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

Research Areas

MR-Fluid and its Applications

MR-Fluid?? → **Magneto Rheological Fluid**

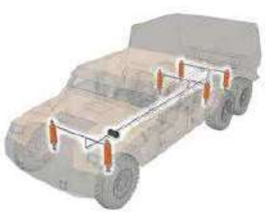
- Magneto: ferromagnetic particles of micron size
- Rheological: deformation and flow of matter in applied force
- Fluid: Carrier Liquids

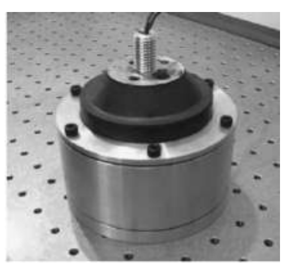
- **Front load Washing machine (Shear mode)**
- **Recoil system (flow Mode)**
- **Driver seat Suspension System (Flow mode)**
- **Military vehicle Suspension system (Flow mode)**
- **Suspension system of Four wheeler (Flow mode)**
- **Seismic Vibration absorber (Flow mode)**
- **Railway vibration absorber (Flow mode)**

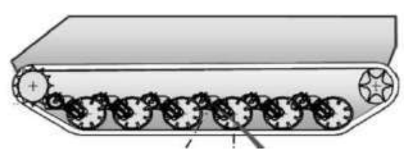
Industry collaboration →

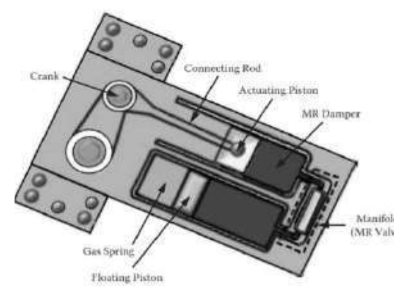
LUBGRAF SYNOILS PRIVATE LIMITED
ISO 9001:2015 CERTIFIED COMPANY

IMP Industrial Metal Powders (I) Pvt. Ltd.
(An ISO 9001, 14001, OHSAS 18001 & ISO 22000 Certified Company)





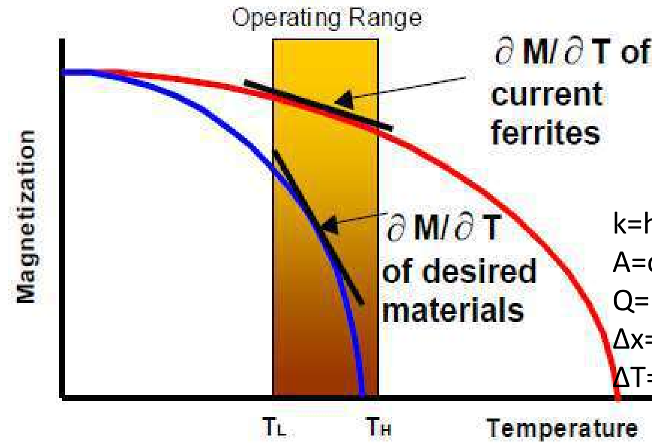




Temperature Sensitive Magnetic Fluid and its Applications in Heat Transfer Devices

(i) flow control by magnetic field and

(ii) Generation of fluid motion by thermal or magnetic means without moving any technical part



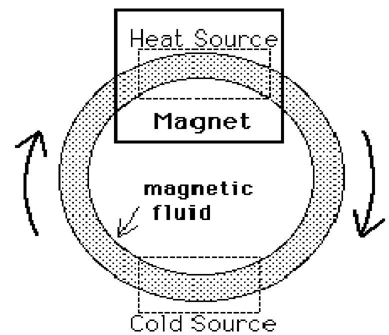
$$K = \frac{A}{Q}\frac{\Delta T}{\Delta x}$$

k=heat transfer co-efficient
A=cross sectional area
Q=heat flux
Δx=height of cell
ΔT=temp difference

Collaborators
PLASVAC, A'bad /SAS, Slovakia

Large scale production
8 kg particles batch

Transformer coolant



Kinnari Parekh et. al International Journal of Thermal Sciences 103 (2016) 35-40. 114 (2017) 64-71.

Future collaborations

Need CFD /COMSOL multiphysics for fluid dynamics study / Enhance electrical resistivity / field study

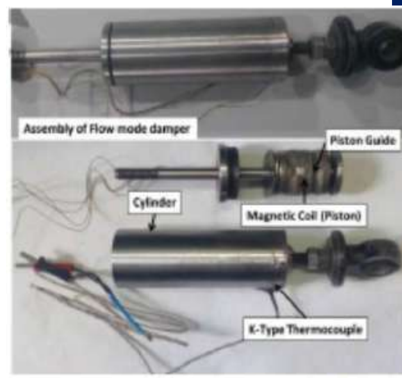
Interdisciplinary Research

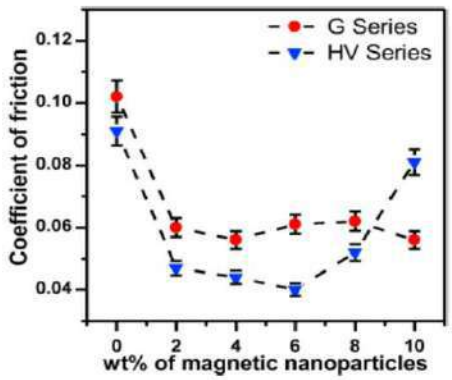
Tribology study

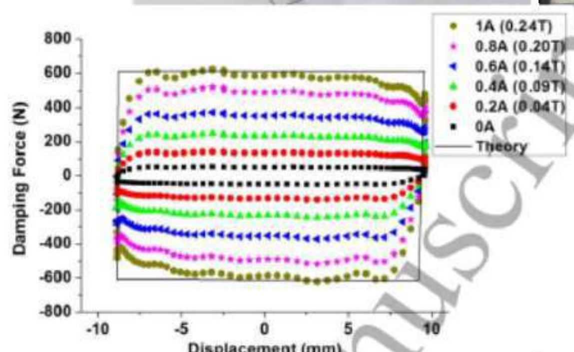
Mechanical Engineering

MR Damper

Four Ball Tester





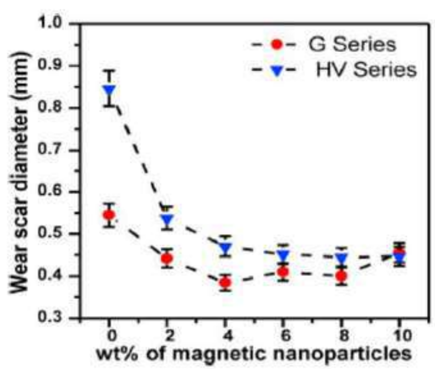


Brazilian Journal of Physics
https://doi.org/10.1007/s13538-020-00781-8

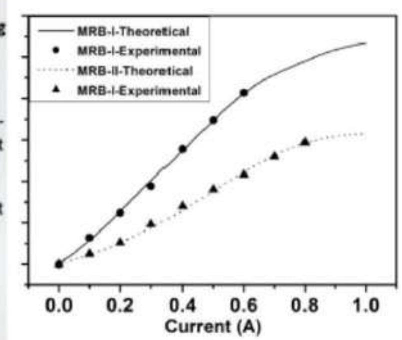
doi:10.1088/1757-899X/992/1/012004

Brazilian Journal of Physics
https://doi.org/10.1007/s13538-019-00711-3

Mater. Res. Express 6 (2019) 015707



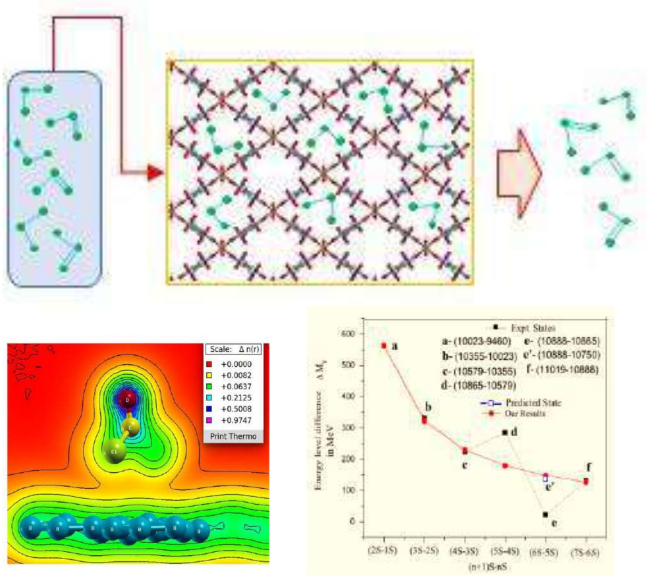
MR Brake



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

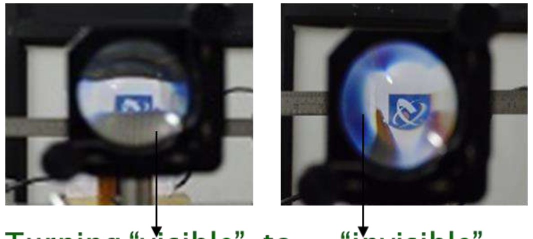
Research Areas

Engineering of Nanomaterials

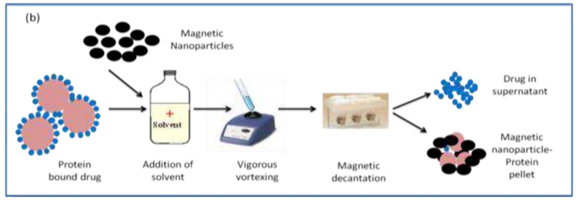


Theoretical Physics (Condensed Mater and High Energy Physics)

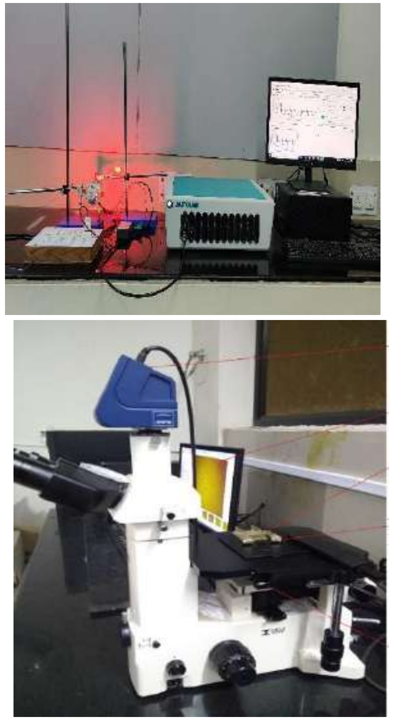
OPTICAL CLOAKING



Turning “visible” to “invisible”



Optics and applications of nanoparticles and magnetic fluids



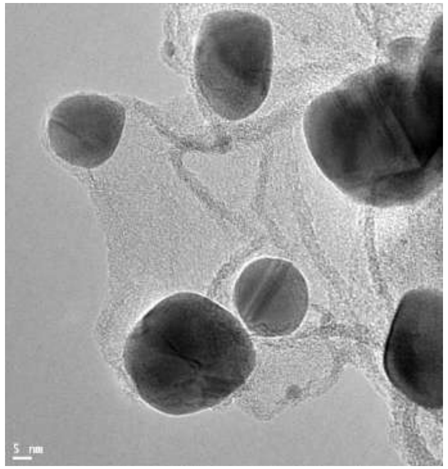
Characterization facilities

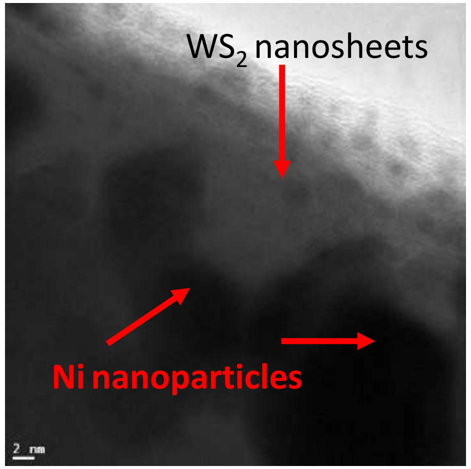
Research Areas: Engineering of Nanomaterials: Applications, devices and systems

Nano Materials

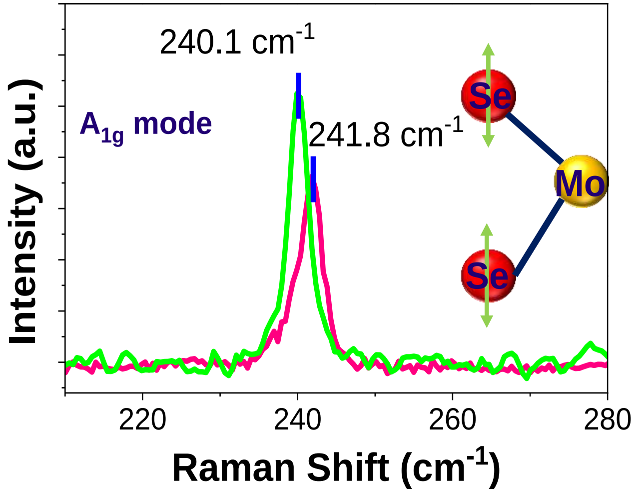
2D-Materials	**Nano Particles**	**Thin films**	**Heterostructures**
Transition metal dichalcogenides, Graphene	Transition metal oxides, Transition metals	Transition metal dichalcogenides	TMDC/TMO, TMDC/TM

Analysis of nanomaterials by HR-TERM





Raman spectra of $MoSe_2$ nanosheets

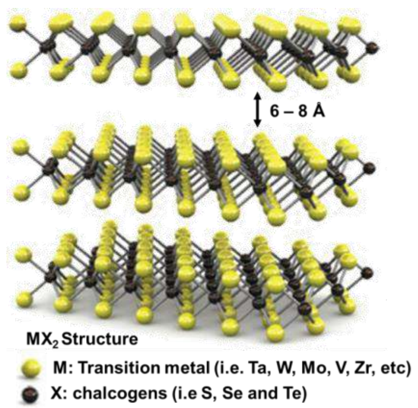


Dr. C. K. Sumesh & group

Our expertise:

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

2D TMDC and analogous materials



Quality Parameters:

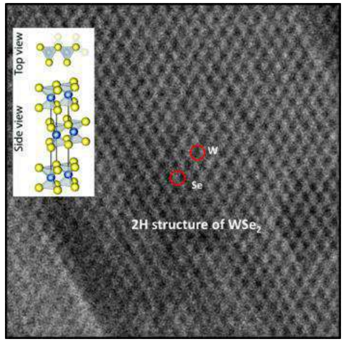
- Tunable optical bandgap
- High surface area
- Easy to functionalize
- complementary material to graphene

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

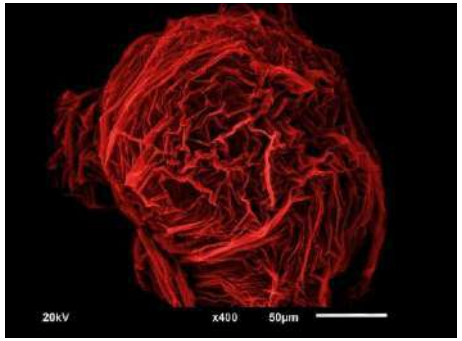
Transition Metal Oxides (TMO) (eg. MoO_3**,** WO_3**, Cu based Oxides)**

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	

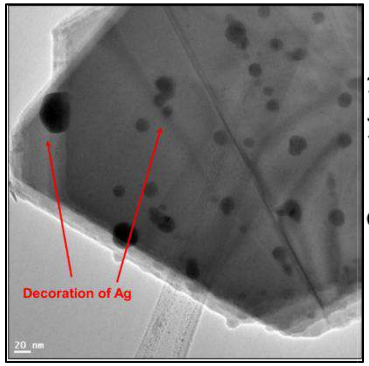
Results



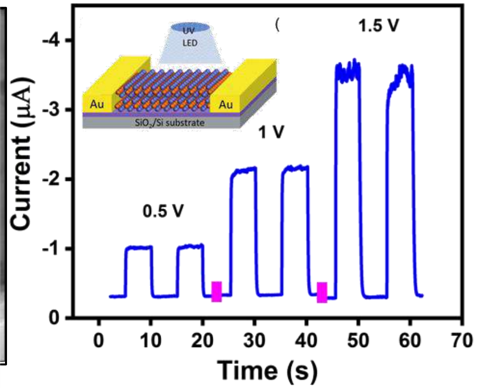
HRTEM image of the WSe_2 *nanosheet represents the honeycomb structure Prepared by*



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**



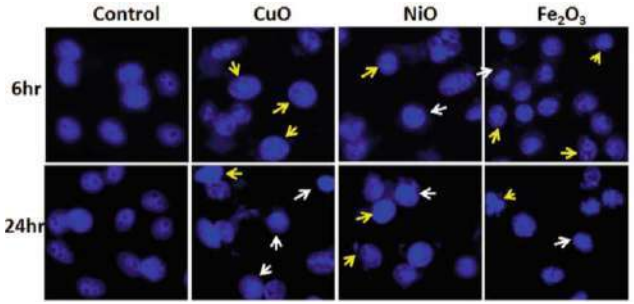
I-T curves of WSe_2 **nanosheets photodetector with and without illumination**

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**

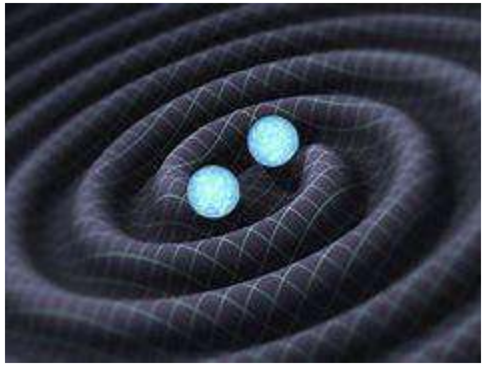
Dr. Kamlesh Chauhan, CSPIT

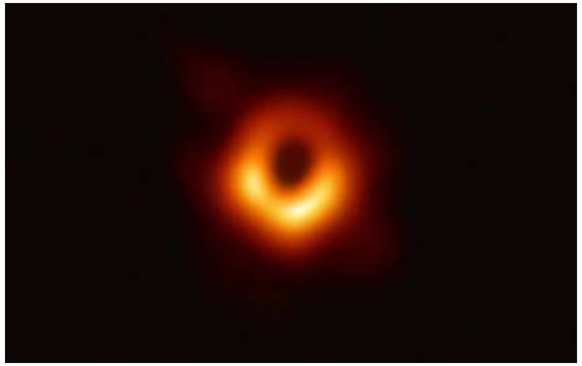
Dr. Sanni Kapatel

Research in Theoretical Physics

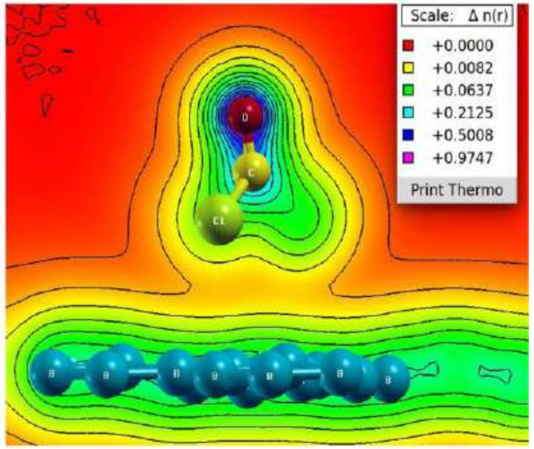
Research Areas : Astrophysics and Cosmology

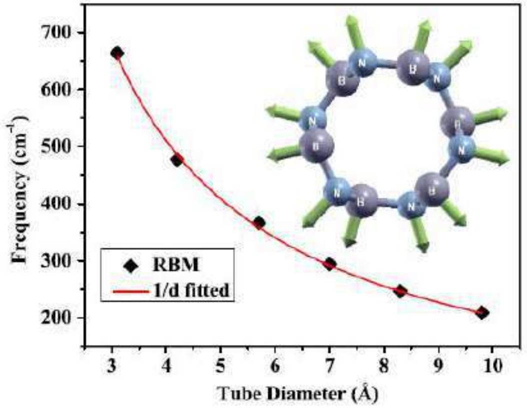
- Black-hole Physics
- Small scale structure formation
- Gravitational Wave
- Digital Image Processing
- Gravitational collapse of stars
- Gravitational lensing and shadows
- Astrometry
- Engineering applications in the field of cosmology





To investigate properties of materials at Nanoscale..



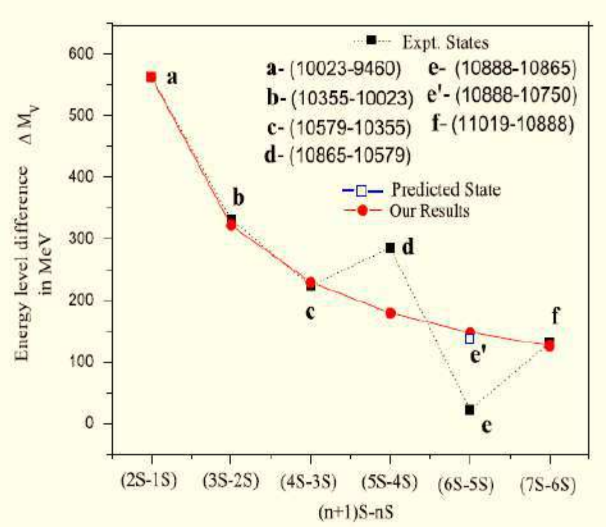


Dr. Shweta Dabhi

Theoretical High Energy Physics, Hadron Physics

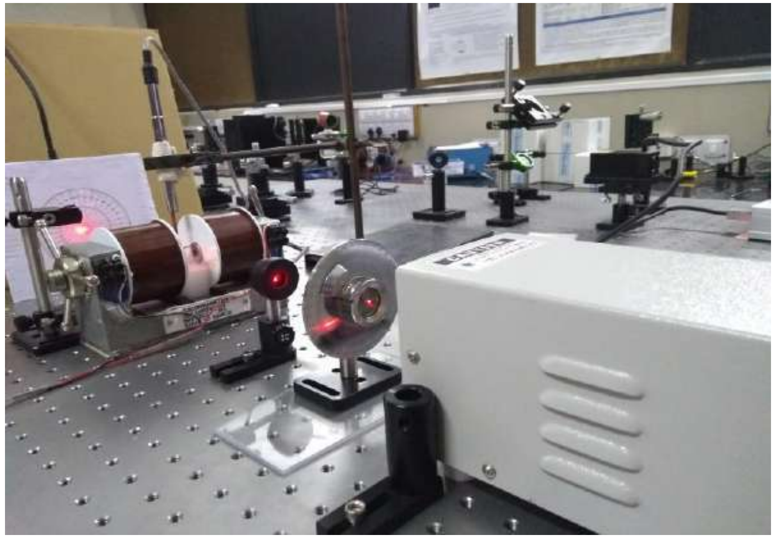
Area of Interest :

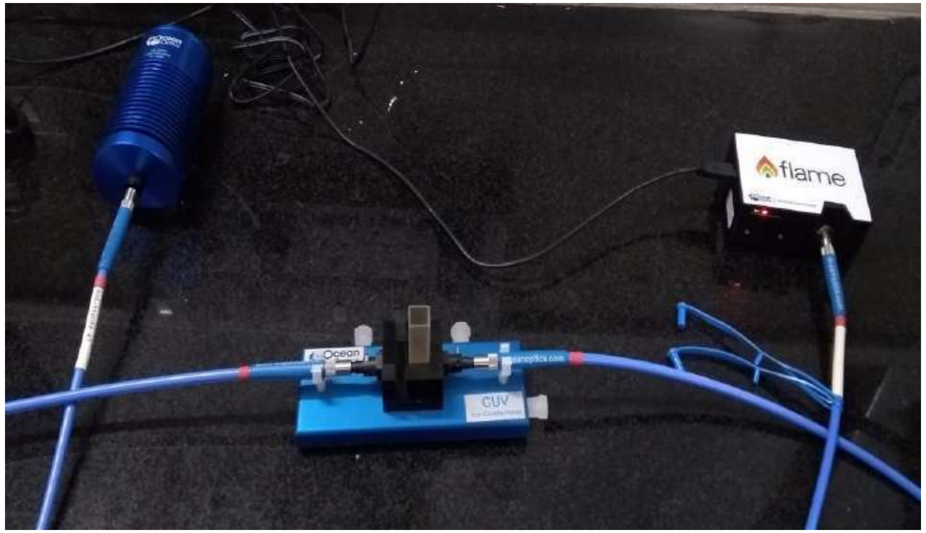
- Mass spectra of Meson
- Decay properties of Meson
- Exotics states
- Masses of tetraquark states in the hidden charm sector

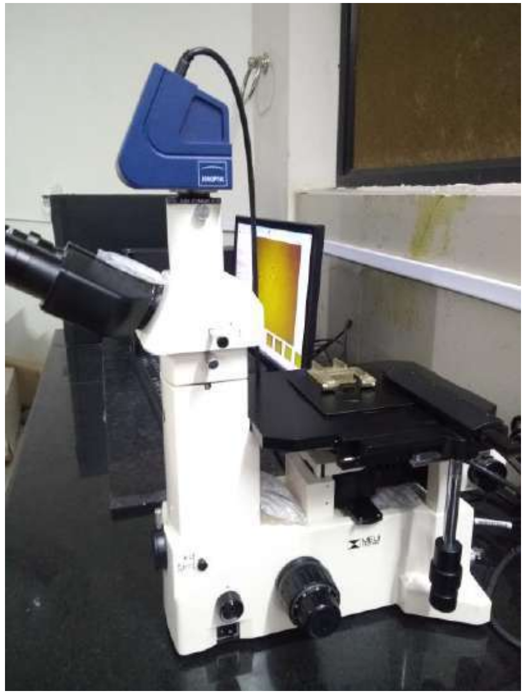


Dr. Manan Shah

Optical Characterization Facility







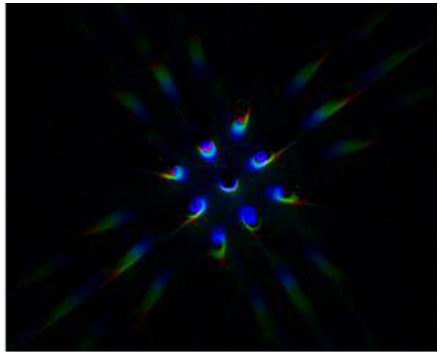
Lasers:
- ➢ **He-Ne Red laser (632 nm, 5mW)**
- ➢ **Diode Green laser (532 nm, 30mW)**
- ➢ **He-Cd laser (442 nm, 30mW)**

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**

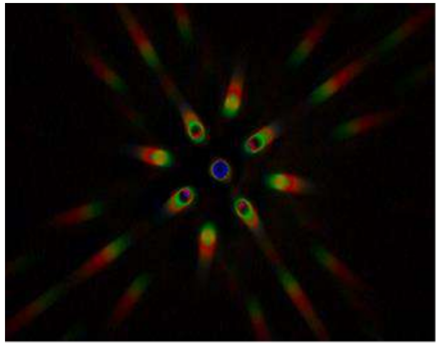
- **Inverted Metallurgical Microscope (Make: Meiji, Japan- IM7200)**
- **Calibrated Scale**
- **Polarizer**
- **Color CCD camera (make: Jenoptik, German, Resolution: 2080×1542 pixel)**

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

Magnetic Fluid based Tunable Diffraction Grating

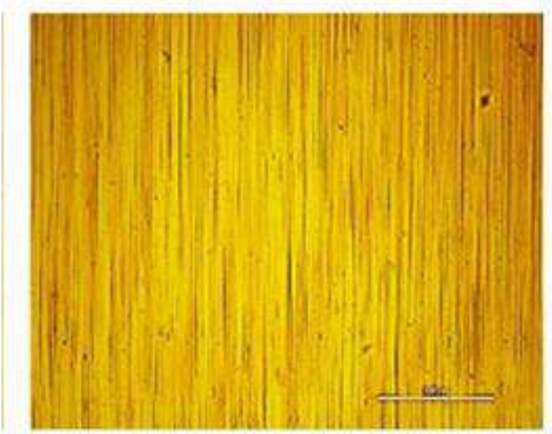


H= 0 G

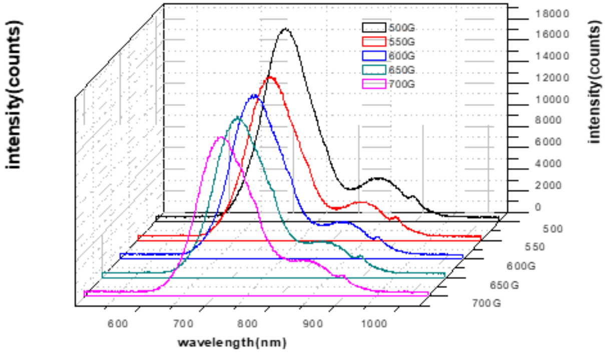


H=370G, T=240sec

Field off H=0,T=30sec

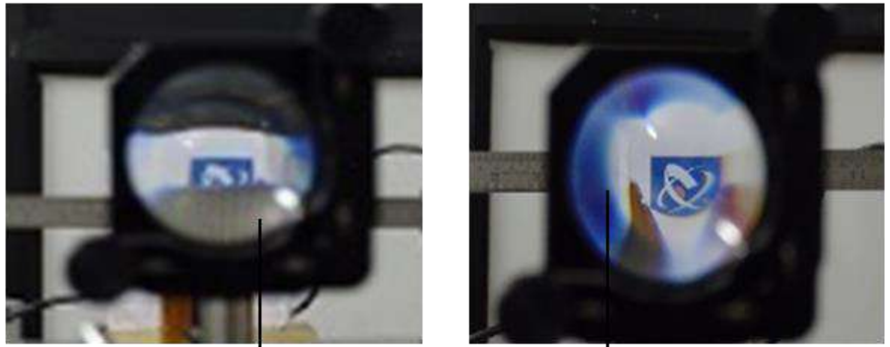


Magnetic field induced chain formation – Microscopic image

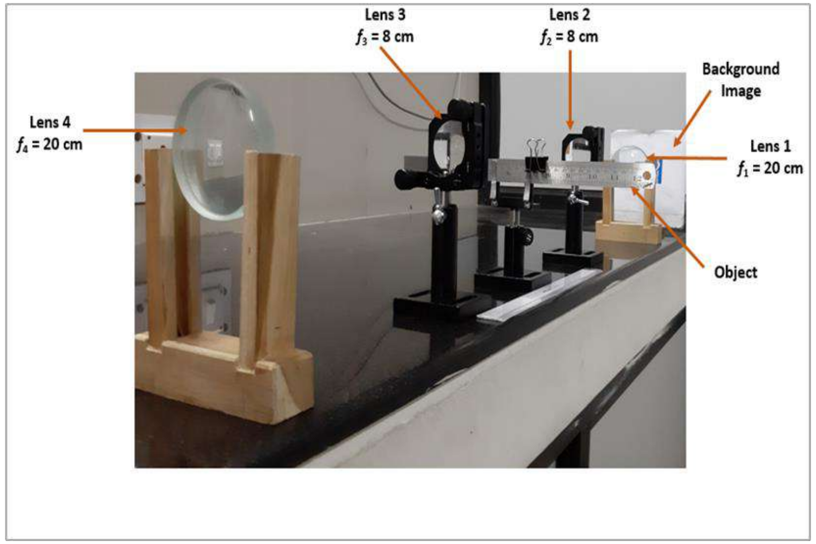


White light spectroscopy – MF as monochromator

OPTICAL CLOAKING

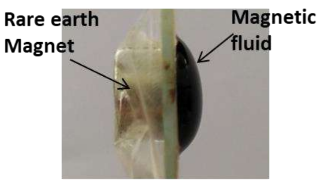


Turning "visible" to "invisible"

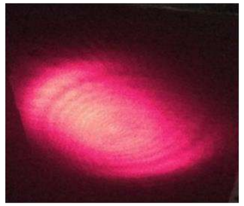


- One-way cloaking
- Two-way cloaking

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

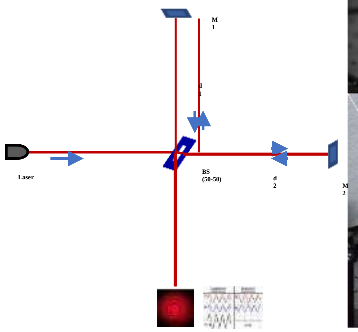
Incident light

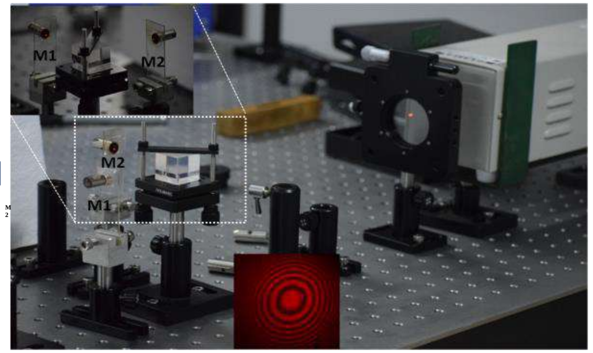
Reflected Beam

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

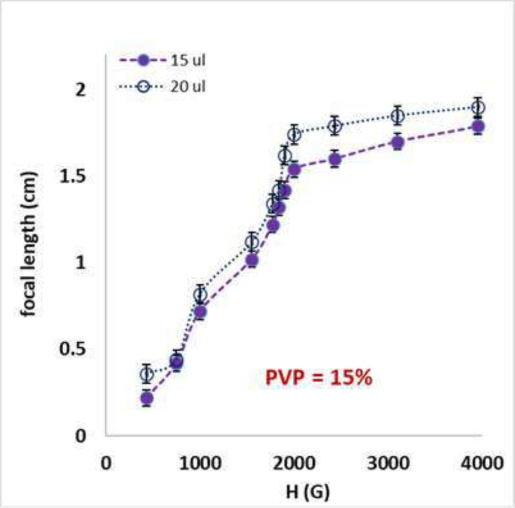
Michelson Interferometer: An application

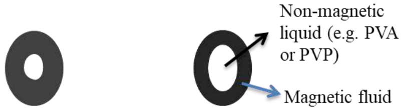
Michelson Interferometer





Adaptive Liquid Lens

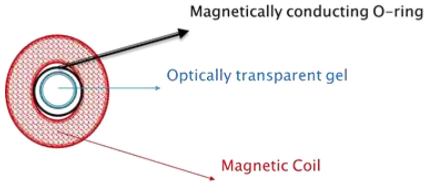




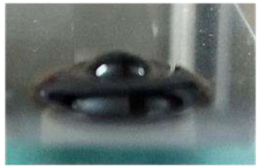
H=1250 G

H=4250 G

Magnetic fluid=40µL



Side view of Curvatures at different magnetic fields



H= 1000 G

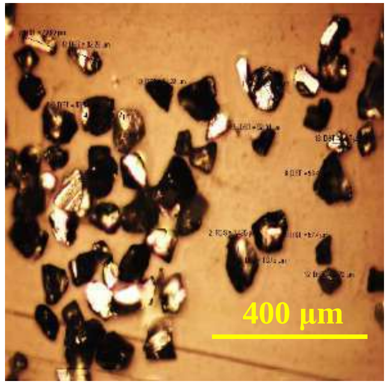
H= 750 G

H= 430 G

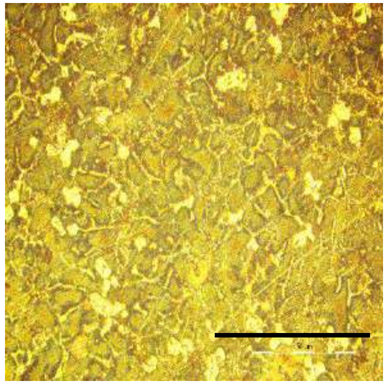
Scope for collaboration

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

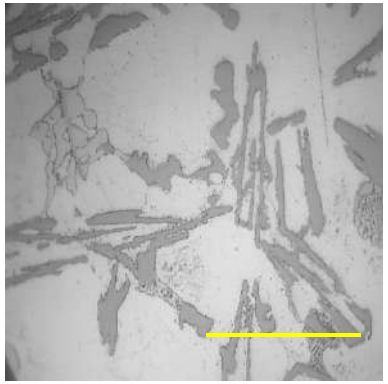
Inverted Metallurgical Microscope – University users



Al Particles



Al - Composite

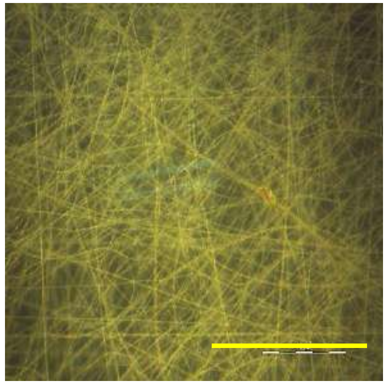


Material Surface

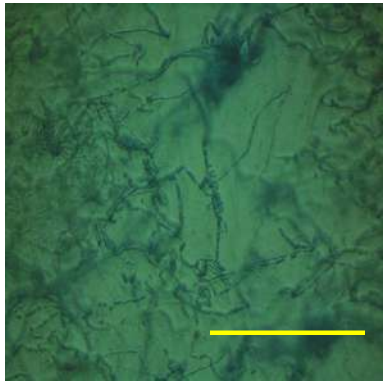
Dr. Mayur Sutaria & Group, Mechanical Engineering, CSPIT, CHARUSAT

Variable Polarization

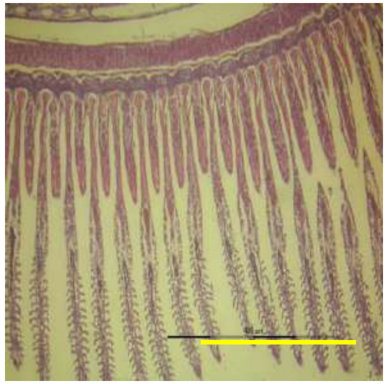
Inverted Metallurgical Microscope (Make: Meiji, Japan- IM7200) equipped with CCD camera (make: Jenoptik, German, Resolution: 2080×1542 pixel)



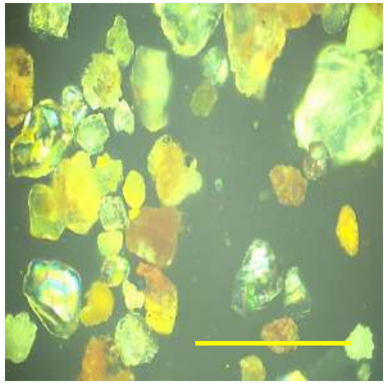
Fiber Dimensions

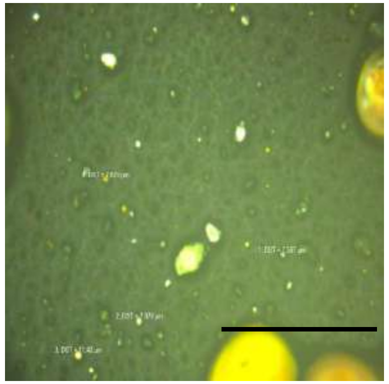


Hyphae Fungus



Fish Bone



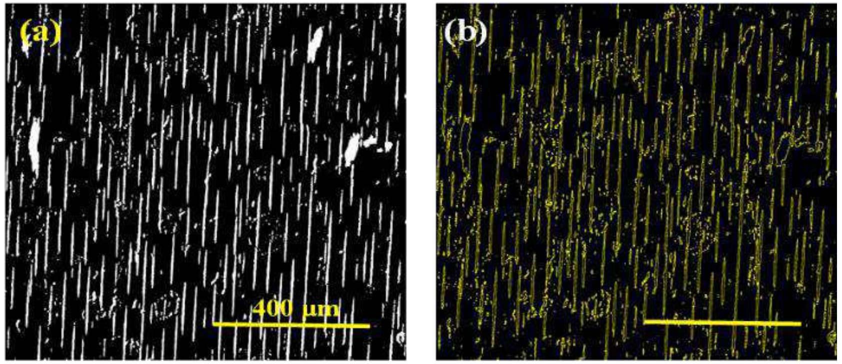


Sand Particles

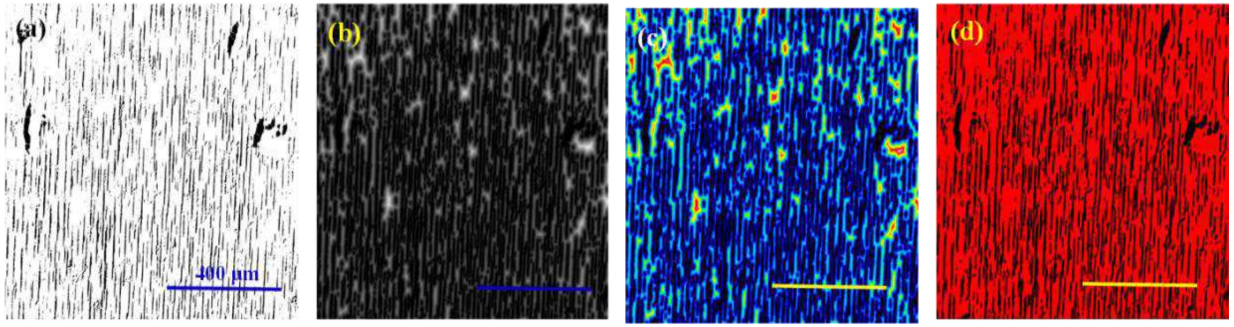
Dr. Vaibhav Patel, PDPIAS Dr. Kiran Patel, PDPIAS Dr. Chirayu Desai, PDPIAS

Dr. Prabin S. Civil Engineering, CSPIT, CHARUSAT

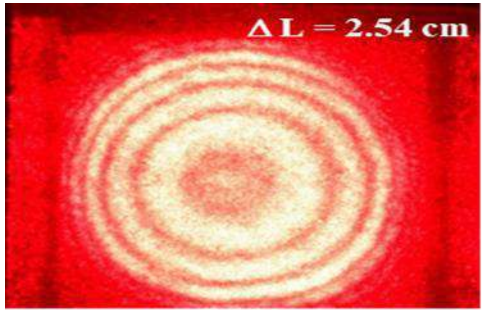
Image Analysis



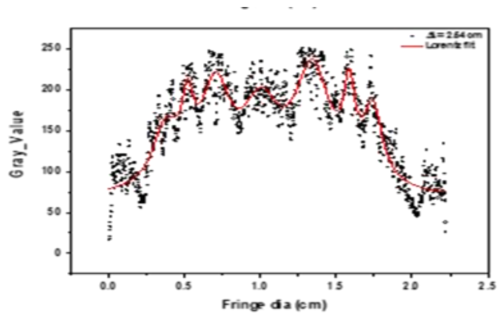
Structure identification



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

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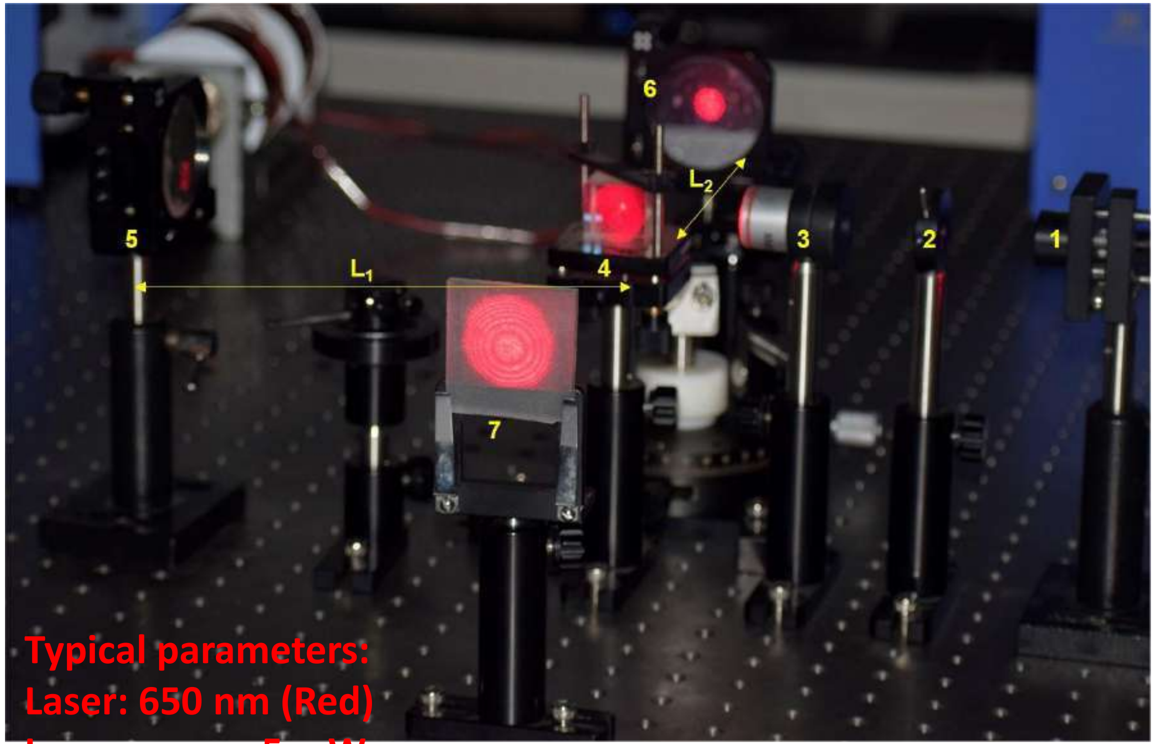
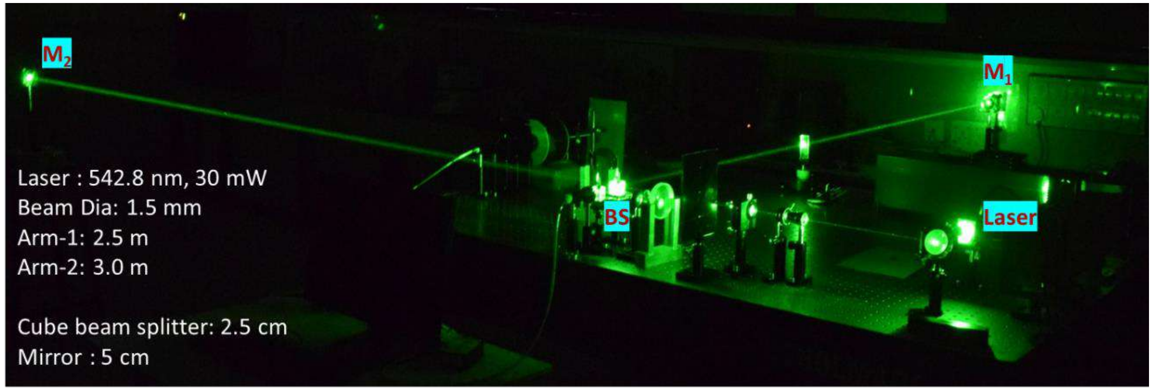
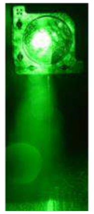
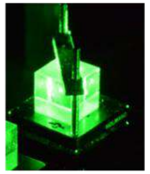
Michelson Interferometer

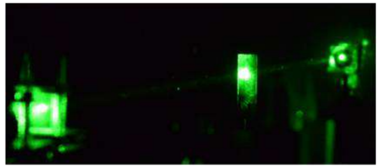


Typical parameters:
Laser: 650 nm (Red)
Laser power: 5 mW
Beam diameter: 0.3 cm



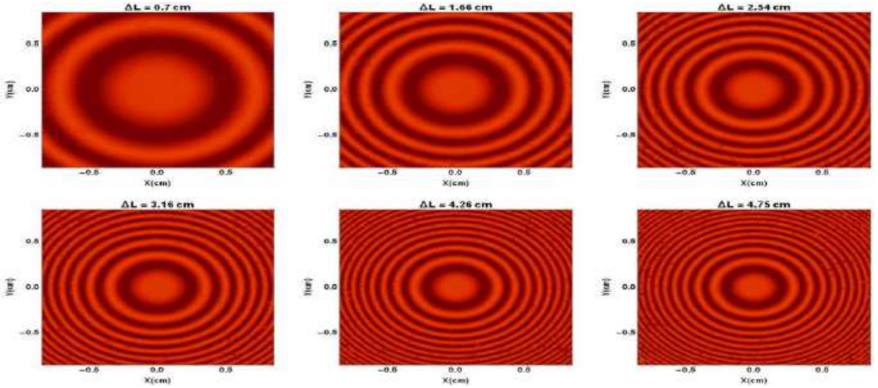


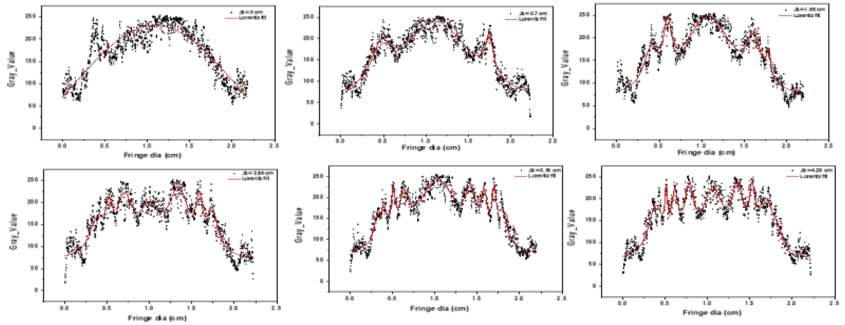


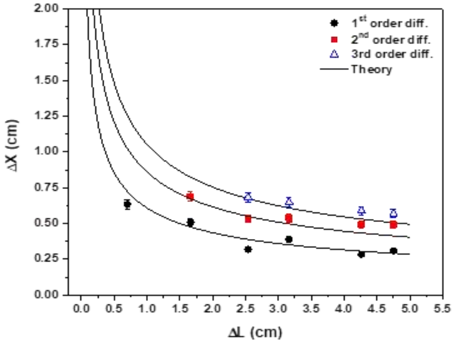


Michelson Interferometer: Applications

Simulated Interference pattern

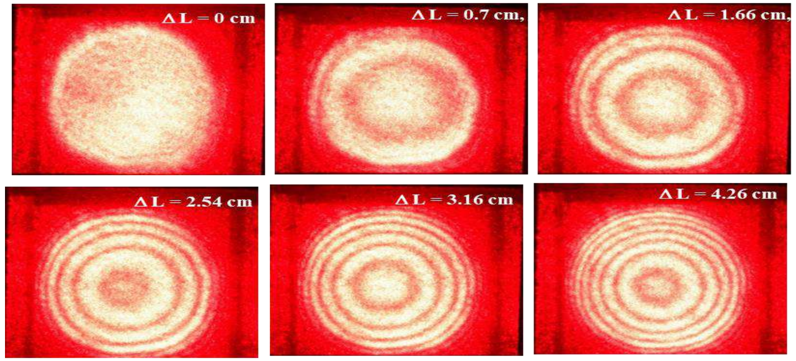


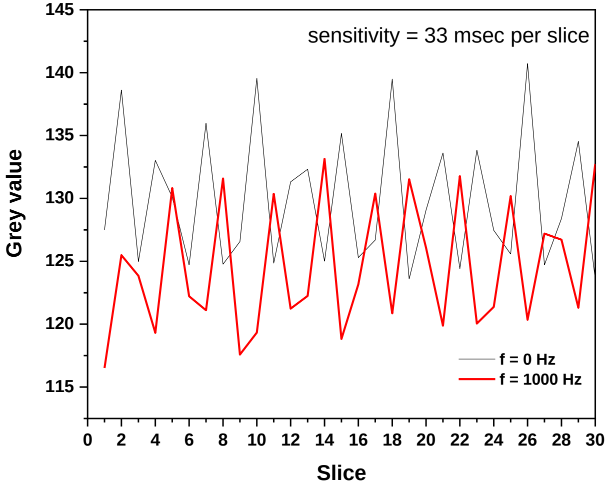




Data obtained using image analysis fitted with Lorentz function (solid line)

Experimental Interference pattern

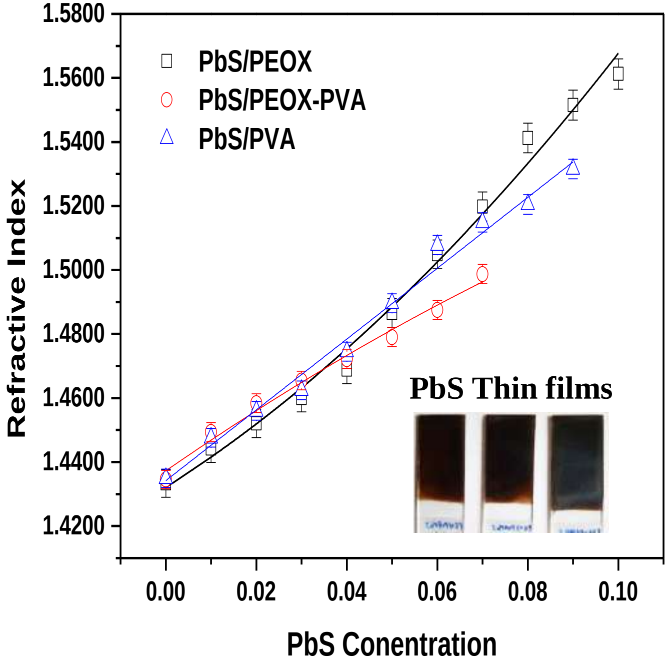




Effect of applied frequency on the interference pattern

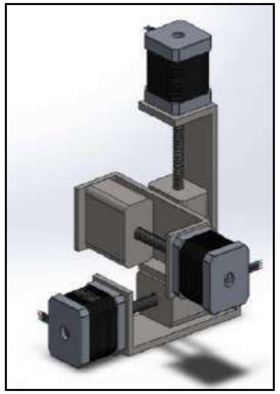
Collaborator: Dr. Dipanjan Dey, Dr. Pankaj S Joshi, ICC, Charusat

Refractive Index measurement

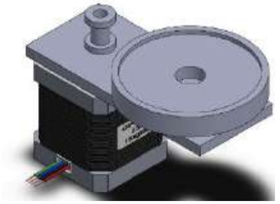


Collaborator: Dr. Vaibhav Patel & Group, Department of Chemical Sciences, PDPIAS, CHARUSAT

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



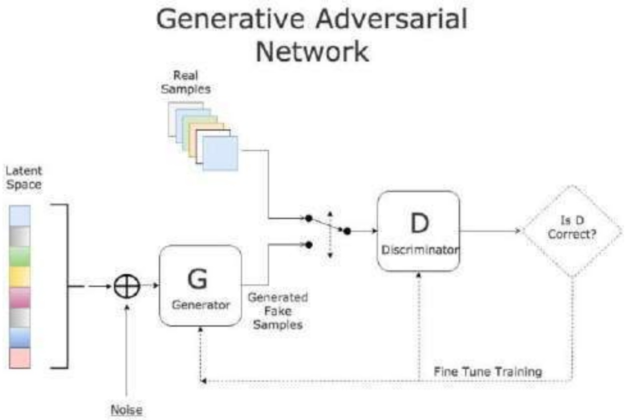
XYZ Stage



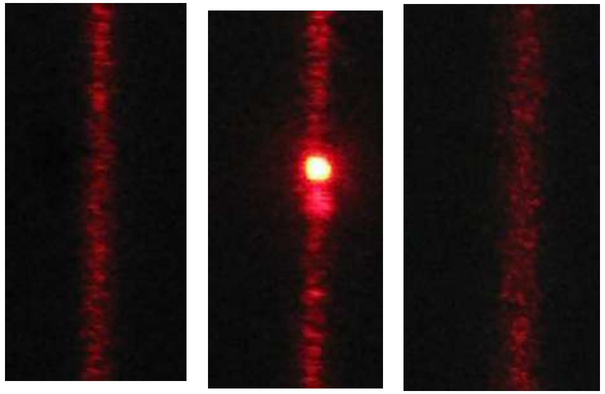
Rotary Stage

Investigators: Maulik shah & Axat patel
CSRTC, Charusat

Machine Learning for Image Generation: GAN



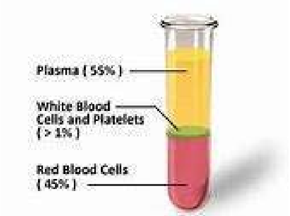
Collaborator: Dr. Parth Shah, Department of Information Technology, CSPIT, CHARUSAT



Magnetic field induced diffraction pattern

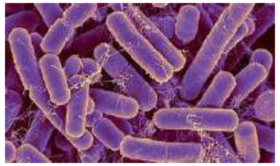
Biological Applications of Magnetic Nanoparticles

Total Protein Extraction



Blood / Plasma

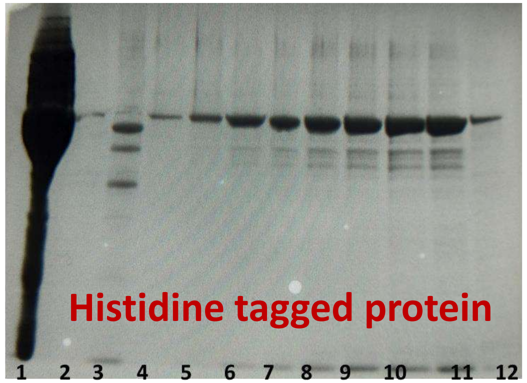
Plant systems

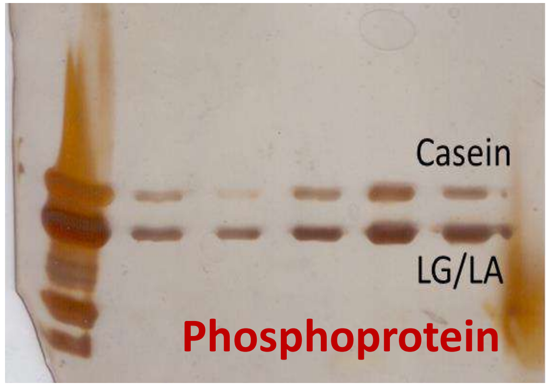


Bacteria (extracellular and intracellular protein)

Collaborator: Dr. C N Ramchand

Protein Purification

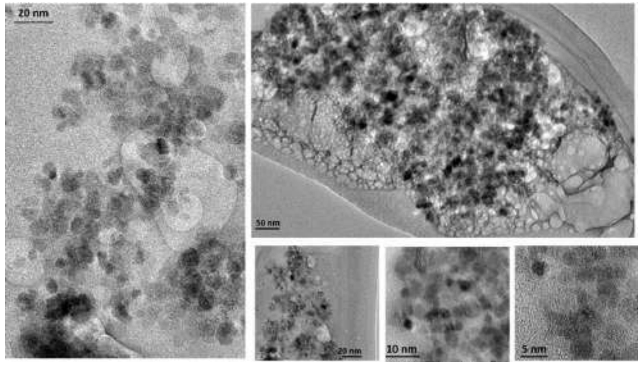


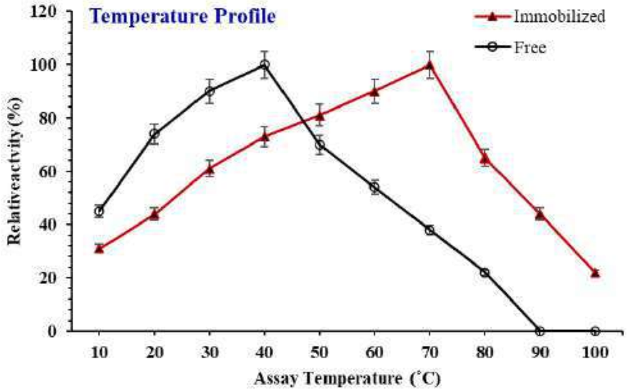


Collaborators:

- 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

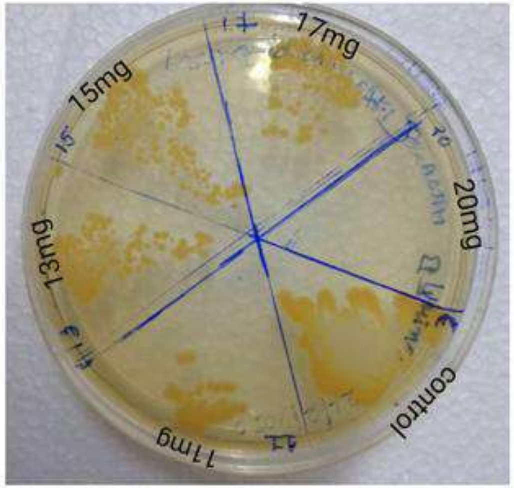


Figure 14 Antimicrobial activity on MRSA

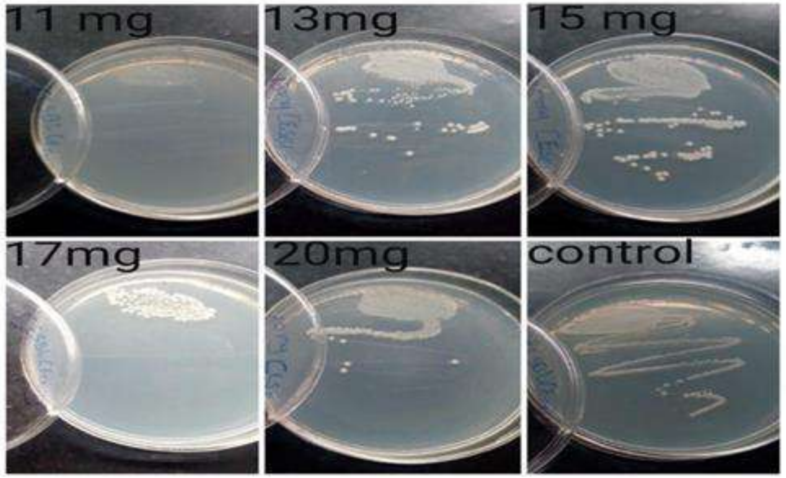
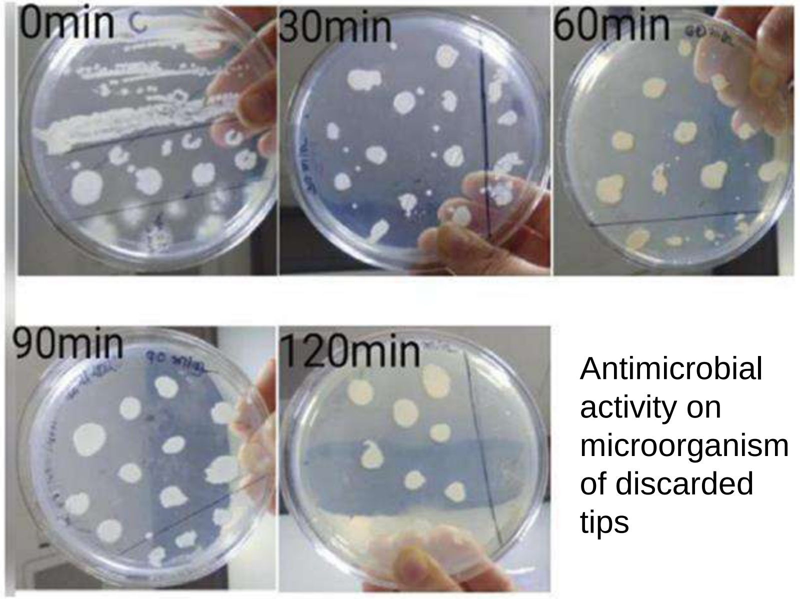


Figure 17 Antimicrobial activity on *E.coli* (ESBL)

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