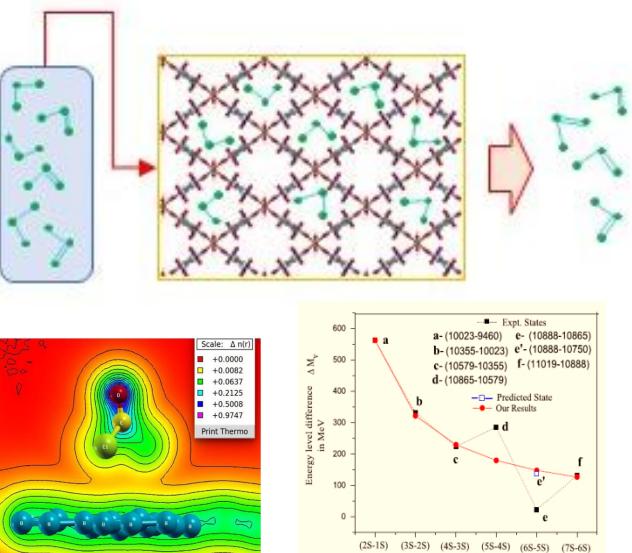


Department of Physical Sciences, P D Patel Institute of Applied Sciences, Charotar University of Science and Technology

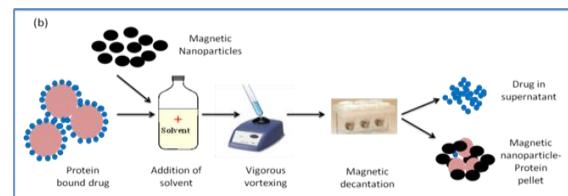
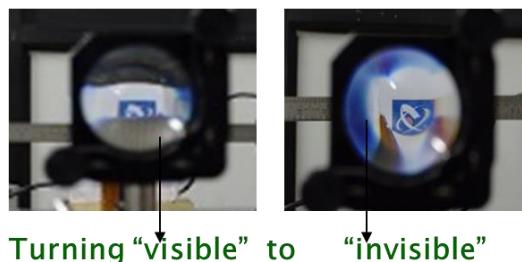
Research Areas



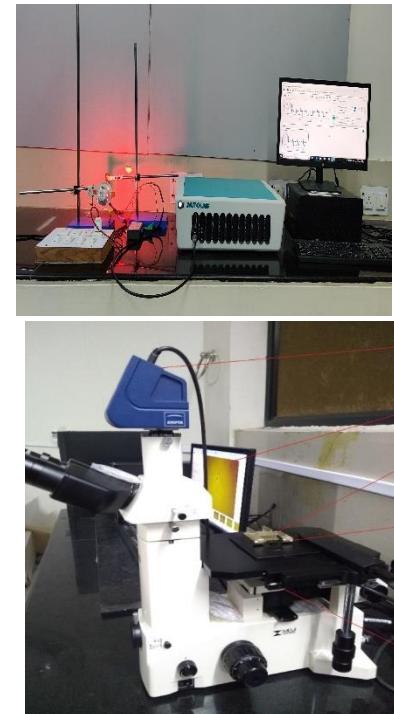
**Theoretical Physics
(Condensed Matter and High Energy Physics)**

Engineering of Nanomaterials

OPTICAL CLOAKING

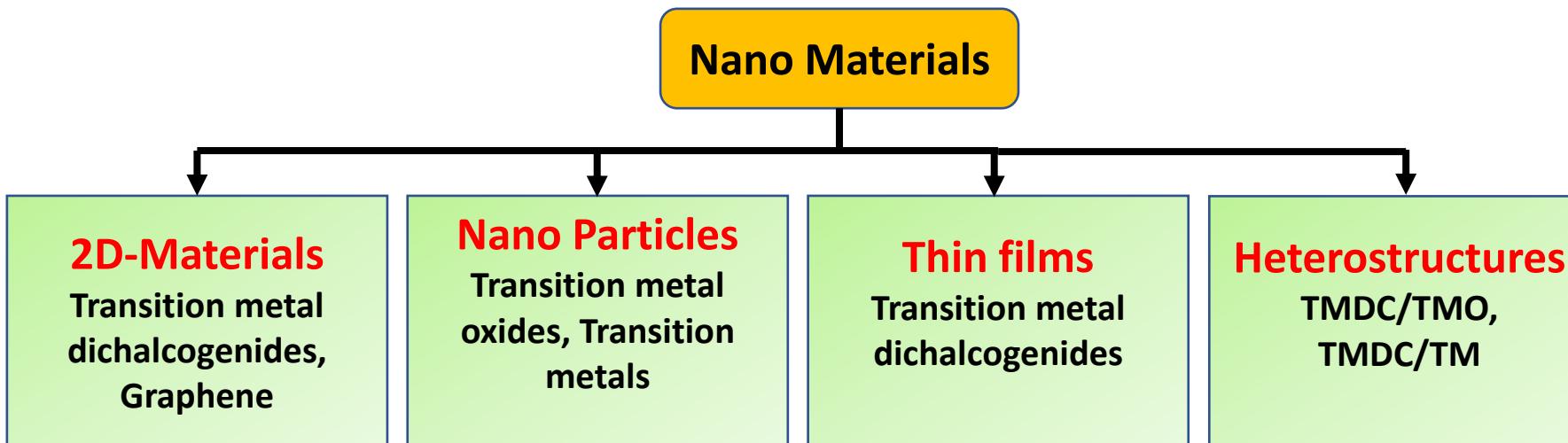


Optics and applications of nanoparticles and magnetic fluids



Characterization facilities

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

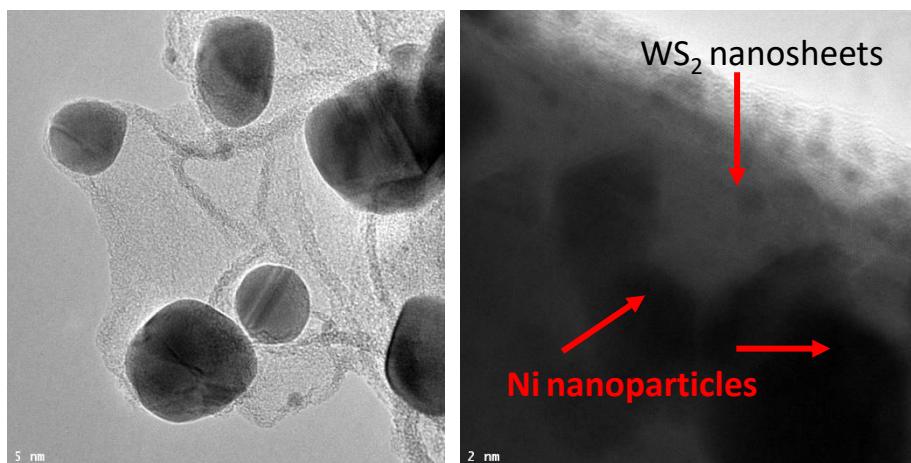


Dr. C. K. Sumesh & group

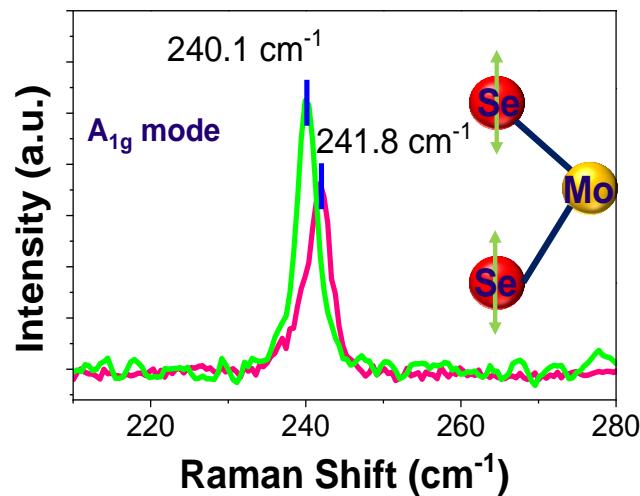
Our expertise:

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

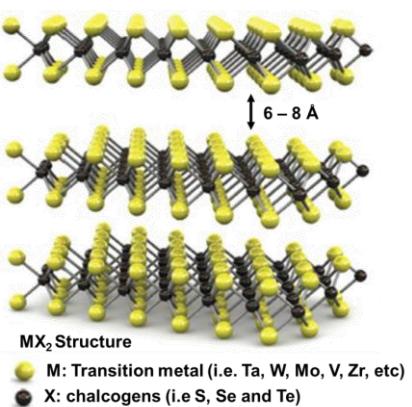
Analysis of nanomaterials by HR-TERM



Raman spectra of MoSe₂ nanosheets



2D TMDC and analogous materials



Quality Parameters:

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

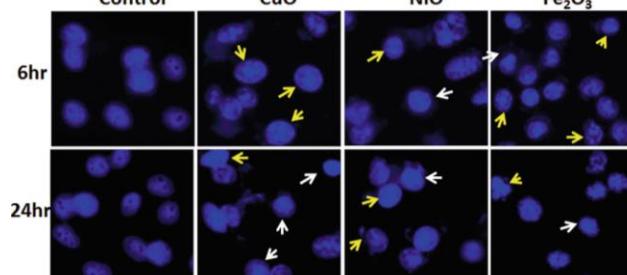
Transition metal dichalcogenides (TMDC) (eg. MoS₂, WS₂, and WSe₂)

Transition Metal Oxides (TMO) (eg. MoO₃, WO₃, 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	
2D oxides	Micas, BSCCO	MoO ₃ , WO ₃	Perovskite-type: LaNb ₂ O ₇ , (Ca,Sr) ₂ Nb ₃ O ₁₀ , Bi ₄ Ti ₃ O ₁₂ , Ca ₂ Ta ₂ TiO ₁₀ and so on	Hydroxides: Ni(OH) ₂ , Eu(OH) ₂ and so on	Others

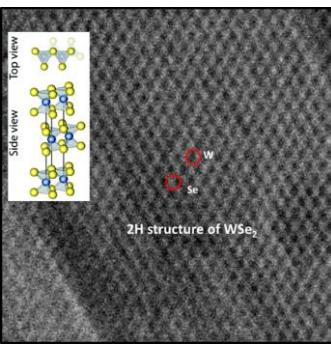
Scope for collaboration

- Anti-cancerous & biological activities using various metal oxides

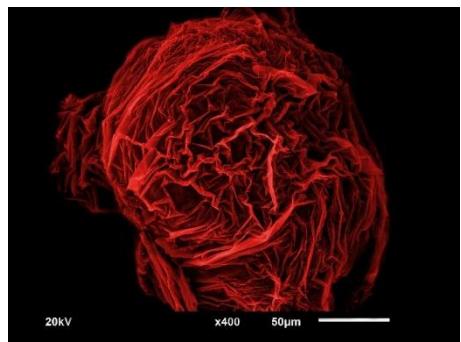


Dr. Nilesh Pandey, CIPS

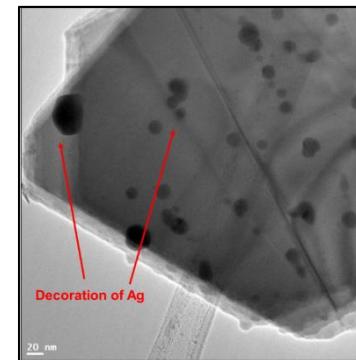
Results



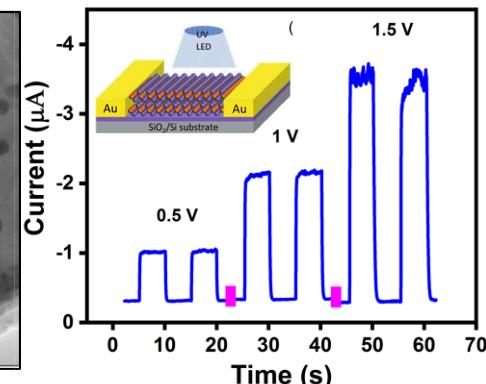
HRTEM image of the WSe₂ nanosheet represents the honeycomb structure Prepared by



SEM Image of WO₃ nanoflowers Prepared by chemical route method



Clusters/ bulk powder of WS₂ is uniformly exfoliated in to thin and isolated-sheets of WS₂ 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 WSe₂ nanosheets photodetector with and without illumination



- Corrosion testing
- Photocatalysis

Dr. Kamlesh Chauhan, CSPIT

Synthesis Methods

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

Main features

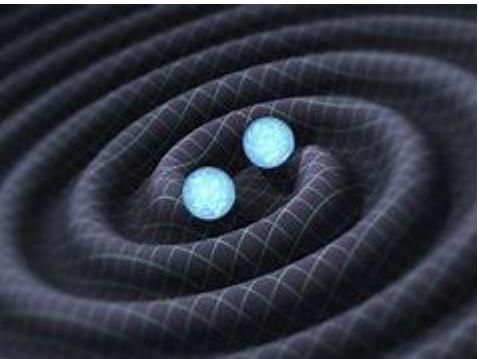
- Easy synthesis methods
- Possibility to fabricate heterostructure
- Optimization in various properties such as optical, electrical, etc
- Contemporary device fabrication such as photodetectors, gas sensors, electronic devices, bio-sensors

Dr. Sanni Kapatel

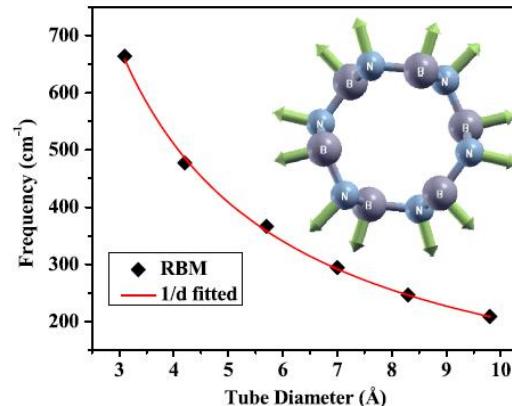
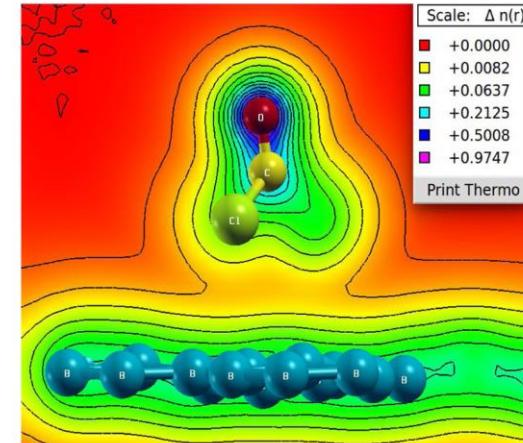
Research in Theoretical Physics

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..

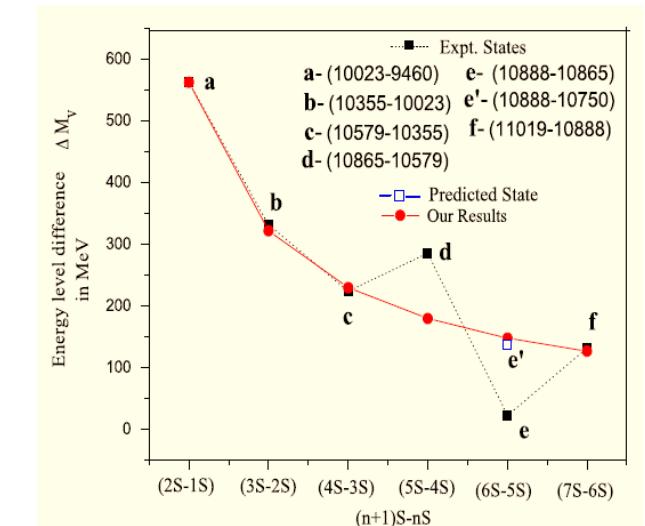


Dr. Shweta Dabhi

Theoretical High Energy Physics, Hadron Physics

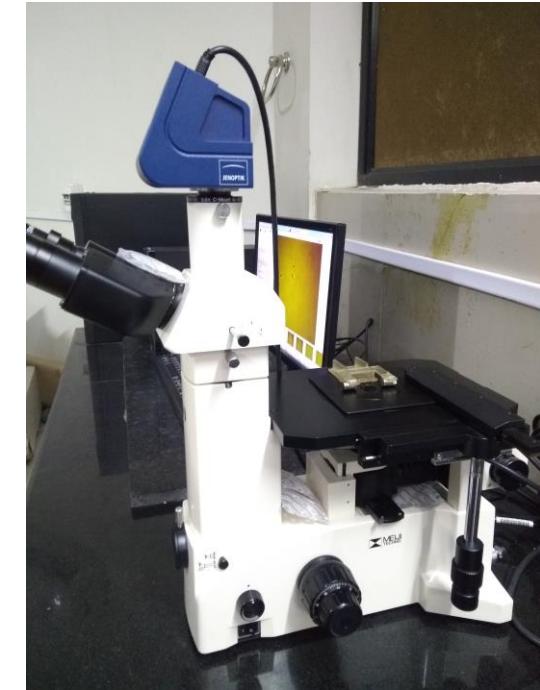
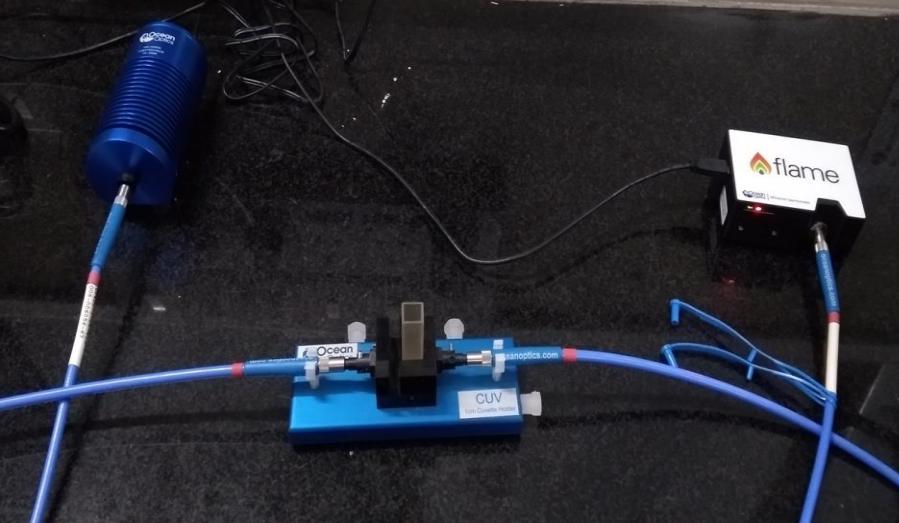
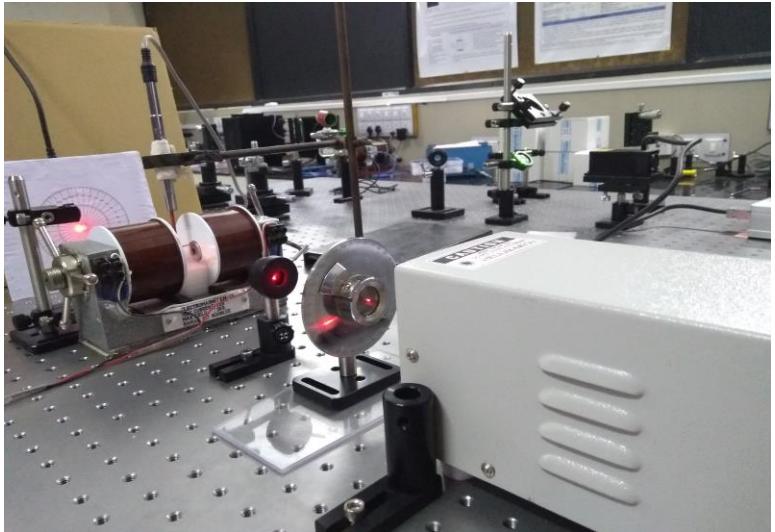
Area of Interest :

- 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:

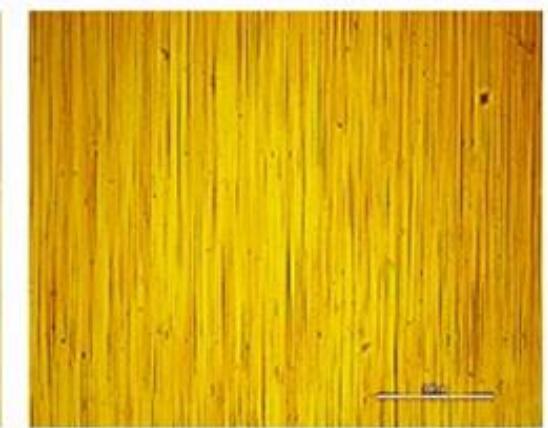
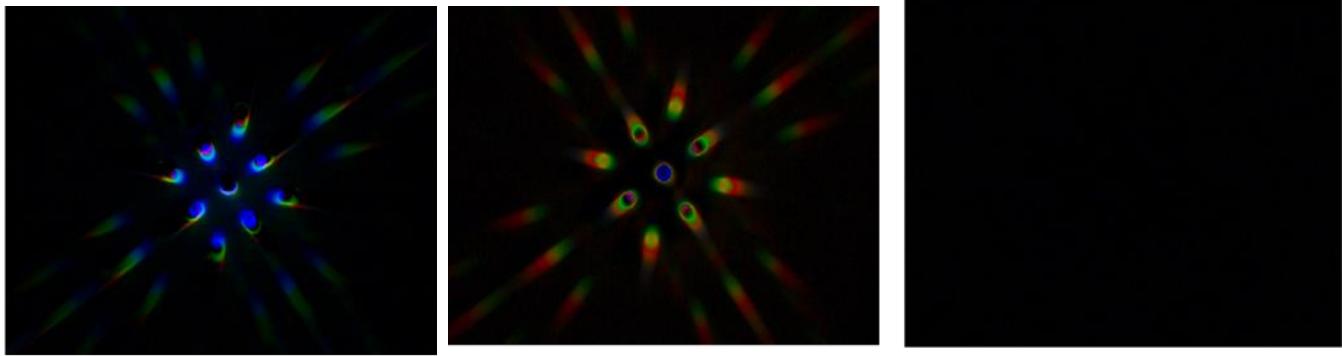
- He-Ne Red laser (632 nm, 5mW)
- Diode Green laser (532 nm, 30mW)
- He-Cd laser (442 nm, 30mW)

Portable spectrophotometer (Make: Ocean optics)

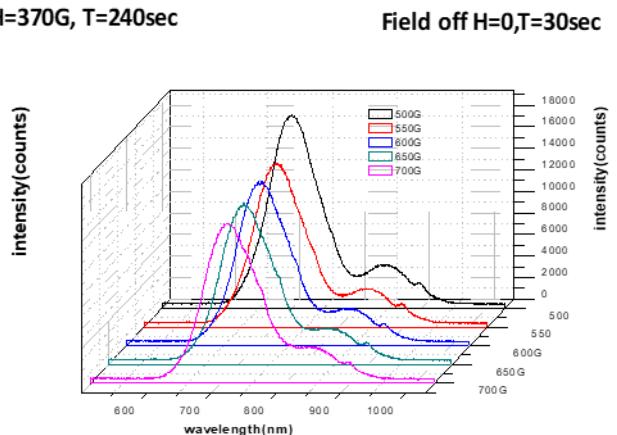
- FLAME-S-XR1-ES Spectrophotometer, detection range, $\lambda = 200\text{nm}-1100\text{nm}$,
- Tungsten Halogen Source, HL-2000-LL, wavelength Range, $\lambda=360\text{nm}-2000\text{nm}$
- $400\mu\text{m}$ UV/VIS optical fibre and cuvette holder

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

Magnetic Fluid based Tunable Diffraction Grating

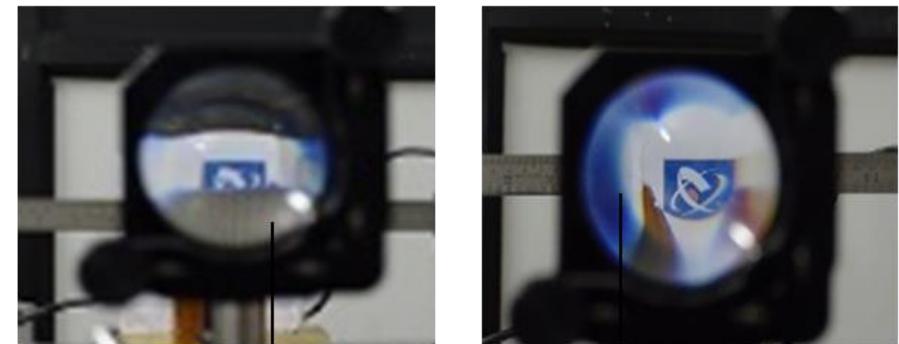


Magnetic field induced chain formation – Microscopic image

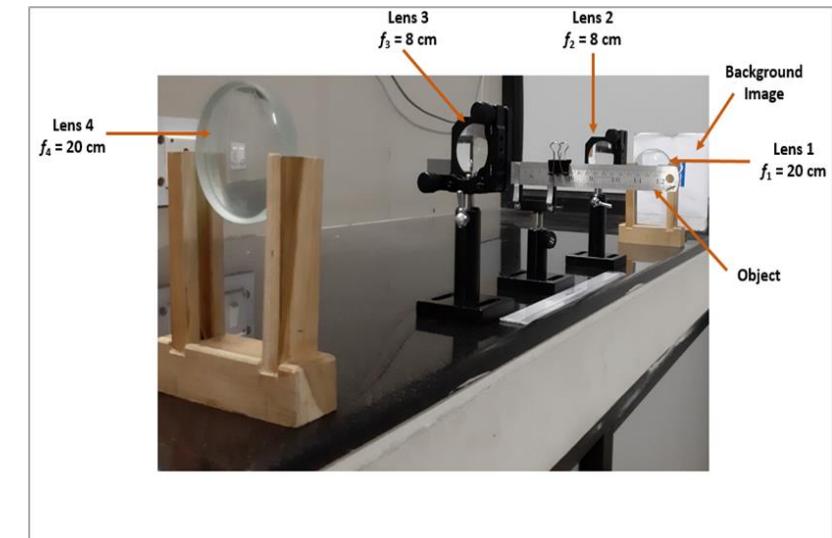


White light spectroscopy – MF as monochromator

OPTICAL CLOAKING

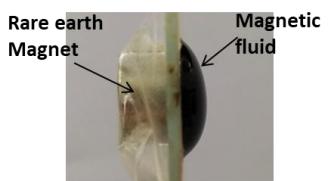


Turning “visible” to “invisible”

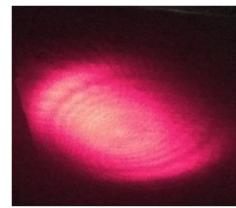


- One-way cloaking
- Two-way cloaking

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

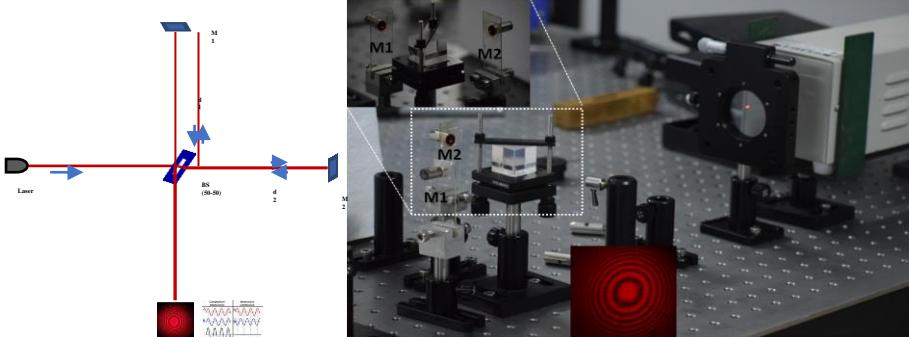


Reflected Beam

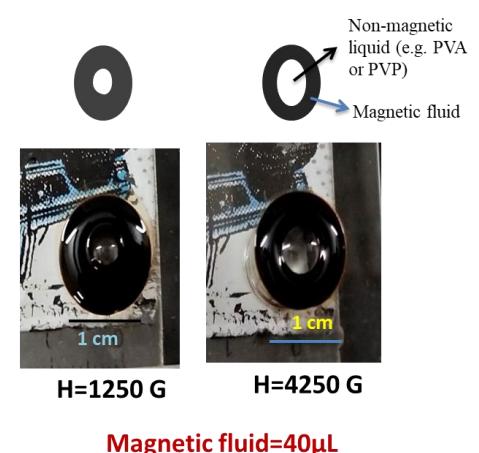
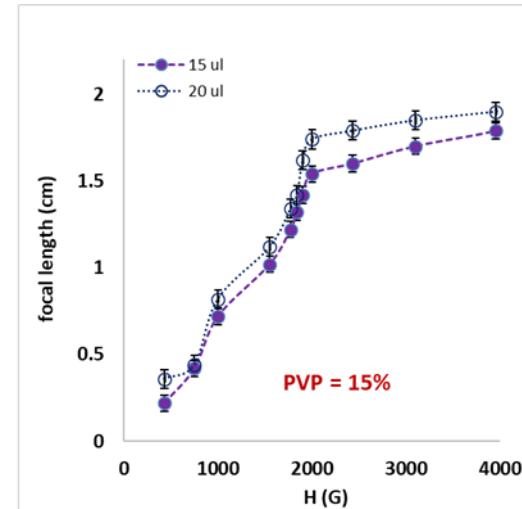
Reflection due to the plane surface of the mirror leads to focused beam (without lens).

Michelson Interferometer: An application

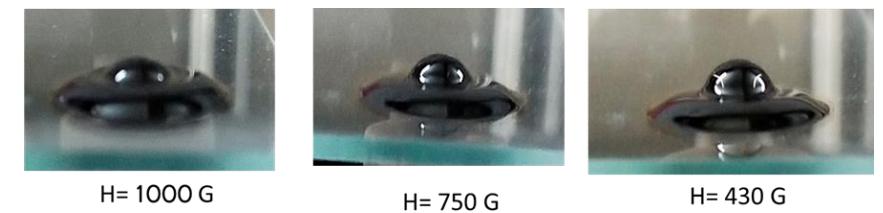
Michelson Interferometer



Adaptive Liquid Lens



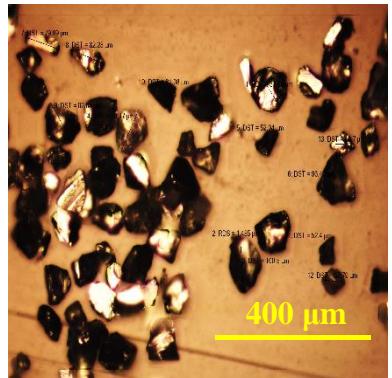
Side view of Curvatures at different magnetic fields



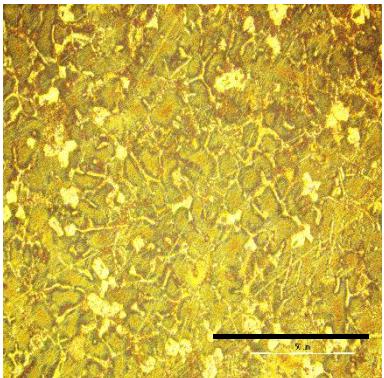
Scope for collaboration

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

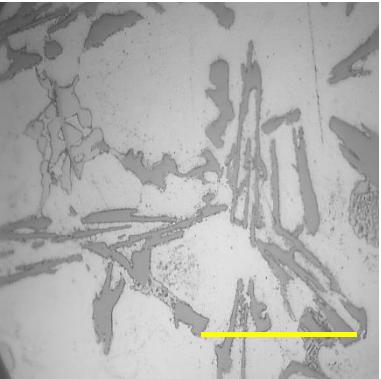
Inverted Metallurgical Microscope – University users



Al Particles



Al - Composite



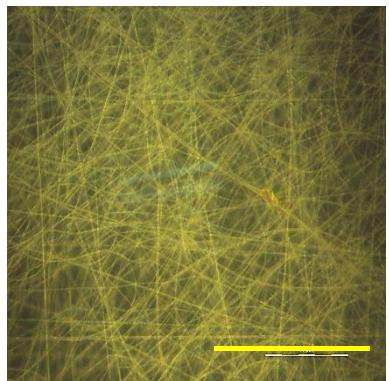
Material Surface

Variable
Polarization

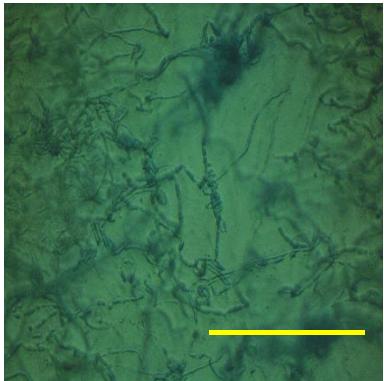


Dr. Mayur Sutaria & Group, Mechanical Engineering, CSPIT, CHARUSAT

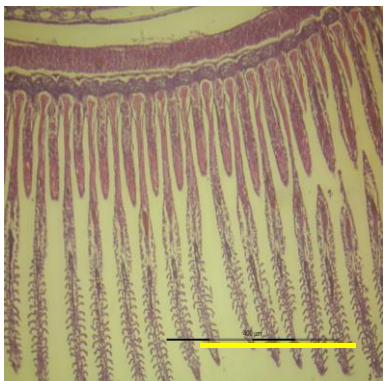
Inverted Metallurgical Microscope (Make: Meiji, Japan- IM7200) equipped with CCD camera (make: Jenoptik, German, Resolution: 2080×1542 pixel)



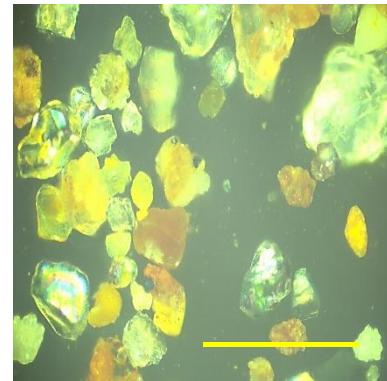
Fiber Dimensions



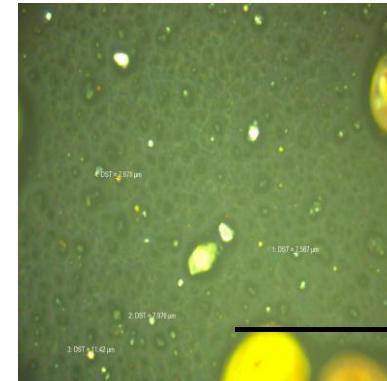
Hyphae Fungus



Fish Bone



Sand Particles

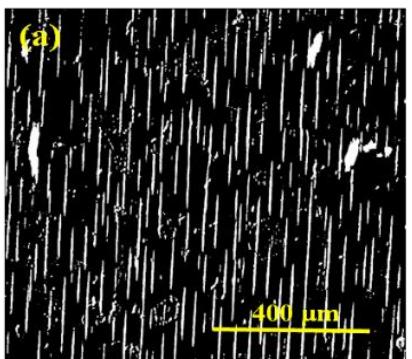


Sand Particles

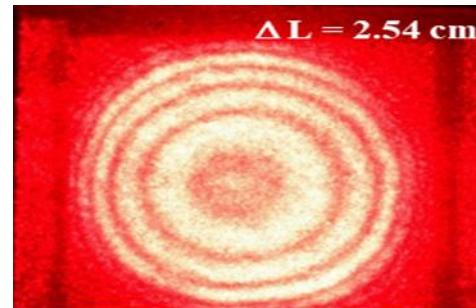
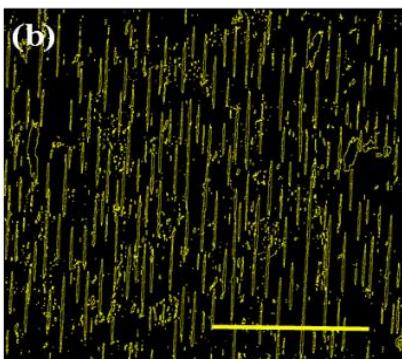
Dr. Vaibhav Patel, PDPIAS Dr. Kiran Patel, PDPIAS Dr. Chirayu Desai, PDPIAS

Dr. Prabin S. Civil Engineering, CSPIT, CHARUSAT

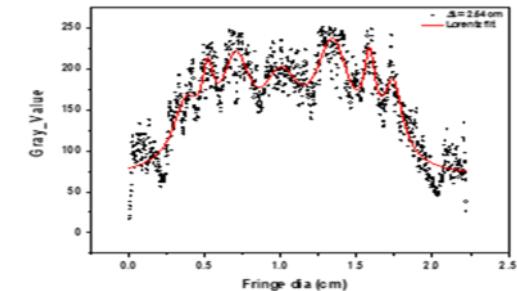
Image Analysis



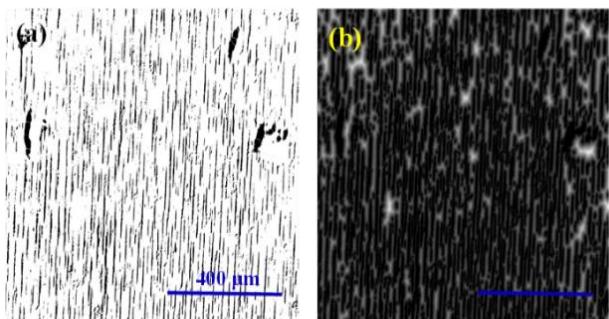
Structure identification



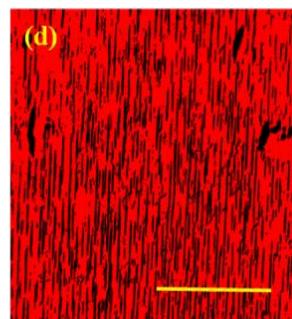
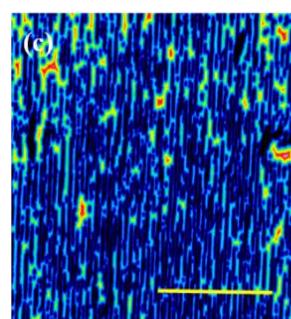
Video of interference pattern



Time dependent data extracted from the video



Inter-chain distance determination

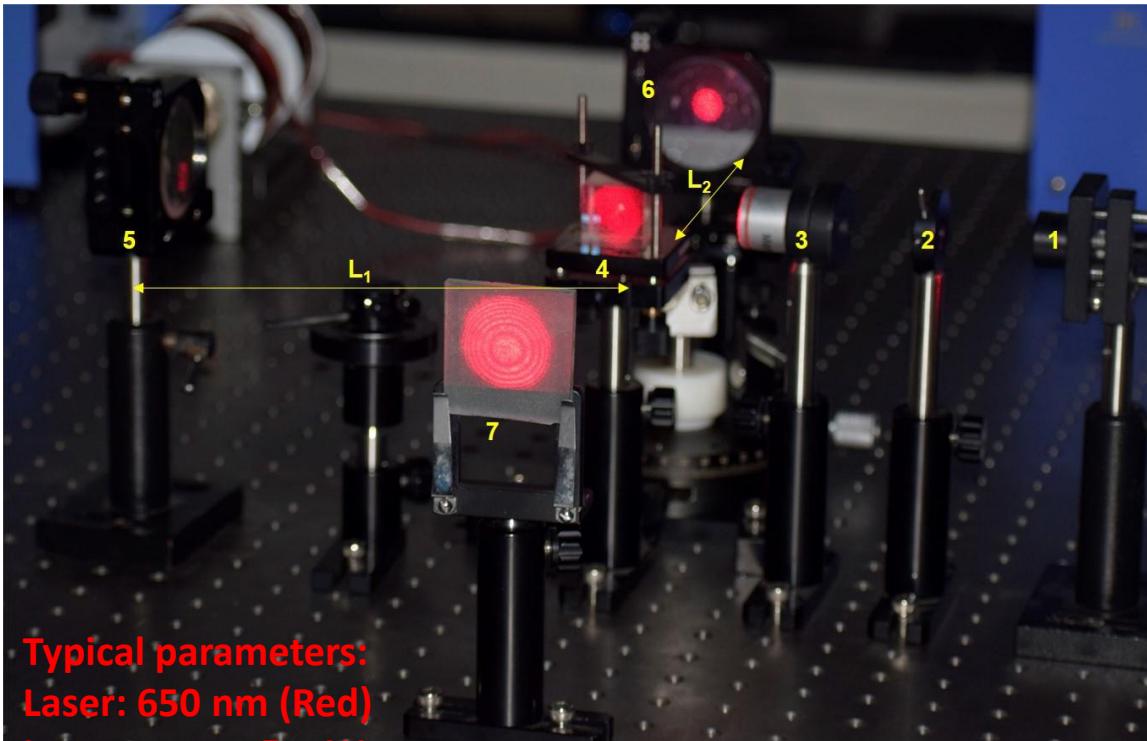


- Analysis of images using ImageJ software – Java based script
- Method developed for the analysis of structure identification & inter-structure distance . The method will be submitted to [github](#), and hence can be added as plug-in in the ImageJ software

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

Michelson Interferometer

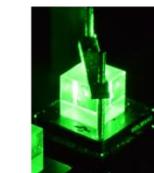
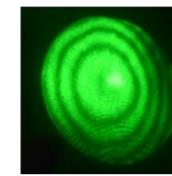
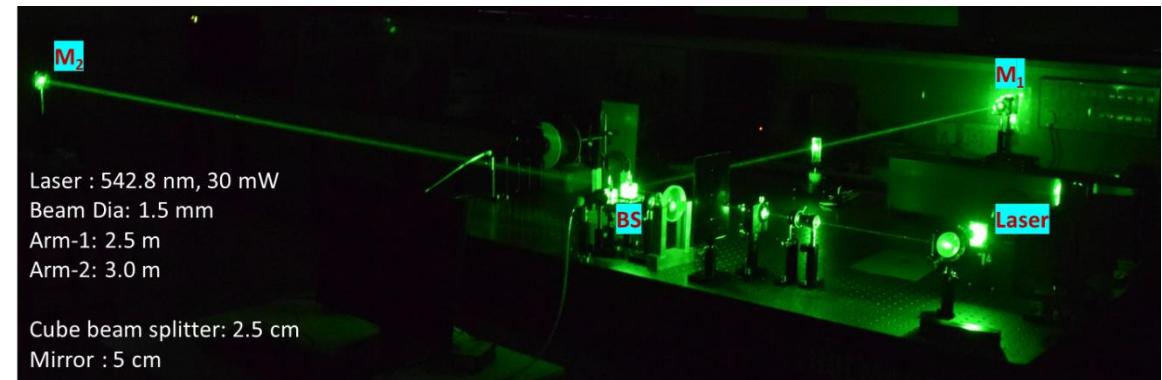


Typical parameters:

Laser: 650 nm (Red)

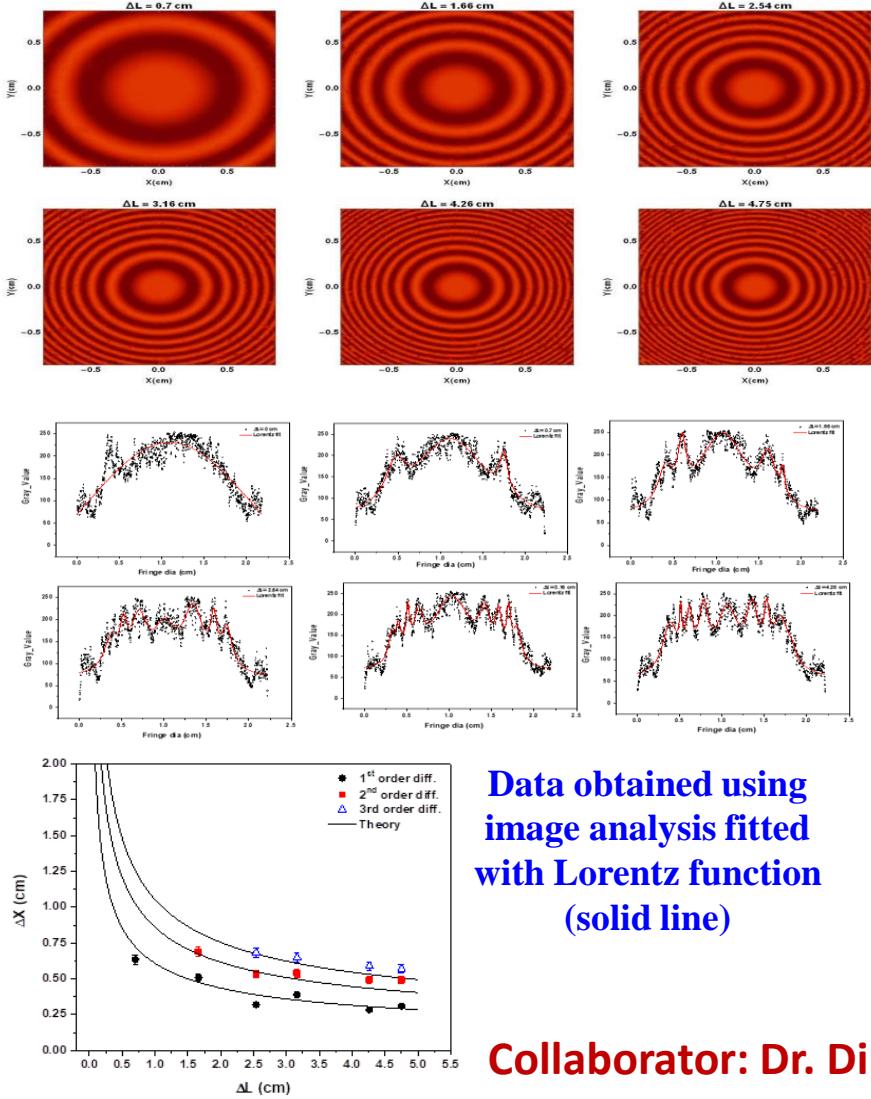
Laser power: 5 mW

Beam diameter: 0.3 cm

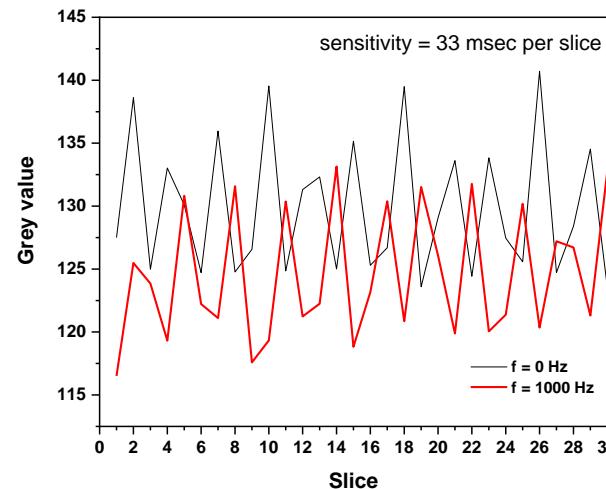
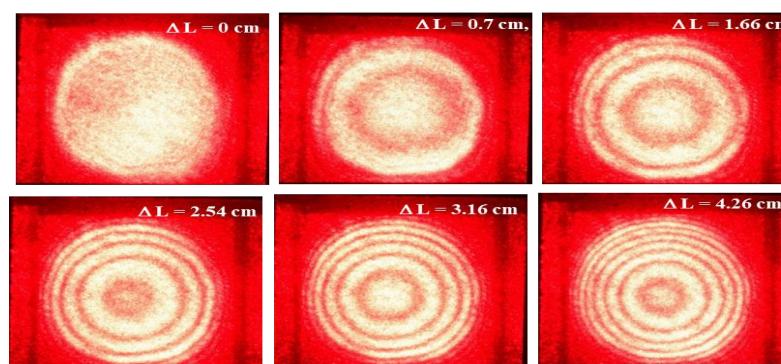


Michelson Interferometer: Applications

Simulated Interference pattern

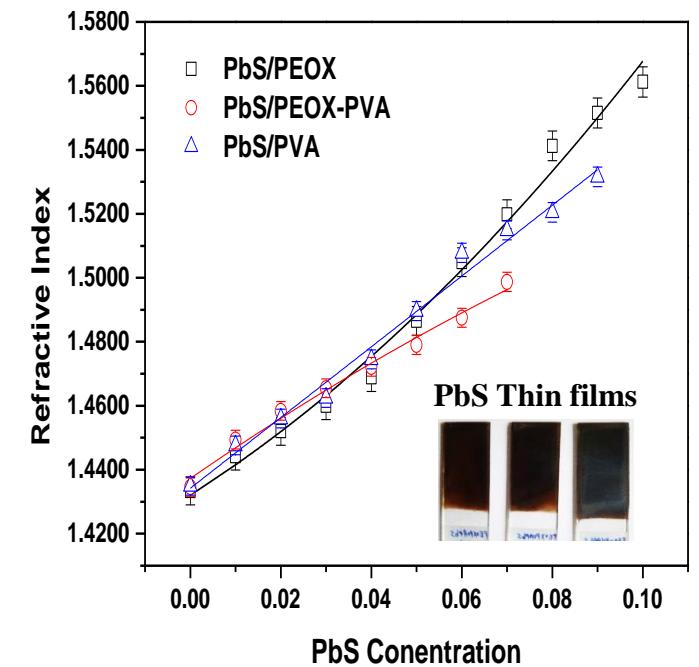


Experimental Interference pattern



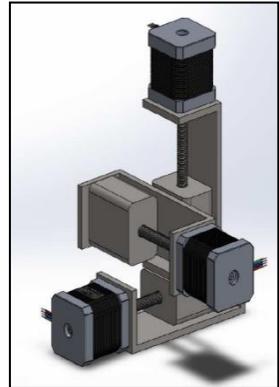
Effect of applied frequency on the interference pattern

Refractive Index measurement

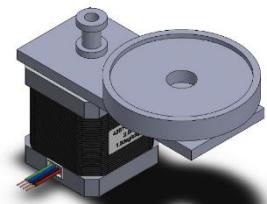


Collaborator: Dr. Vaibhav Patel & Group, Department of Chemical Sciences, PDPIAS, CHARUSAT

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

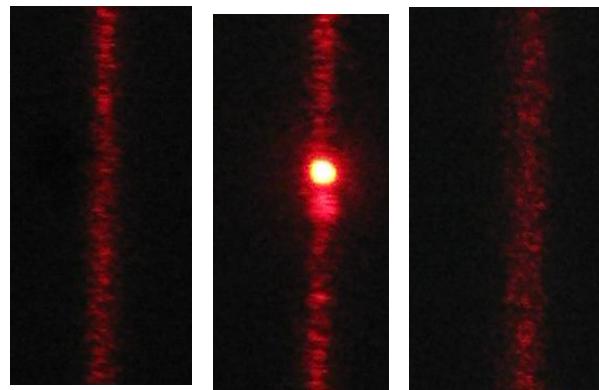


XYZ Stage



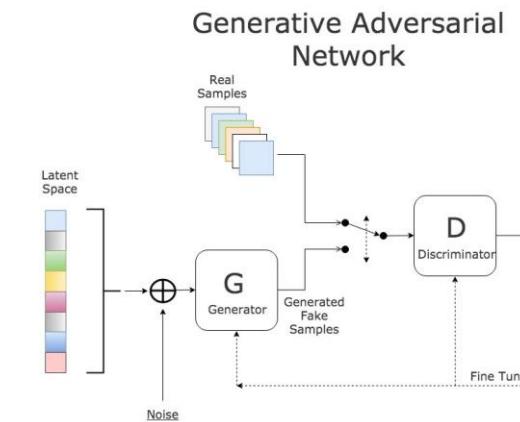
Rotary Stage

Investigators: Maulik shah & Axat patel
CSRTC, Charusat



Magnetic field induced diffraction pattern

Machine Learning for Image Generation: GAN

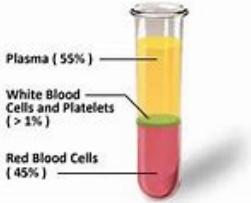


Collaborator: Dr. Parth Shah, Department of Information Technology, CSPIT, CHARUSAT



Biological Applications of Magnetic Nanoparticles

Total Protein Extraction



Blood / Plasma



Plant systems



Bacteria (extracellular and intracellular protein)

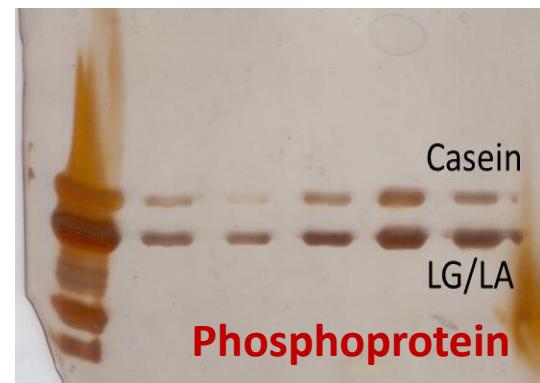


Collaborator: Dr. C N Ramchand

Protein Purification



Histidine tagged protein



Casein

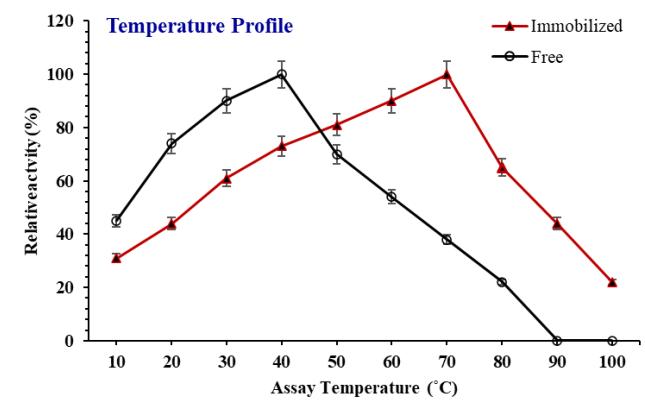
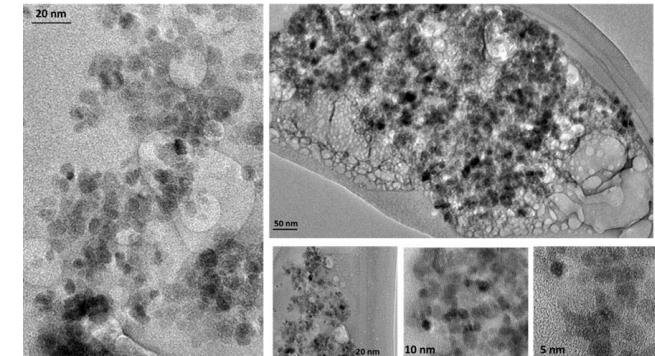
LG/LA

Phosphoprotein

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

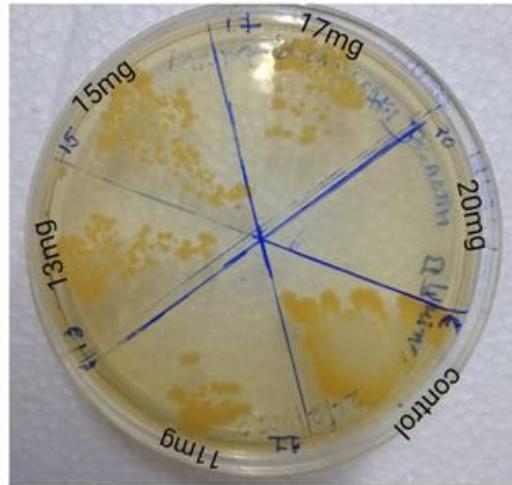


Figure 14 Antimicrobial activity on MRSA

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

Table 3 Result of antimicrobial activity

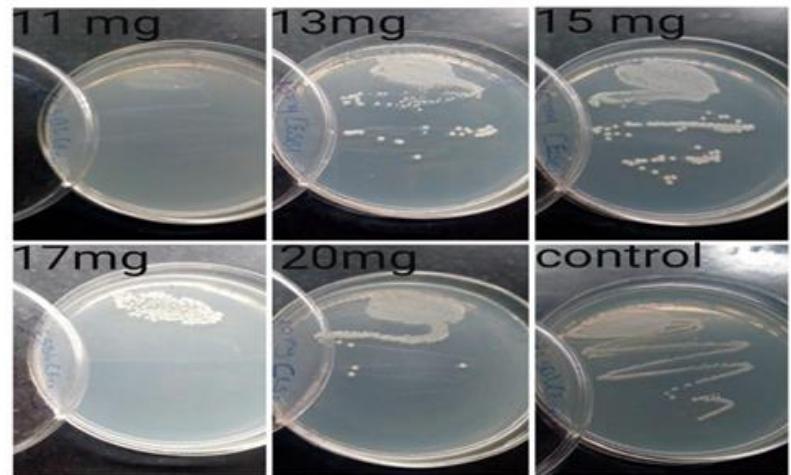
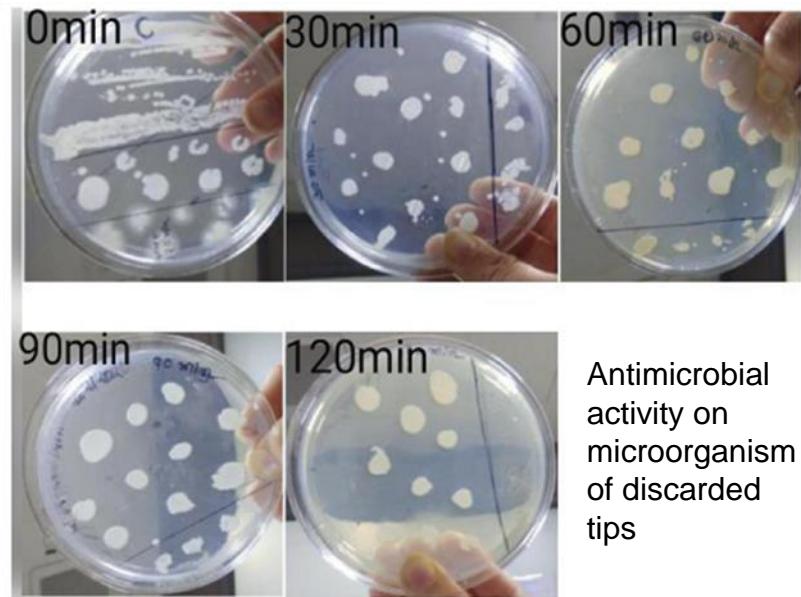


Figure 17 Antimicrobial activity on *E.coli* (ESBL)



Antimicrobial activity on microorganism of discarded tips