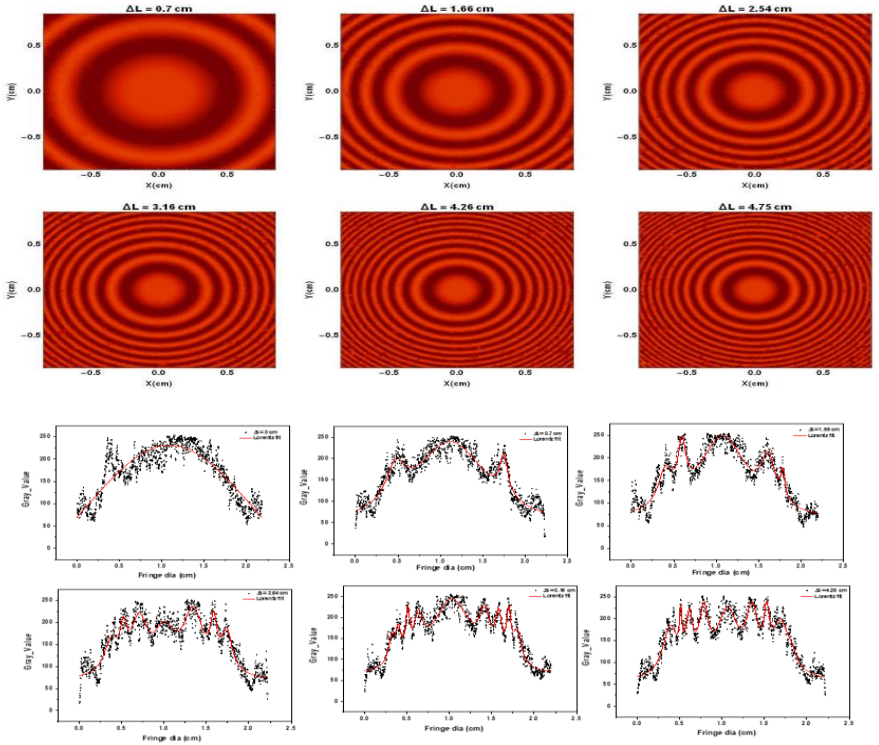


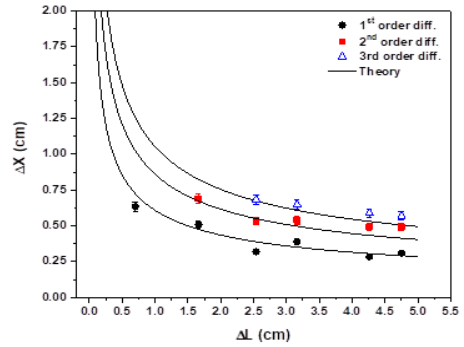




Michelson Interferometer: Applications

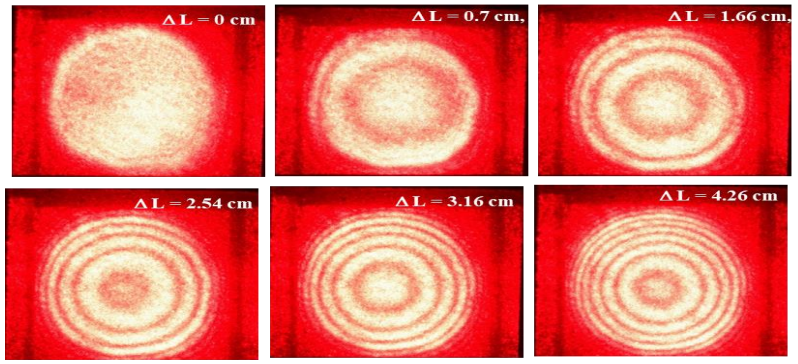
Simulated Interference pattern

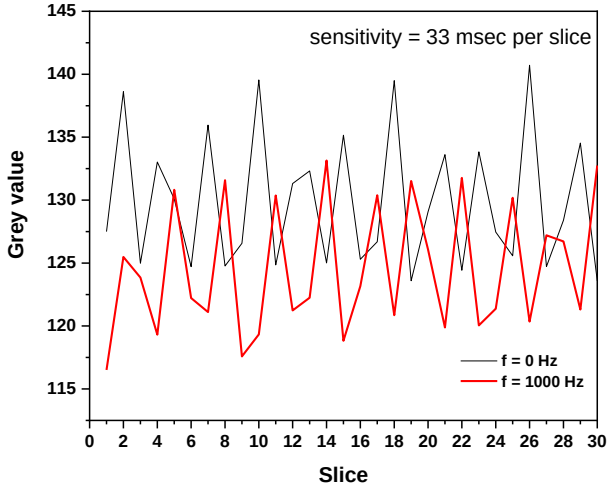




Data obtained using image analysis fitted with Lorentz function (solid line)

Experimental Interference pattern

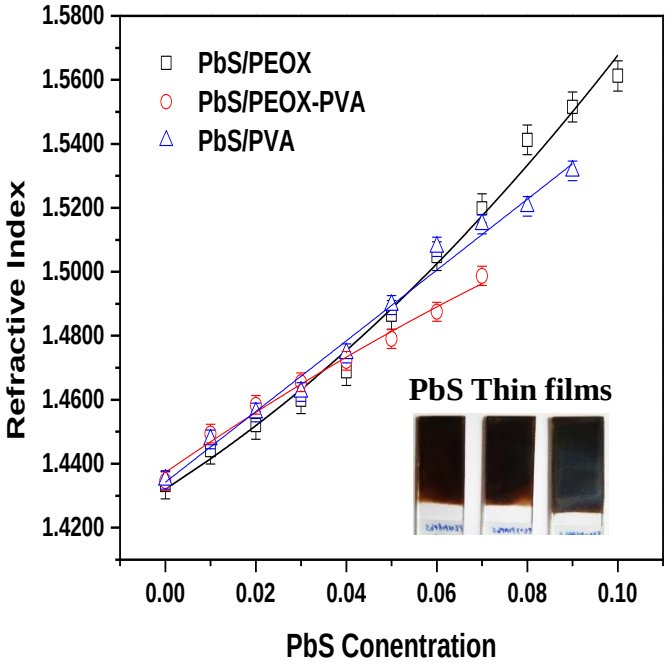




Effect of applied frequency on the interference pattern

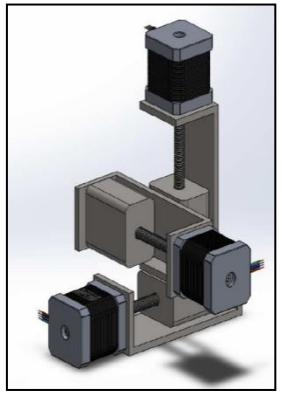
Collaborator: Dr. Dipanjan Dey, Dr. Pankaj S Joshi, ICC, Charusat

Refractive Index measurement

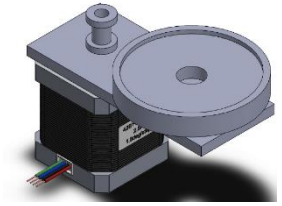


Collaborator: Dr. Vaibhav Patel & Group, Department of Chemical Sciences, PDPIAS, CHARUSAT

3-stage translational and a rotational motorized system for optical elements



XYZ Stage

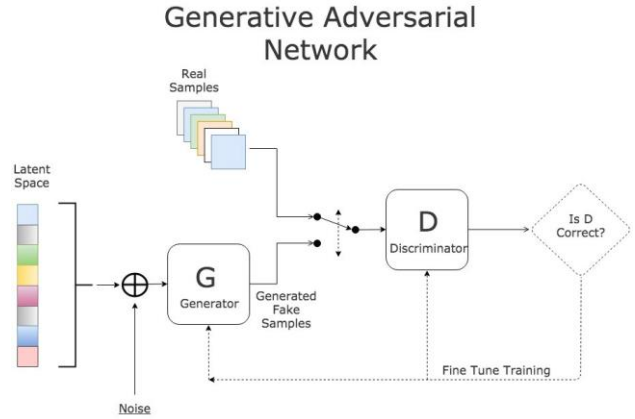


Rotary Stage

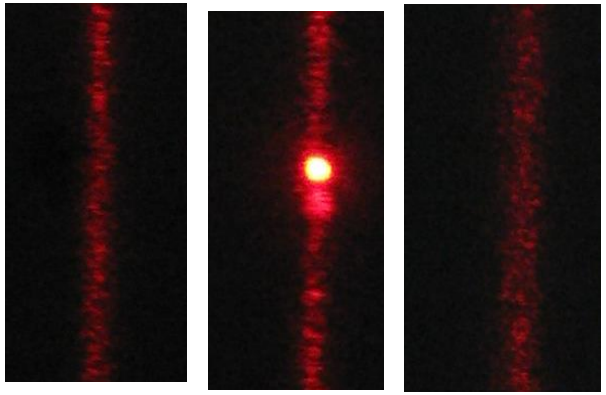
Investigators: Maulik shah & Axat patel

CSRTC, Charusat

Machine Learning for Image Generation: GAN



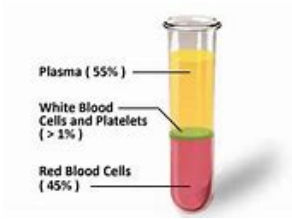
Collaborator: Dr. Parth Shah, Department of Information Technology, CSPIT, CHARUSAT



Magnetic field induced diffraction pattern

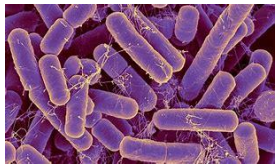
Biological Applications of Magnetic Nanoparticles

Total Protein Extraction



Blood / Plasma

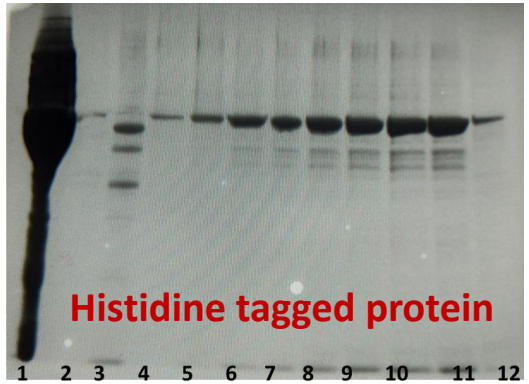
Plant systems

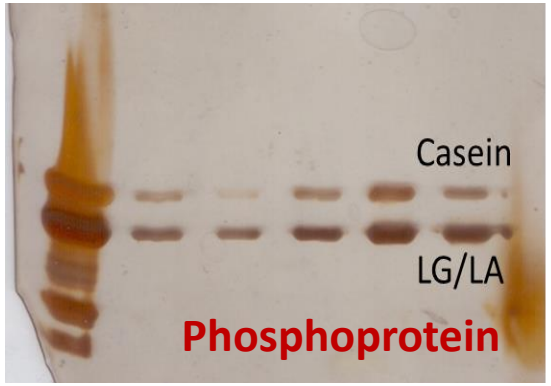


Bacteria (extracellular and intracellular protein)

Collaborator: Dr. C N Ramchand

Protein Purification

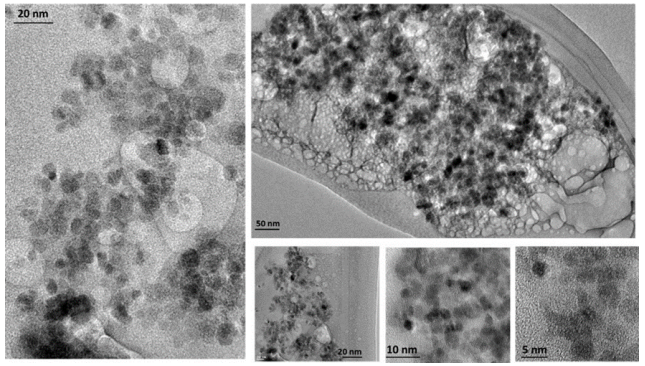


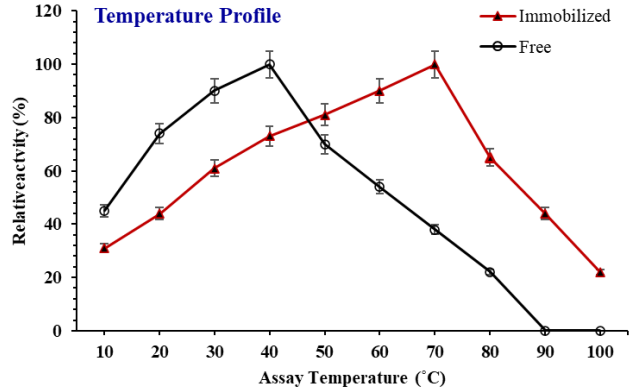


Collaborators:

- Dr. Darshan H Patel, CIPS, Charusat
- Dr. Ruchi Chaturvedi, Dept. of Biological Sciences, PDPIAS, Charusat

Enzyme Immobilization





Collaborator: Dr. Bhavtosh A. Kikani, Dept. of Biological Sciences, PDPIAS, Charusat

Exploring antimicrobial activity of MgO nanoparticles on antibiotic resistant strains

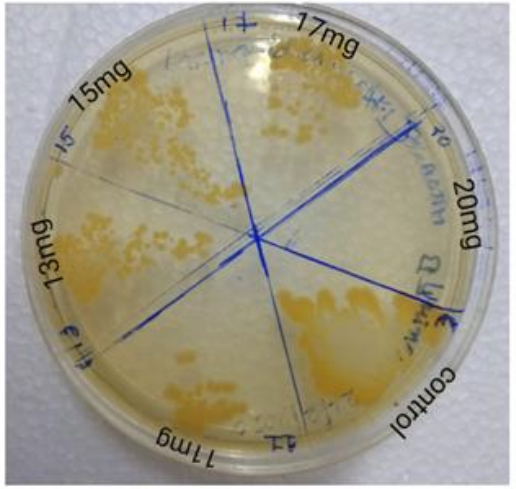


Figure 14 Antimicrobial activity on MRSA

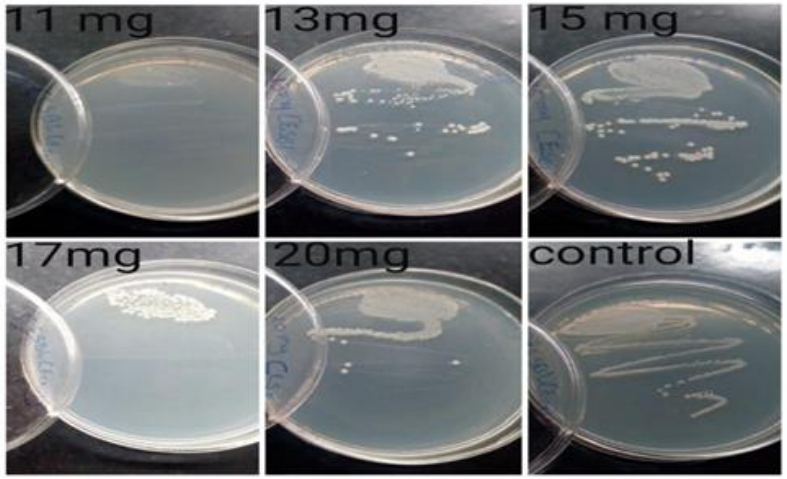
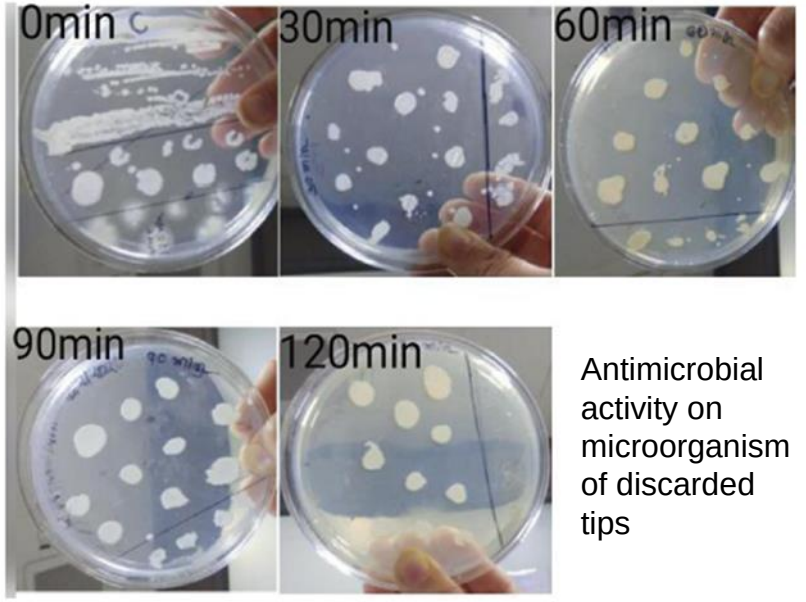


Figure 17 Antimicrobial activity on *E.coli* (ESBL)

Multi-drug resistantstrains (MDR)	Antibacterial concentration of MgO NPs	Sensitive strains	Antibacterial of MgO NPs
MRSA	20 mg	MSSA	11 mg to 20 mg
E.coli(ESBL)	11 mg	*E.coli*	7 mg and 10 mg inhibitory concentration. Lethal concentration11 mg 20 mg
Pseudomonas.aeruginosa	18 mg to 20 mg	*Proteus mirabilis*	13 mg 20 mg

Table 3 Result of antimicrobial activity



Antimicrobial activity on microorganism of discarded tips

Collaborator: Dr. Artee Tyagi, Dr. Darshan H Patel, CIPS, Charusat

Thank You

P D Patel Institute of Applied Sciences

RESEARCH
@
DEPARTMENT OF BIOLOGICAL SCIENCE (DBS)

Faculty Name	Research area(s)
 **Palash Mandal**	Fatty Liver Disease, Development of therapeutic interventions to normalize both alcohol and nonalcoholic-induced increases in hepatic inflammation, which could be used to treat patients with ALD, NASH, Role of gut-microbioata in Fatty Liver Disease, Obesity and Diabetes.
 **Gayatri Dave**	Product and Process Development such as Eco-friendly fabric and Reporter assays for Microbial activity testing Anti-microbial activity testing Product characterization Toxicity analysis assays

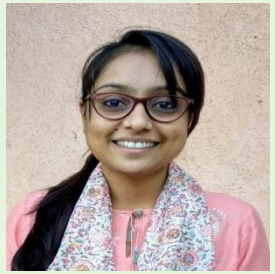
Faculty Name	Research area(s)
 **Janki N. Thakker**	Ecofriendly Bricks and construction materials: Plant Microbe interaction Agriwaste management (Biochar preparation and use as bio fertilizer) Purification and applications of plant as well as microbial pigments
	Use of Magnetic nanoparticles in controlling plant pathogens
 **Aditi Buch**	Nonbiological applications of biomolecules

Faculty Name	Research area(s)
 **Bragadish Iyer**	Study of redox reactions, electroactive biopolymers, corrosion due to biofilms, biocatalysis
	Development of Bioadhesives
 **Seema Amin**	Liquid Waste Management
	Biotransformation
	Liquid Waste Management
 **Anamika Jha**	Nanotechnology for post-harvest storage applications
	Biofertilizers and plant-microbe interactions

Faculty Name	Research area(s)
 **Anoop Markande**	Bioconcrete development
	Developmemtn of Moonlighting proteins
	Effect of medical imaging on surface microflora
	Protein Molecular Dynamics simulation
 **Kirankumar Patel**	Plant Microbe interaction, Optimization of Large scale Bio-control cultivation, Enzyme Engineering

Faculty Name	Research area(s)
 **Chirayu Desai**	**Integrated eco-electrogenic system** for efficient and sustainable treatment of textile wastewater
	Microaerophilic-aerobic based treatment of textile effluents
	Microbial diversity across the Ganges
 **Bhavtosh Kikani**	**Protein engineering:** Purification of various enzymes; Enzyme Immobilization using nanomaterils to increase its stability

Inter Disciplinary Research @ Biological Sciences, PDPIAS

Faculty Name	Research area(s)
 **Tapan A. Patel**	Toxicity (in vitro and in vivo) and ameliorative studies of herbal-natural compounds, phytochemical analysis, cytogenetics
 **Mandar Kulkarni**	Nutrition (Probiotics), Host-microbe interactions and Computational Biology
 **Janki K. Patel**	Plant-Microbe interaction; Biocontrol activity, ISR and SAR response in plant

Faculty Name	Research area(s)
 **Neeraj Jain**	**Cancer Biology:** Development of novel cancer therapeutic approach using magnetic nanoparticles for the treatment of solid tumors
	Synthesis of heterocyclic derivatives and evaluation of anti-cancer parameters
	Immunotherapy for Colorectal Cancer: Focus on Cancer like Stem Cells & Advance stages

Ongoing Research Work (KBK)

Research Area: Fractional Calculus, Mathematical Physics

- Fractional derivatives are widely used by researchers in modelling realistic systems. Such derivatives, due to their nonlocal nature are able to model memory and hereditary effects observed in physical systems. It is observed that systems involving fractional derivatives can exhibit chaos. Below a threshold value of fractional order derivative, these systems show regular behavior. **We are studying chaos in various fractional order system.**
- We are **developing analytic and numerical methods to solve fractional differential equations** with various fractional order derivatives.
- Linear viscoelasticity is certainly the field of the most extensive applications of fractional calculus, in view of its ability to model hereditary phenomena with long memory. **We develop fractional viscoelastic models with various fractional derivative operator.**
- **Lie Algebra and Fractional order polynomials**
- **Image Processing using Fractional calculus**
- We trying to **obtain certain properties of fractional order polynomials using Lie-Algebra**.
- We are working on **applications of fractional calculus in image processing.**

Ongoing Research Work (MHC)

Research Area: Special Functions, Hypergeometric Function, Mittag-Leffler Function

- Special Functions are developed out of Mathematical Physics and Statistics. Many Special Functions appear as solutions of differential equations or integral of elementary functions.

- Gauss hypergeometric function, Bessel functions, Legendre, Laguerre, Hermite functions, Mittag-Leffler function are here worth mentioning.

- Some mathematical models depending upon more number of parameters and to control them as per the physical problem requirement, the generalized structure of Special Functions is needed. We have generalized Gauss hypergeometric function, Bessel functions, and Mittag-Leffler function satisfying infinite order ordinary and fractional differential equations and studied their properties together with the eigen function property by the construction of a new operator with the aid of ordinary and classical fractional derivatives operators.

Ongoing Research Work: (JRP)

Research Area: Tribology, Fluid Mechanics

- Tribology is very useful to reduce the friction and wear of the system. Nowadays, it is important and crucial in industries.
- We are working on magnetic fluid based squeeze film bearing systems with the effect of porosity, roughness and slip velocity.
- Mainly we have studied the performance of squeeze film Slider bearing, Annular bearing, circular bearing and Journal bearing considering the influence of magnetic fluid, porosity, roughness and slip velocity.
- In our investigation, we start with the Reynolds equation of the conventional fluid based bearing system. Then, we modified this Reynolds equation with Ferrofluid flow models(Neuringer-Rosensweig's model, Shliomis' model, Jenkins's model), Porosity, roughness and slip velocity. After solving modified equation, we can derived Pressure, Load carrying capacity and Friction of the bearing system. In this way we can analyse the performance of the bearing system.
- Our above research is totally theoretical.

Ongoing Research Work: (YFP)

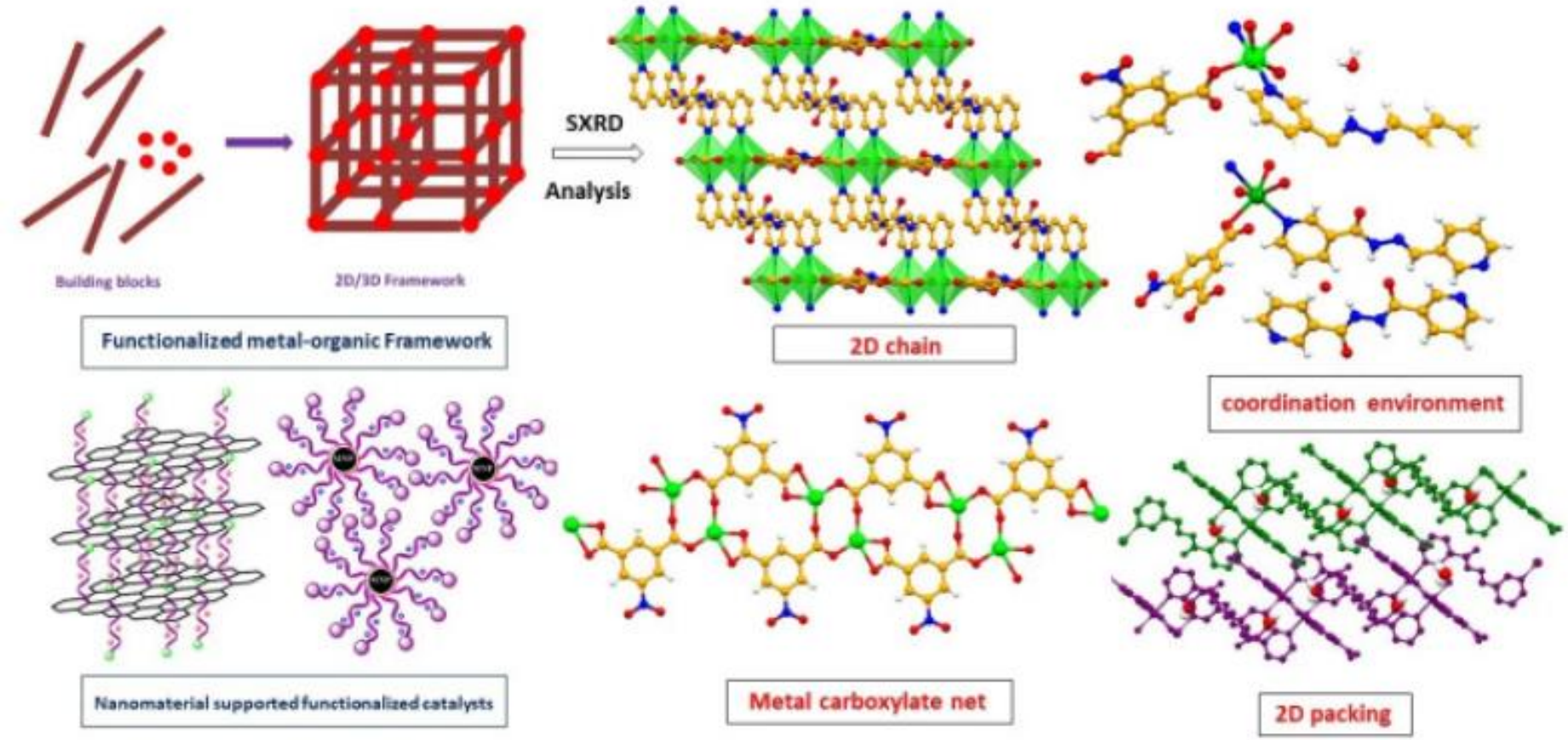
Research Area: Compartmental Modeling & Computational Methods

- Dynamical models are crucial in the field of engineering, science and technology as they represent the real world phenomena
- Compartmental modelling can be considered as the best tool to comprehend physical phenomena as well as the effect of various parameters involved in the dynamic models.
- Due to the complex nature of biology, chemistry, physics, pharmacokinetics model, it is necessary to reduce into simple form so that one can easily understand the effect, behaviour and interaction of various parameters which can be easily achieve using compartment modelling.
- Most of the time compartment models are described mathematically by ordinary or partial differential equations .
- As more parameters are involved, the mathematical modeling leads to complicated system of differential equations and solution to such kind of problem became a challenge for one.
- So we required a computational methods which provide solution with less computational efforts and less time.

Ongoing Research Work (RVS)

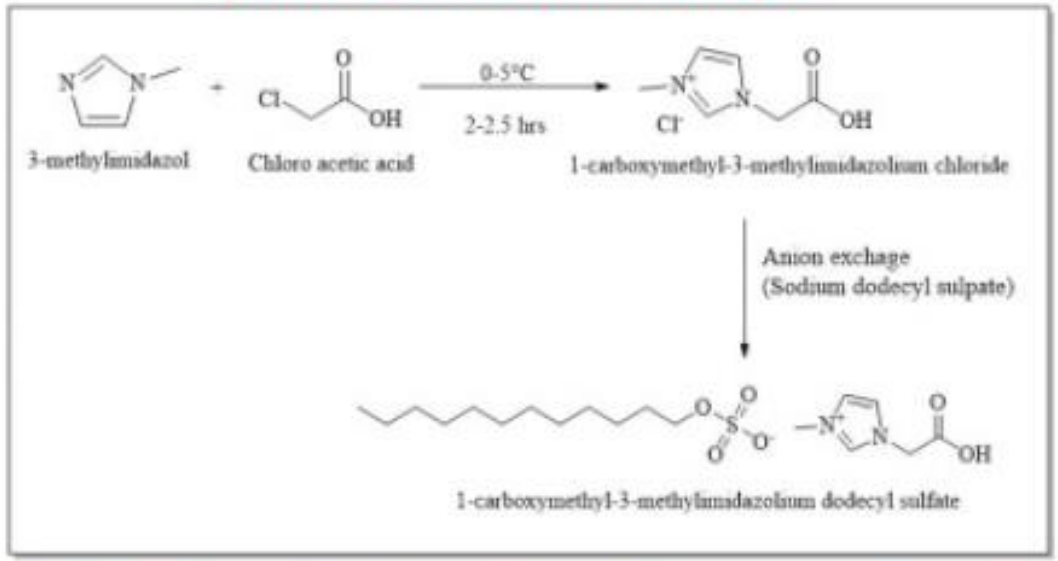
Research Area: Special Functions, Orthogonal polynomials and their generalizations

- The extension to classical polynomials along with their q-versions in the sense of p-deformation
- The inverse series relations of these p-polynomial with the help of general inversion pair
- Combinatorial identities with help of general inversion pair
- p-Version of Riorden's classification of Combinatorial identities
- The differential equation of p-polynomial using recurrence and differential recurrence relation
- The generating function relation, summation formulas involving the polynomials
- The Companion matrix and its application to find eigen values
- p-version of Ramanujan's theorems



Design and Development of Advance Functional Materials

Synthesis of Surface Active Ionic Liquids

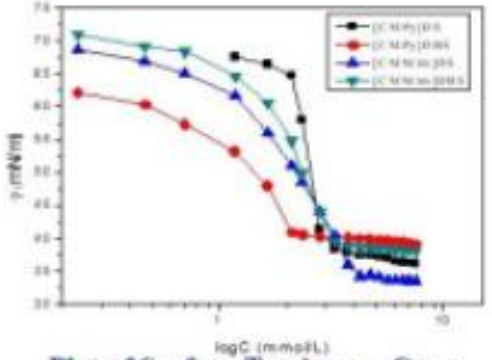


Highlight: The carboxy functionalized SAILs are expected to step forward for green surface-active agents

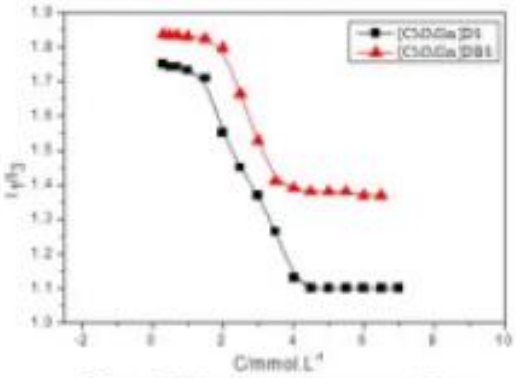
Determination of Physical Parameters

Critical Micellar Concentration (CMC), Aggregation Number
Thermodynamics of Micellization, Surface Active parameters

Characterization SAILs

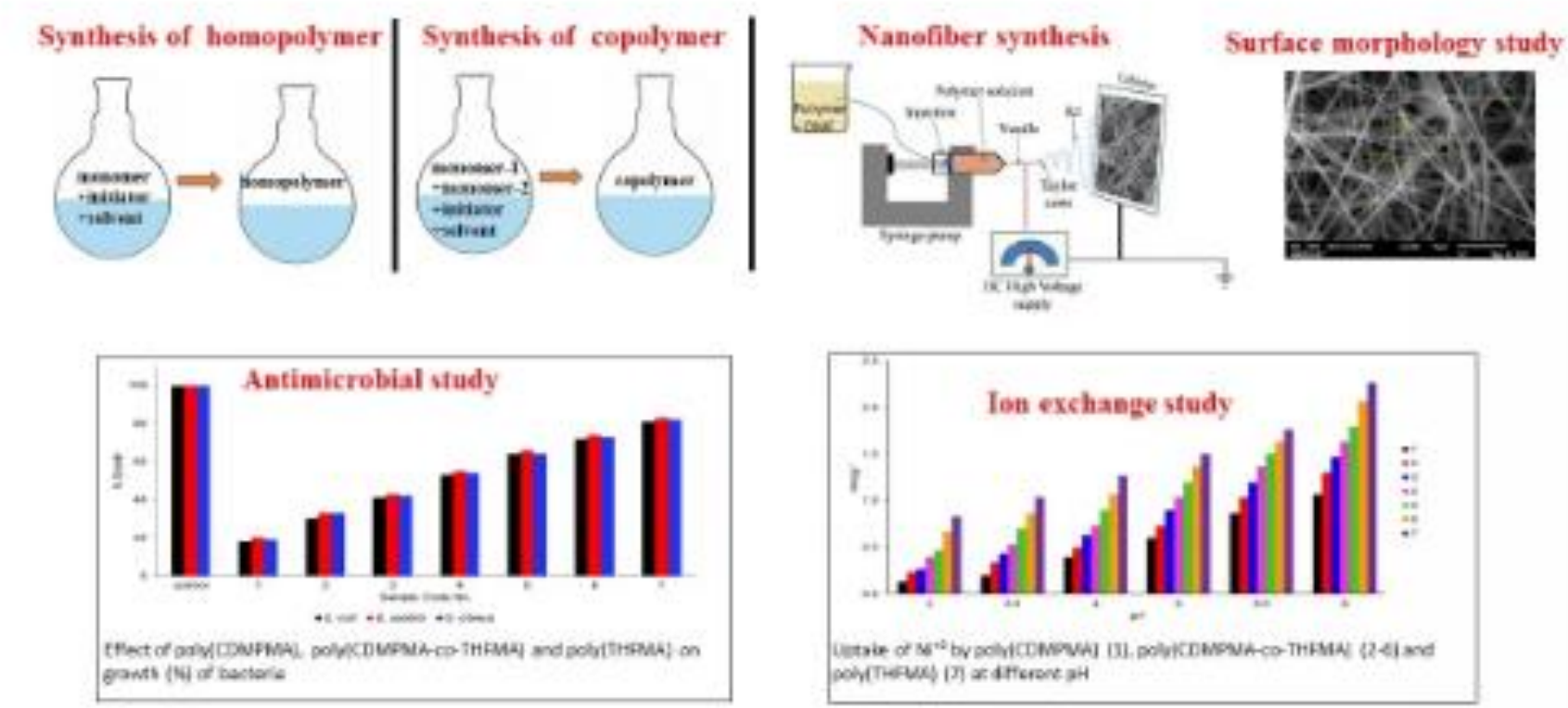


Plot of Surface Tension vs. Conc.



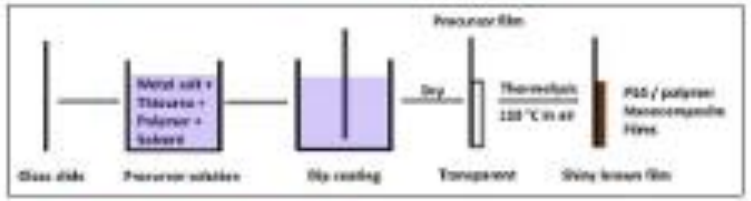
Plot of Fluorescence quenching

Design and Development of Surface Active Ionic Liquids

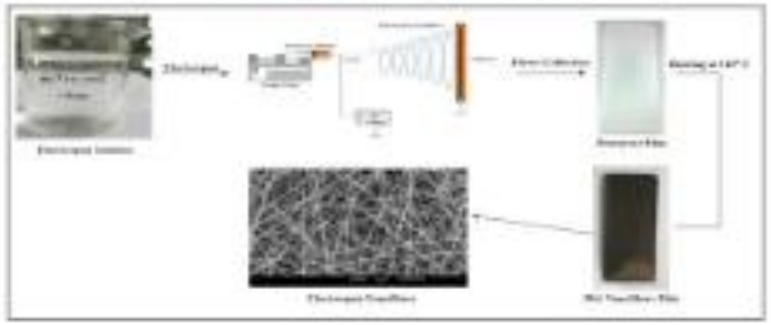


Development of Acrylate Polymer, Nanocomposites and Nanofibres

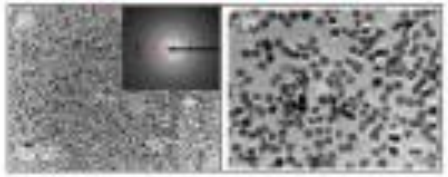
Development of single step in-situ protocol for NCs



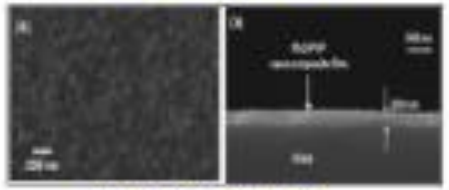
Metal/Polymer Nanofibers



Morphological study

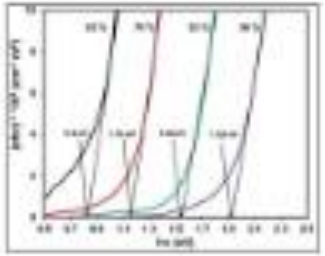


TEM of PbS/PVP NC

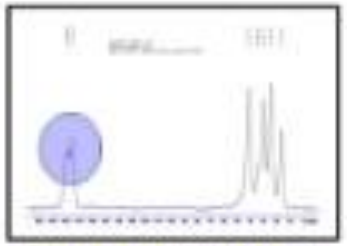


SEM of PbS/PVP NC

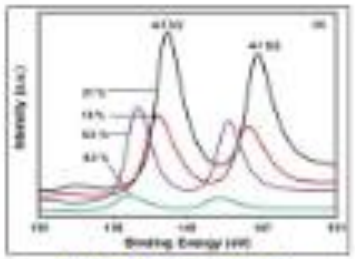
Optical Study



Interaction Study



^{13}C NMR of PbS/PVP NC



XPS of PbS/PVP NC

Nanocomposites and Nanofibers