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INSTITUTE OF ADVANCED STUDY IN SCIENCE AND TECHNOLOGY
GUWAHATI
1979

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R & D Programme and Progress 2013-14:

The Institute of Advanced Study in Science and Technology, Guwahati, Assam is engaged in multi disciplinary research activities, both in fundamental and applied, across frontier areas of science and technology such as Plasma physics, Polymer Sciences, Biochemistry, Drug design & development, Nano-science, Medicinal plants, Seri biotechnology, Microbial biotechnology, Environmental Sciences, Microbial Fuel Cell etc.

Five major research programmes of the Institute are :

i) Plasma process- Theory & Applications
ii) Polymer and Advanced material sciences
iii) Computational and numerical sciences
iv) Bio-Diversity & Eco-system research
v) Traditional knowledge based drug design, development and delivery

Research focus of these frontier areas is to generate scientific knowledge and technologies for utilization of resources of North Eastern Region and to contribute towards overall scientific and economic growth of the country.

Two Major divisions of the Institute oversee the five R & D programs

1. Physical Sciences Division (Centre for Computation & Numerical Sciences, Plasma, Polymer sections).
2. Life Sciences Division (Biological & Chemical Sciences and Resource Management & Environment Sciences Sections).

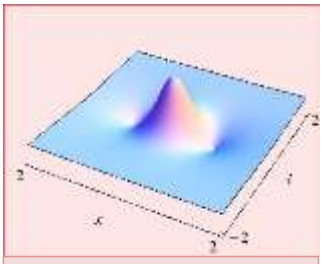
Major research and development accomplishments during the year in the major research programmes

1. Plasma process- Theory & Applications

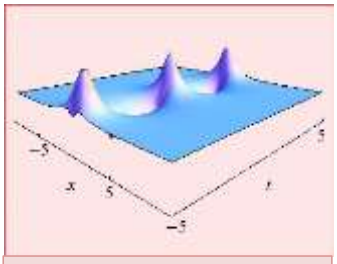
Basic Plasma

- Investigation Various nonlinear phenomena of plasmas e.g. ion acoustic solitons, sheath and sheath induced instabilities, wave particle interaction, chaotic phenomena.
- Waves and Instabilities in Multicomponent and Dusty Plasma.

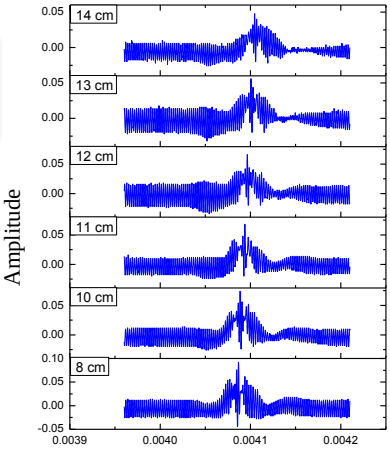
Observation of Peregrine solitons (Rouge wave) in multicomponent plasma



Peregrine solitons of NLSC



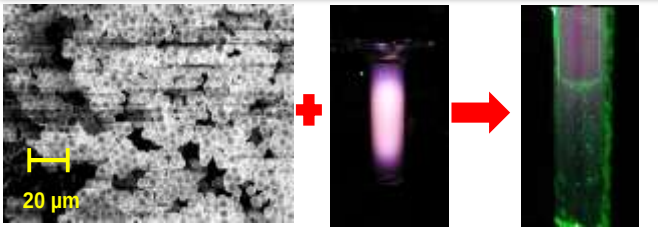
Breather soliton of NLSC



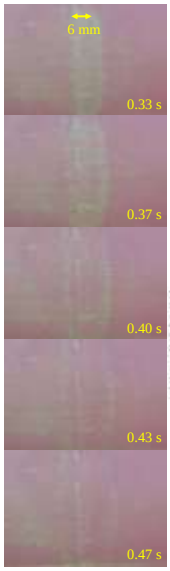
Time in seconds

Experimental temporal profile of **Peregrine soliton** in Laboratory

Waves and Instabilities in Dusty Plasma

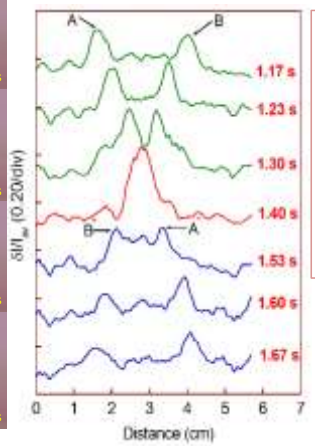


Dusty plasma set up



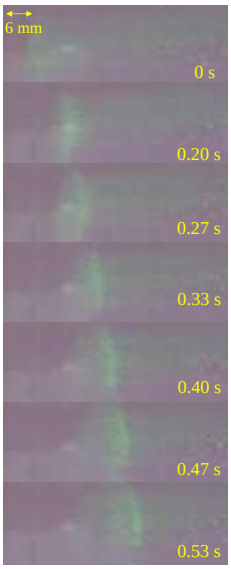
Laboratory observation of Dust acoustic wave

Laboratory observation of Dust acoustic solitary wave



- These Solitary waves are similar to the Tsunami waves of Ocean described by Korteweg de Vries equation.
- Solitons are solitary waves which survives collision with another solitary wave

Spatial profile on Head on collision of Dust acoustic solitary waves



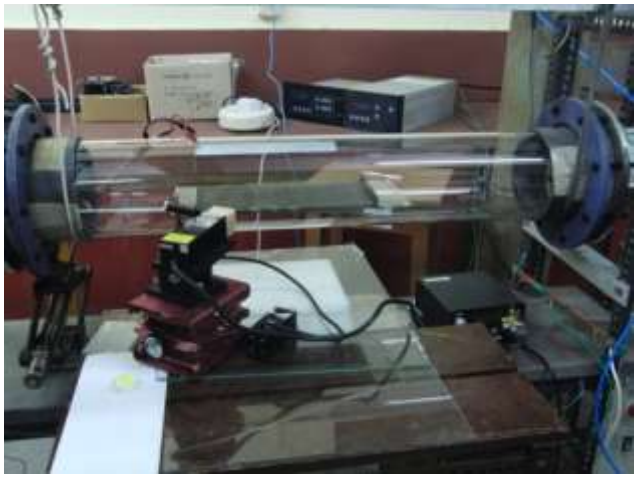
(1) Basic dusty plasma phenomena

Dust Acoustic Solitons:

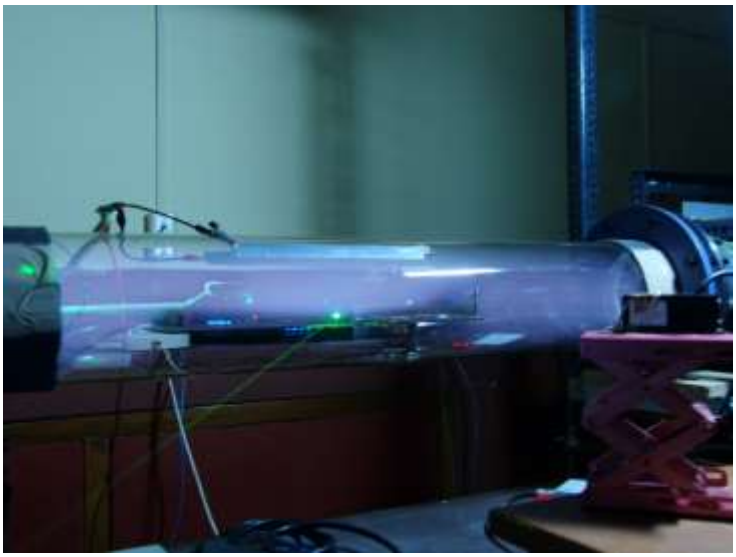
Plasma with micron size dust particles as additional species supports some very low frequency new wave modes. Dust acoustic mode is one of these modes which resembles with the well-known ion acoustic waves in two component plasmas. We designed a novel technique to excite low frequency dust acoustic (DA) perturbations in a radio frequency dusty plasma device. Characteristics of linear dust acoustic wave (DAW) and nonlinear DA soliton are studied in a strongly coupled dusty plasma. Head on collision between two DA solitons is observed for the first time.

Experimental setup and procedure

Experiment is performed in a newly installed setup (100 cm in length and 15 cm in diameter) at IASST. Argon plasma is produced by applying rf power (2 - 10 W) at pressure 0.1 – 2.0 Pa. A rectangular graphite plate (30 cm x 14.5 cm x 0.2 cm) is kept horizontally inside the chamber with vertical fencing at both ends (Figure below). Gold coated silica particles (~5 μm diameter) are injected into the plasma by using a piezoelectric buzzer. The particle cloud (~ 2-3 mm thick) levitating (~0.8 – 1 cm) above the plate is illuminated by green laser sheet and is recorded in a high resolution digital camera (First Figure in the next page). The working pressure is maintained in the range 0.5 to 2.0 Pa so that the particles remain in the fluid like state i.e. the coupling parameter Γ lies in the range $1 << \Gamma < \Gamma_c$. Typical values of electron and ion densities ~ 10^8 cm^{-3}, electron temperature ~ 5 eV, ion temperature ~ 0.1 eV, dust charge ~ 10^4 electron charge, dust density ~ 10^3 cm^{-3}, dust temperature ~ 0.03 eV.



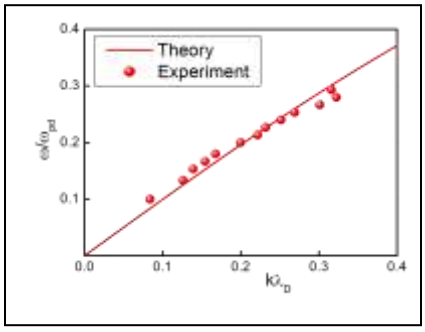
Dusty Plasma experimental Device



RF plasma with 532 nm Laser for dust illumination

Excitation of dust acoustic wave and measurement of its dispersion relation

The DAW is a low frequency wave (of the order of few tens of Hz) where the inertia is provided by dust mass and electron and ion pressure provide restoring force to sustain the wave. DAW is excited by applying a continuous small amplitude sinusoidal signal (1 – 20 Hz) to the exciter E1. The exciter is 0.6 cm wide insulated graphite section. A small positive dc offset is also applied to the exciter prior to the application of the excitation signal, which creates a potential deep filled with particles just above the exciter. The wave number (k) of the observed wave is measured from the recorded frames for different frequencies (ω) of the applied signal to obtain the dispersion curve as shown in Figure below. The measured values are found to follow the linear dispersion relation of the DAW in the long wavelength limit given by $\omega^2 = \omega_{pd}^2 k^2 \lambda_D^2 / (1 + k^2 \lambda_D^2)$ where ω_{pd} and λ_D are the dust plasma frequency and effective Debye length respectively. The measured velocity of the observed DAW is ~ 5.0 – 6.0 cms^{-1} for pressure in the range 0.5 – 2.0 Pa.

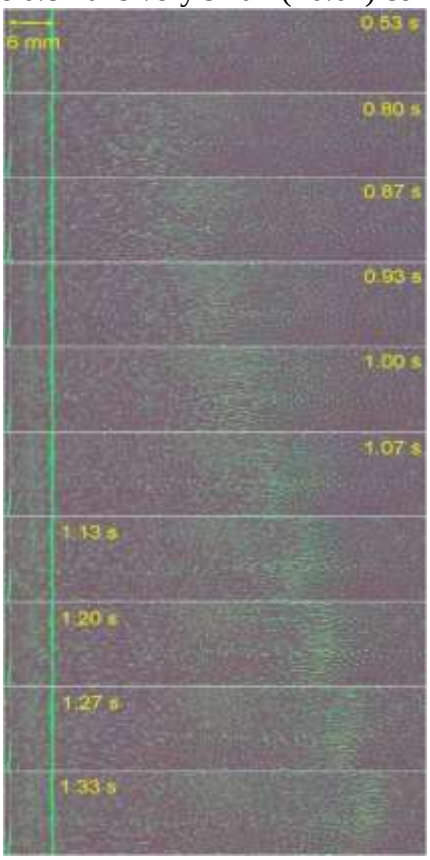


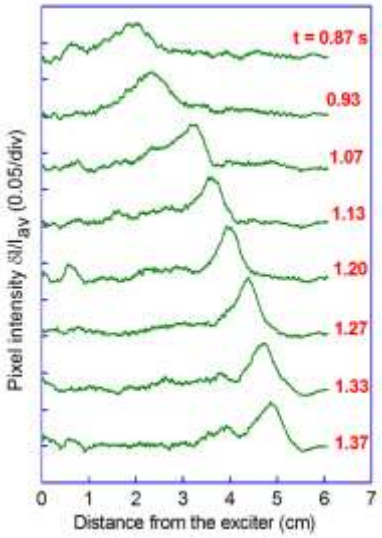
Measured Dispersion relation of DAW

Excitation and evolution of dust acoustic soliton

The DAW can transform into nonlinear structure like soliton when nonlinear steepening of the wave is balanced by dispersive broadening. In order to excite DA soliton a short negative pulse 5 - 20 V (100 ms duration) along with the small positive dc offset is applied to the exciter. The applied pulse gives an upward push to the particles floating in the potential deep above the exciter. As the vertical motion of the particle is limited within the equilibrium dust levitation height, a density compression is created in the adjacent region in the horizontal plane. The compression then propagates horizontally away from the exciter which is recorded in the camera.

The pixel intensity profile $\delta I/I_{av}$ (proportional to dust density perturbation), of the recorded images is obtained by using ImageJ software and is shown in Figure (b) below for -5 V excitation pulse at pressure ~ 0.8 Pa. Here $\delta I = I - I_{av}$ and I_{av} is the averaged pixel intensity obtained from a large number of images. Close to the exciter, the perturbation is wide with spatial width comparable to the exciter width. As it propagates, the leading part of the pulse steepens (1.07 s) which is balanced by the dispersion effect to form a solitary wave (1.20 s) which travels further distance maintaining its shape and velocity. The measured amplitude of the DA solitary wave is ~ 0.08 and its velocity is ~ 6.0 cms^{-1}. Moving further away from the exciter, the wave amplitude decreases with the increase in its width (1.33 – 1.37 s), which is due to the viscous damping effect. The dust neutral collision frequency (ν/ω_{pd}) for the present working pressure 0.8 Pa is very small (~0.07) compared to the viscosity coefficient.



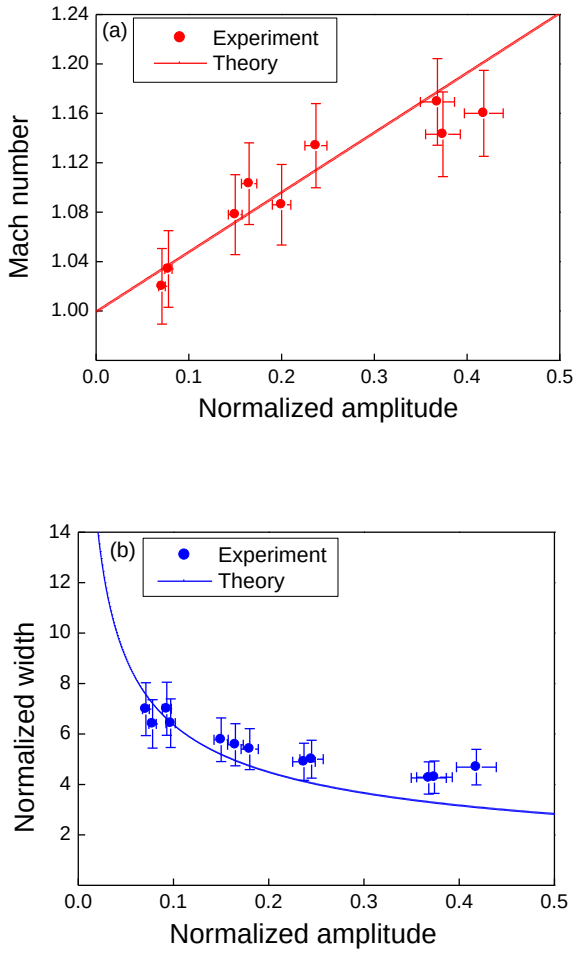


(a) **(b)**

(a) *Selected frames (snapshots) showing the propagating dust compression,* ***(b)*** *Pixel intensity profiles of the Dust acoustic soliton*

Characteristics of dust acoustic soliton and its comparison with theory

The Mach number *M* and the normalized width *D* (full width at half maxima) of the observed DA solitary wave are measured and shown in Figure below. With the increase in wave amplitude, the *M* increases linearly and *D* decreases satisfying two distinctive properties of a solitary wave. The measured values show good agreement with the theoretical values (solid curves) obtained by using the the Korteweg-de Vries equation (KdV) derived for a strongly coupled dusty plasma.

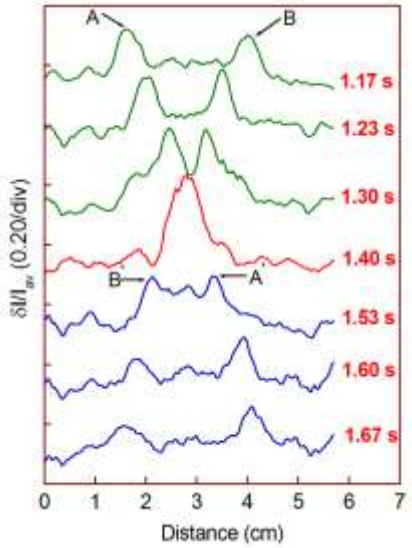


***(a)** Mach number M and **(b)** normalized width D of the observed DA solitary wave*

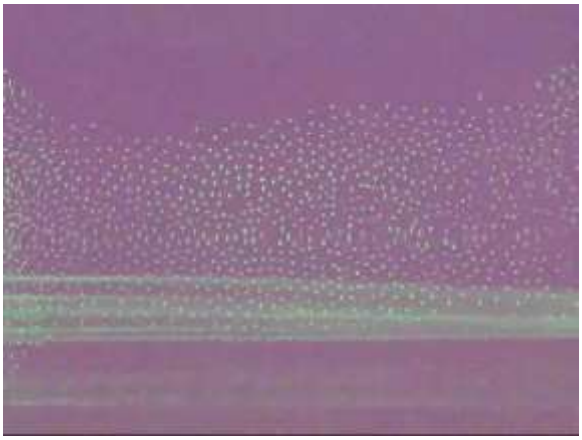
Head on collision between two dust acoustic solitons

One important criterion for a solitary wave to be identified as a soliton is that it has to survive a collision (head on / overtaking) with another solitary wave. In order to observe a collision between two DA solitons, a negative pulse of amplitude 5 to 15 V is applied simultaneously to the exciters which excite two DA solitons of equal amplitude propagating toward each other. A typical example of the observed collision between two such counter propagating solitons excited

by a - 10 V pulse at pressure ~ 1 Pa is shown in Figure below. The amplitude and Mach number of the incoming solitons (A and B) just before the interaction are 0.15 and 1.08 respectively. During the interaction the two solitons merge into a single pulse for a very short time and then they pass through each other. The maximum amplitude (~ 0.31) of the resultant pulse observed (1.40 s) in this case is nearly twice the incoming soliton amplitude indicating a linear interaction. The outgoing solitons (A' and B') propagate with a slightly smaller velocity compared to the incoming ones because of the reduction in wave amplitude with time due to the viscous damping. The measured velocities of the outgoing solitons are nearly the same. However, the asymmetry in their shapes is thought to be due to the fact that they are now propagating in a medium slightly disturbed by the incoming solitons. The solitons suffer a small time delay (Δt = 0.0445 s) after collision which is obtained from their trajectories before and after collision. The measured delay time is found to increase with the increase in the excitation amplitude.



Pixel intensity profiles showing head on collision of two counter propagating dust acoustic solitons.



A view of dust fluid

Dust acoustic instability: Dusty plasma exhibits low frequency instability in presence of streaming ions or electrons. We use poly dispersed carbon nano powder (50~100 nm) in a narrow RF produced plasma column to observe the dust acoustic instability. The ion streaming

toward the grounded lower plate induces the spontaneous generation of the instability. A snapshot of the instability showing bright and dark bands in the dusty plasma column is shown in Figure below. The instability frequency is ~10 Hertz and wavelength is of the order of mm.

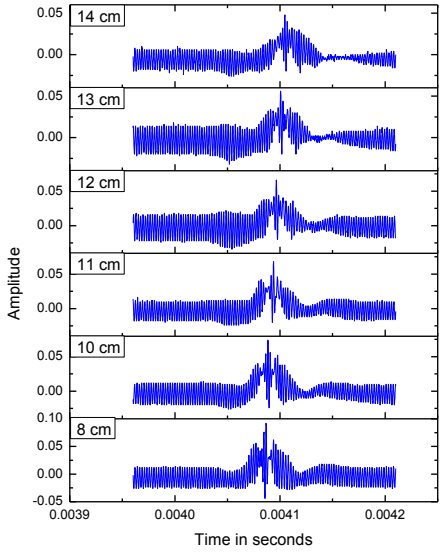
Snap shot of dust acoustic instability in a nanodusty plasma column.

Ion Acoustic Peregrine solitons:

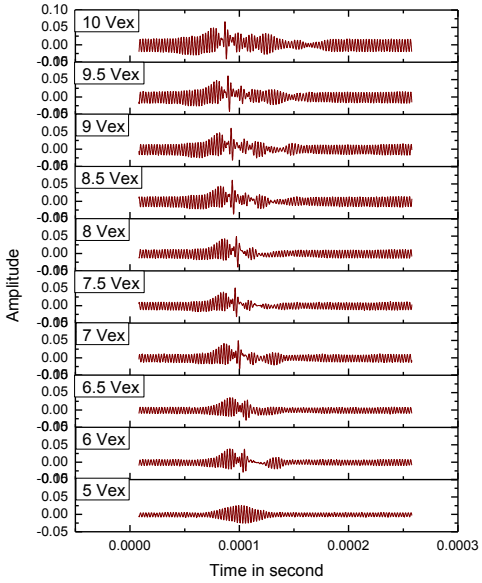
Peregrine solitons was theoretically predicted by Mathematician D H Peregrine in in 1983. This special kind of solitons have attracted attention among nonlinear dynamics researchers during last couples of years after its experimental observation in few nonlinear dispersive media e.g. fibre optics, plasma and water tank. Peregrine solitons appear as a special class of solution of Nonlinear Schrodinger Equation (NLSE) and considered to be the prototype of well-known Giant killer wave or Rogue wave encountered in the ocean. One special characteristics of this solitons is that its maximum amplitude suddenly rises to more than 3 times of the carrier amplitude in the neighborhood.

In plasma, Peregrine solitons was observed in a double plasma device at IASST and reported in Physical Review Letters (2011). A detail investigation on the soliton has been taken up under a project funded by SERB, Department of Science and Technology. The project started in 2013.

The experiment is carried out in multicomponent plasma with negative ions in a double plasma device. A suitable carrier frequency is selected in the range of half of the ion plasma frequency and amplitude is slowly modulated. The modulation strength is less than 30%. The synthesized signal is than applied into the anode of the driver plasma and its evolution at different spatial location is monitored in digital storage oscilloscope. Some typical signals showing the evolution of the solution are presented in the Figures below.



Typical Temporal profile of density perturbation showing the generation of the Peregrine solution at different distances. Carrier frequency = 443 KHz, Modulation frequency = 23 KHz, Excitation amplitude 8V.



Nonlinear evolution of the solitons at different excitation amplitude. f_c= 400 KHz, f_m= 17 KHz, Probe is fixed at 11 cm from the exciter.

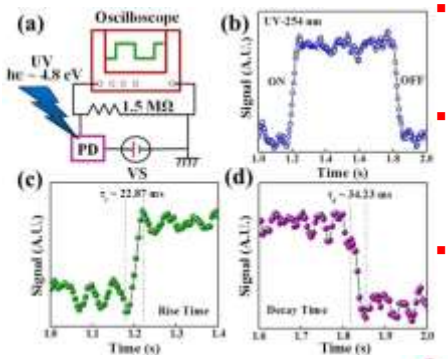
Plasma Nanotechnology

Advances in Developing Nanocomposite for Hybrid Photodetectors, Immobilization of Trypsin and Low Temperature Growth of Carbon Nanotubes

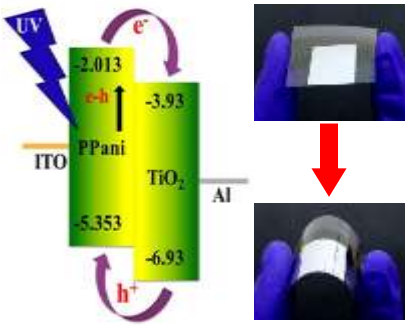
GOALS

- To fabricate a highly sensitive flexible ultraviolet photodetector employing hybrid geometry.
- Low temperature growth of vertically aligned carbon nanotubes.
- Immobilization of trypsin on nanocomposite for protein digestion.

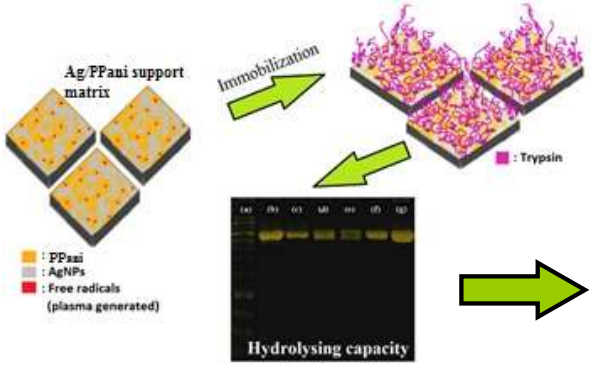
Efficient High Gain and Fast Response Hybrid Flexible UV Photodetector



- A high performance flexible hybrid UV photodetector based on PPani-TiO_2 is developed.
- High photoconductive gain ~ 10^5 and fast response and recovery time of 22.87 ms and 34.23 ms is recorded for the photodetector.
- Achieved an excellent result towards getting a balance in gain and response speed trade-off of the photodetector



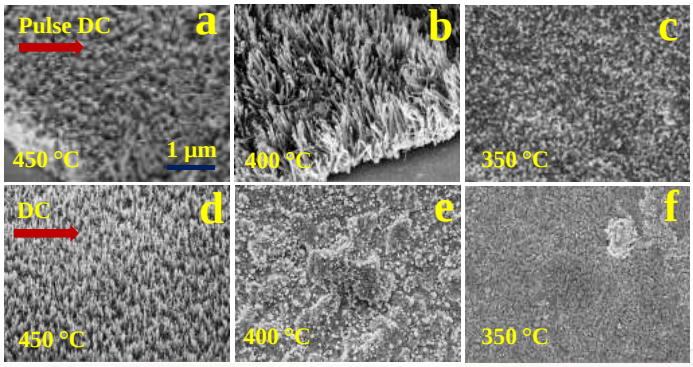
Immobilization of Trypsin on Ag/PPani nanocomposite



- Plasma polymerization and magnetron sputtering is used to prepare supportive matrix for trypsin immobilization.
- Presence of free radicals and nanoparticles proven to be efficient in increasing the trypsin stability.
- Immobilized trypsin is able to exhibits high hydrolyzing capacity of BSA protein.

Vertically Aligned Multi-walled Carbon Nanotubes

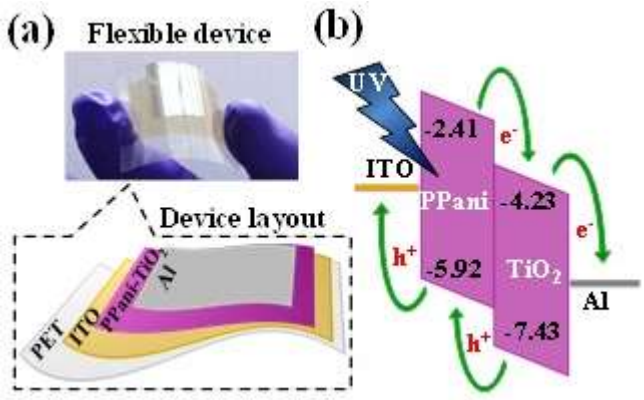
- Growth of vertically aligned carbon nanotubes by plasma enhanced chemical vapour deposition process.
- Low temperature growth of carbon nanotubes is achieved at 350°C.
- Highly dense carbon nanotubes of the order of 10^9 tubes cm^{-2} is observed.



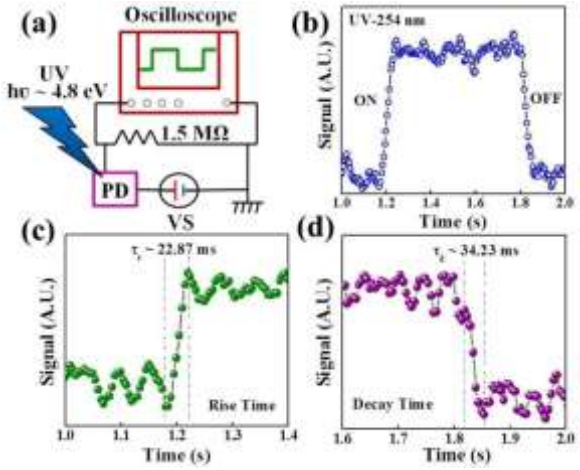
A completely dry and green technology for nanoscale material synthesis and device engineering

Efficient Fast Response and High-Gain Solar-Blind Flexible UV Photodetector Employing Hybrid Geometry

A high performance flexible hybrid UV photodetector with solar-blind sensitivity has been developed using nanocomposite film of PPani-TiO_2. A facile solvent-free plasma technique is used to synthesize superior quality hybrid material with high yield. Schematic device structure of the PPani-TiO_2 nanocomposite based flexible hybrid UV photodetector with energy level diagram is presented in the figure. The hybrid photodetector exhibited high photoconductive gain of the order of ~ 10^5 and fast speed with response and recovery time of 22.87 ms and 34.23 ms. This is an excellent result towards getting a balance in the response speed and photoconductive gain trade-off of the photodetectors reported so far. In addition, the device has the advantages of enhanced photosensitivity ($(I_{light} - I_{dark}) / I_{dark}$) of the order of ~ 10^2 and high responsivity of ~ 10^4 AW^{-1}. All the merits substantiates that, to prepare hybrid material, plasma based method holds potential to be an easy way for realizing large scale nanostructured photodetectors for practical applications.



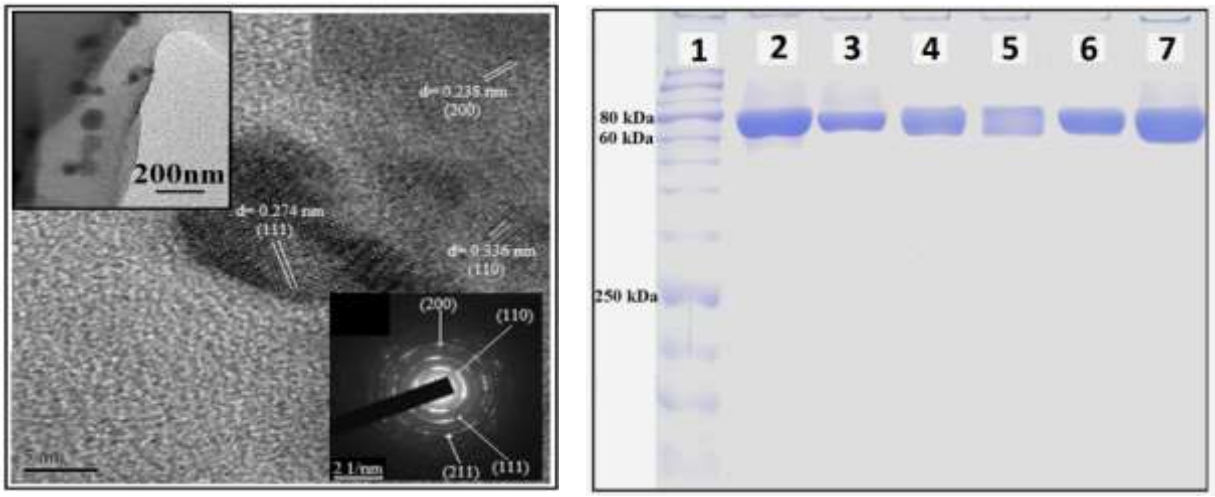
(a) *Schematic device structure of the PPani-TiO_2 nanocomposite based flexible hybrid UV photodetector* ***(b)*** *energy level diagram of hybrid photodetector*



(a) *Schematic diagram of the experimental setup for photodetector speed measurement* ***(b)*** *single cycle on/off switching of the hybrid photodetector under UV illumination of 254 nm at 0.06 mW/cm^2* ***(c)*** *response time (i.e. rise time, τ_r) of the hybrid photodetector* ***(d)*** *recovery time (i.e. decay time, τ_d) of the hybrid photodetector.*

Immobilization of Trypsin on Plasma Prepared Ag/PPani Nanocomposite Film for Efficient Digestion of Protein

This work demonstrates the efficacy of a support matrix prepared by plasma process for trypsin immobilization without any surface activator. Plasma polymerization cum sputtering process is used to prepare the nanocomposite support matrix as shown in the transmission electron microscopic image of the adjacent Figure. Plasma sputtered silver nanoparticles (AgNPs) are uniformly embedded into plasma polymerized aniline (PPani) film. Various characterization tools are employed to study the surface morphology, microstructure and chemical composition of the support matrices. Trypsin is immobilized onto the support matrix via the formation of covalent bond between them. Plasma generated free radicals on composite films activate the support matrix and to make it efficient for increasing the tertiary enzyme stability via multipoint covalent attachment. Trypsin immobilized onto Ag/PPani matrix has more hydrolyzing capacity (58.0 ± 0.2 %) of bovine serum albumin (BSA) than free trypsin (41.0 ± 0.3 %) as well as trypsin immobilized onto PPani (39.0 ± 0.5 %) films shown in the figure.

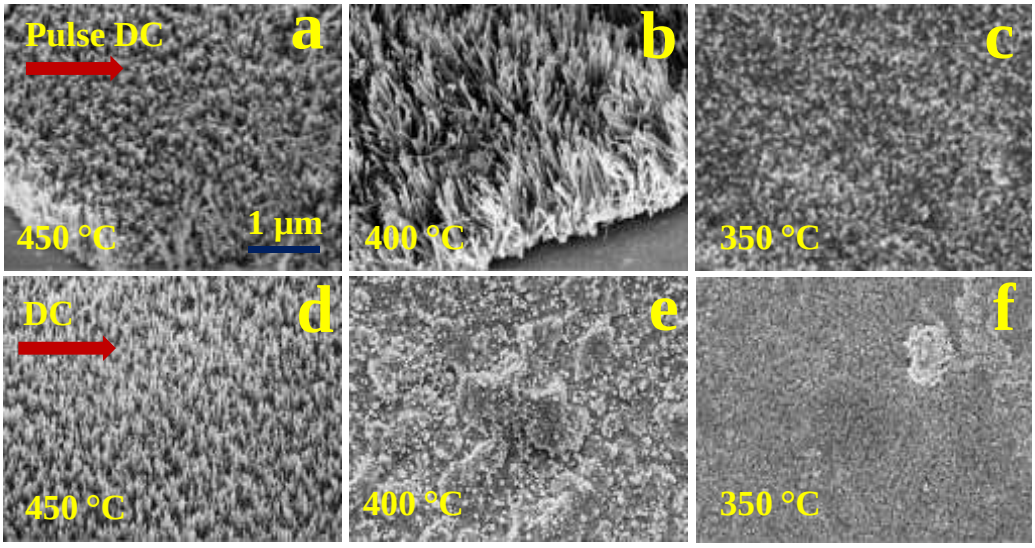


(a) **(b)**

(a) *TEM image and SAED of the nanocomposite,* ***(b)*** *SDS-PAGE of peptides produced by native and immobilized trypsin Lane 1: Marker (P7703S); Lane 2: BSA; Lane 3: Protein extracts digested by free trypsin; Lane 4: protein extracts digested by immobilized trypsin onto PPani matrix; Lane 5: protein extracts digested by immobilized trypsin onto Ag/PPani matrix; Lane 6: protein extracts digested by PPani only; Lane 7: protein extracts digested Ag/PPani matrix only.*

Influence of pulsed bias on the growth of vertically aligned carbon nanotubes at low temperature

Pulsed plasma enhanced chemical vapour deposition (PECVD) process has been used for growth of vertically aligned multiwall carbon nanotubes (CNTs) at low temperature range of 450-350 $^{\circ}$C. Carbon nanotubes are synthesized from Ni catalyst film of thickness 20 - 40 nm deposited on silicon substrate at a pressure of 0.5 Torr by magnetron sputtering as shown in the figure. The effect of Ni catalyst film morphology on low temperature growth of carbon nanotubes by pulsed PECVD has been studied. It is found that CNT grown from Ni catalyst films depend upon the deposition pressure. The catalyst film deposited at 0.5 Torr has a rough granular structure which enhances the density of CNTs upto 10^9 tubes cm^{-2}. Further, it has been observed that under continuous dc PECVD, the growth of CNTs is not prominent at low temperatures down to 350°C.

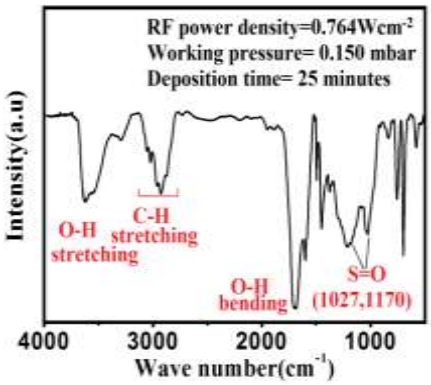


FESEM micrographs showing CNT growth at different temperatures (a) 450 °C (b) 400 °C (c) 350 °C by pulsed dc PECVD and (d) 450 °C (e) 400 °C (f) 350 °C by continuous dc PECVD.

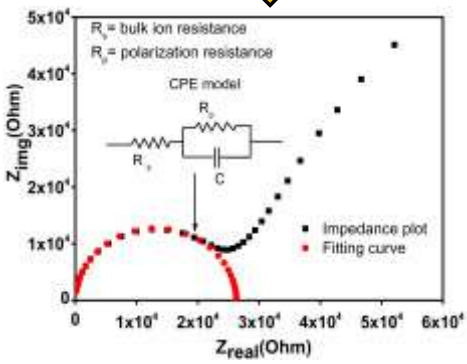
Proton Exchange Membrane for Fuel Cell

Synthesis of proton exchange membrane for fuel cell

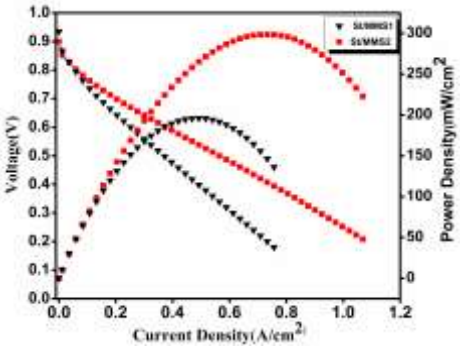
FTIR spectrum of Plasma polymerized membrane



Proton conductivity measurement

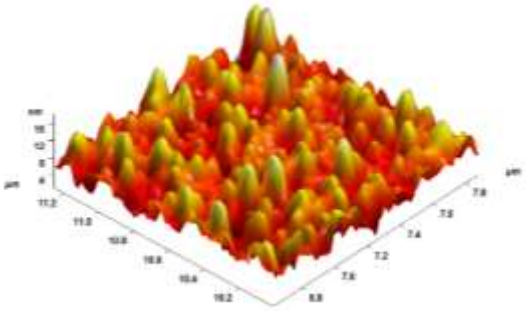


Fuel Cell performance of the membrane (polarization curve)

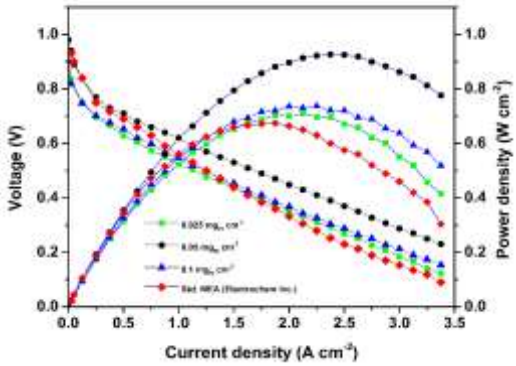


PEM Fuel Cell electrode catalyst prepared by high pressure plasma sputtering

Surface morphology of sputtered electrode



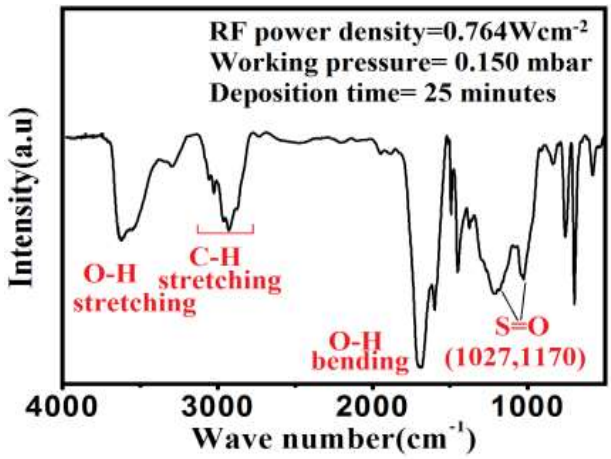
Fuel cell performance (polarization curve)



Growth of Pt Nanopillar surface structure of the electrode

Development of St/MMS proton exchange membrane

Among many issues in fuel cell research, the development of the membrane with high proton conduction efficiency at a lower cost is a significant one. The conventional membrane that is in use at present is a product of Dupont, named *Nafion*. It is a sulfonated polymer and exhibits poor adhesion properties against any substrate due to low surface energy associated with fluorochemistry and thus, the film casting from Nafion solution is difficult. Nafion is highly expensive and also it starts degrading at a temperature of 80^0C. To address the issues involved in conventional proton exchange membrane plasma polymerization has been used in the present research work to synthesize the membrane and also to fabricate the fuel cell. The co-polymerization of styrene /MMS monomer mixture was carried out using RF glow discharge plasma in a parallel plate plasma reactor to prepare the proton exchange membrane. FTIR spectrum of the St/MMS membrane is presented in the figure below. The retention of the aromatic backbone structure in the polymer is confirmed from FTIR peaks at 1490 cm^{-1}, 759cm^{-1}, 1600 cm^{-1}. The sulfonate group present in the polymer matrixes can be confirmed by the peak appeared at 1030 cm^{-1}(symmetric S=O=O) 1080 cm^{-1}(S=O), 907 cm^{-1}(S-O) 1155 cm^{-1} and 1170 cm^{-1} which are the assignment of S-O and S=O vibration in SO_3 group.



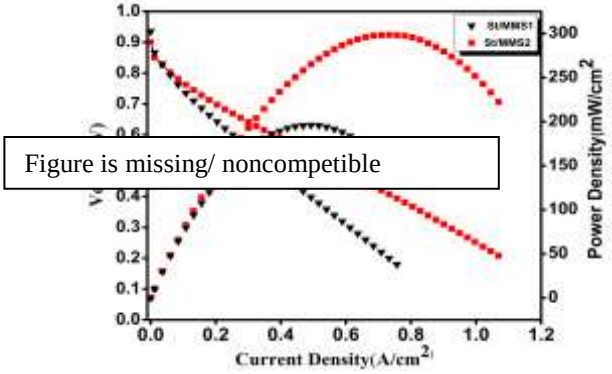
FTIR spectra of Plasma polymerized St/MMS membrane

Furthermore, the proton conductivity of St/MMS2 membrane is found to be 0.141 Scm^{-1} which is deposited at 0.15 mbar pressure with 1:1 partial pressure ratio of monomers while the $1x10^{-4}$

Scm^{-1} for the plasma polymerized St/MMS1 membrane deposited at 2:1(Styrene : MMS) partial ratio of monomers.

Performance of the developed cell

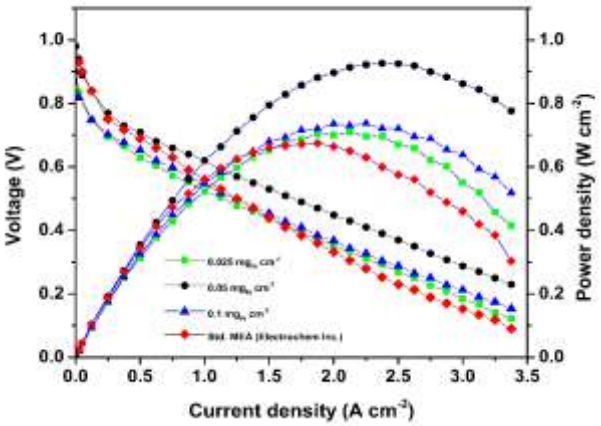
To evaluate the cell performance of the membrane, the membranes are deposited on Standard electrode of 1 mg/cm^2 platinum loading supplied by Electrochem (USA) is evaluated in fuel cell test station (CFCT, Chennai). The Open Circuit Voltage (OCV) is found to be 0.95 V for St/MMS1 membrane while for St/MMS2 membrane the value is 0.90 V.



Polarization curve of Plasma polymerized St/MMS membrane

PEM Fuel Cell electrode catalyst prepared by high pressure plasma sputtering

Platinum (Pt) nanoparticles of size 2-5 nm are deposited on porous carbon paper by plasma sputtering to prepare anode for fuel cell applications and the influence of Pt loading on catalytic activity is investigated. Fuel cell electrodes are prepared with a low Pt loading of 0.05 mg_{Pt} cm^{-2} is found to have an effective electrochemical active surface area of 114 m^2 g^{-1} and optimum porosity to be used as efficient electrodes in fuel cell. The polarization curve is recorded for the MEA assembled with an anode of different Pt loading of 0.025 mg_{Pt} cm^{-2}, 0.05 mg_{Pt} cm^{-2} and 0.1 mg_{Pt} cm^{-2} and a standard commercial electrode of 1 mg_{Pt} cm^{-2} as cathode. It is observed that MEA with 0.05 mg_{Pt} cm^{-2} shows a current density of 2.93 a cm^{-2} at 0.3 V and a maximum power density of 0.93 Wcm^{-2}. When compared with an MEA assembled with standard electrodes on both anode and cathode side, it is observed that the plasma prepared electrode has a better performance as compared to standard commercial electrodes.

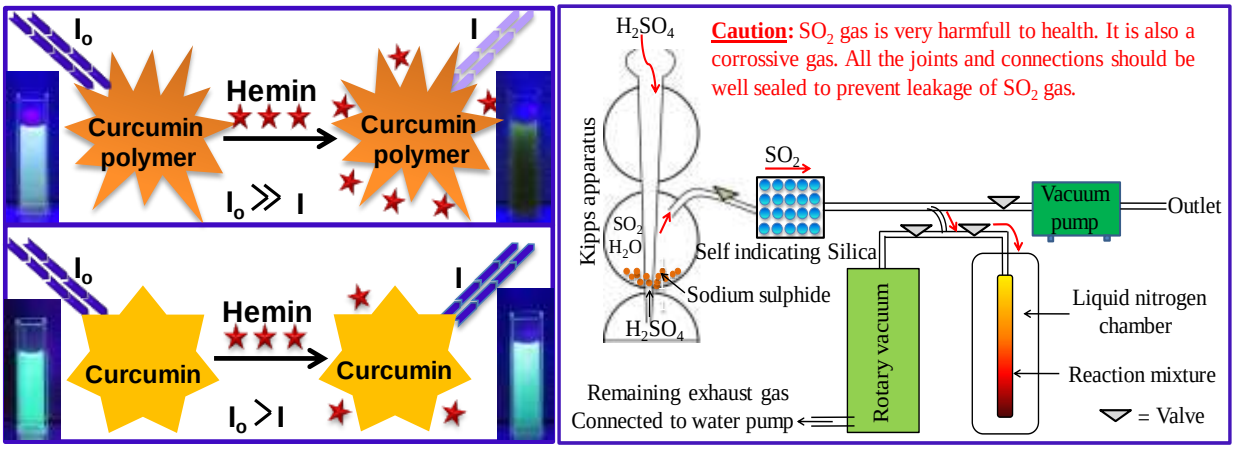


Linear sweep polarization curve for MEA with plasma prepared anode (0.05 mg_{Pt} cm^{-2}) and commercial electrode (1 mg_{Pt} cm^{-2}) as standard cathode.

2. Polymer and Advanced material sciences

Sensing of biological component hemin by polysulfone of curcumin through a novel process of polymerization.

Curcumin [1, 7-bis(4-hydroxy-3-methoxyphenyl)-1,6-heptadiene-3,5-dione][7] is a yellow coloring dye and is found in the rhizomes of turmeric plant (*Curcuma longa*). A novel polymer of curcumin is synthesized by sulfonation and incorporation of aliphatic groups to the polymeric structure. It undergoes efficient fluorescence quenching in presence of hemin and act as a selective biosensor for the later. The quenching efficiency increases significantly up to 90.82 % at a maximum of 100 µM concentration of hemin and at λ_{ex} of 410 nm. The high zeta potential of the polymer (-98 mV) decreases to -38 mV at 100 µM concentration of hemin which confirmed the transfer of electron density from the polymer to the quencher during fluorescence quenching. The polymer is very selective for hemin only. Interference of other chemicals have very negligible effect. The work is published in RSC Advances.

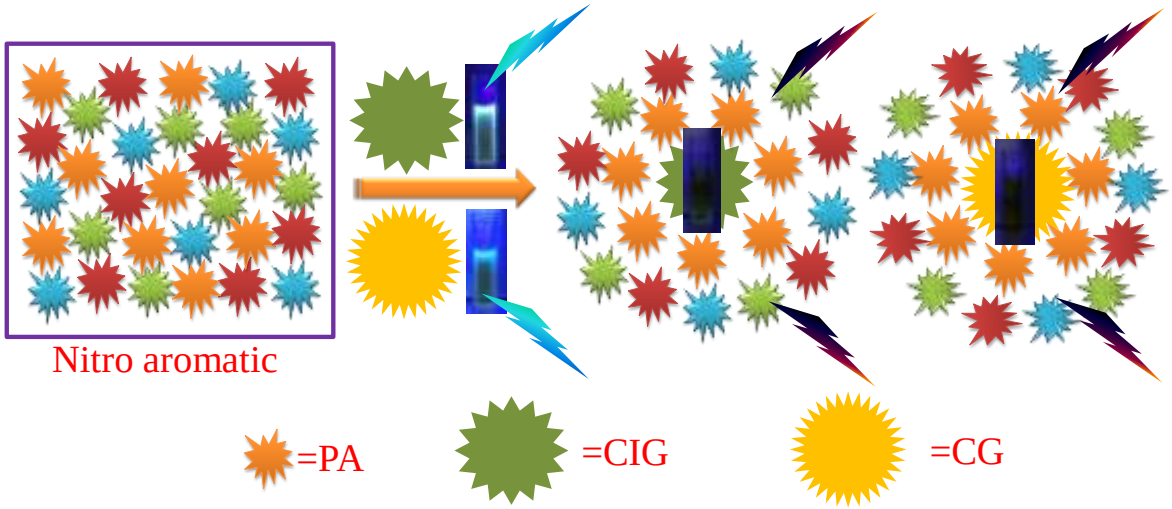


Schematic representation of the fluorescence quenching behavior of curcumin polymer and curcumin in presence of hemin and the experimental setup for sulfonation. Hemin is represented by star marks in the scheme.

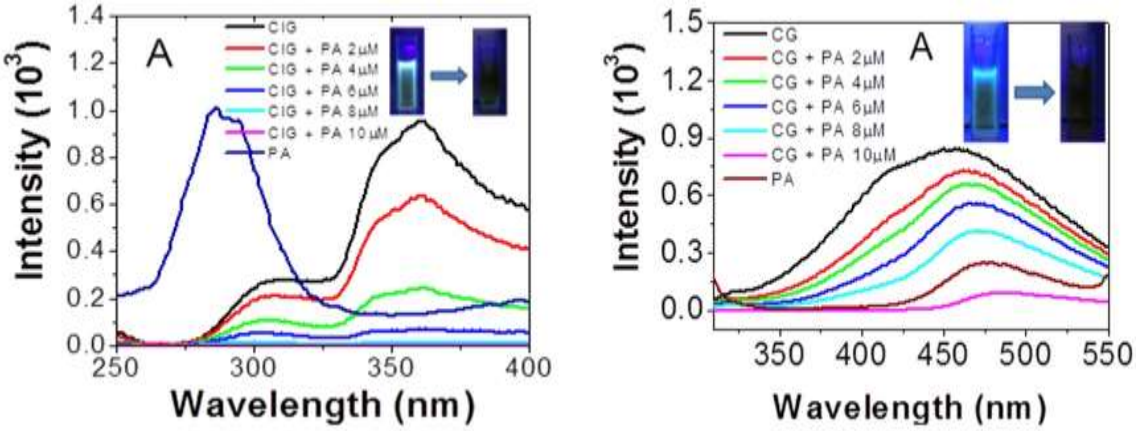
(a) Greener routes for explosive chemical detection

Detection of trace amount of Picric acid in water is very important from the perspective of human health, environment and homeland security. A new greener route has been reported which incorporate the flavones Scutellarin and Hispidulin-7-O-glucoronide as a mixture (1:1) with glycerol (CIG) as a fluorescent probe for selective real time detection of Picric acid in

aqueous solution. It has a detection limit of 1.03 µM of Picric acid. This method has also been able to detect Picric acid in real samples like ground water, drinking water and sand samples. Its comparative study has been carried out with curcumin glycerol (CG). The CIG fluorescence quenching efficiency has been found to be 99% while for CG it is 88.9% for 0.5 µM concentration of Picric acid. In both cases the quenching is governed by FRET between the fluorophore and the quencher and the FRET efficiency has been found to be 0.968 and 0.792 for CIG and CG respectively. Both the systems possess very high value of Stern Volmer binding constant with the order of 10^6. In terms of selectivity, CIG is more selective towards PA compared to CG and both the systems are statistically accessible. Use of readily available cheap biomaterials without using sophisticated systems for detection of PA in aqueous state further enhances the utility of the method.



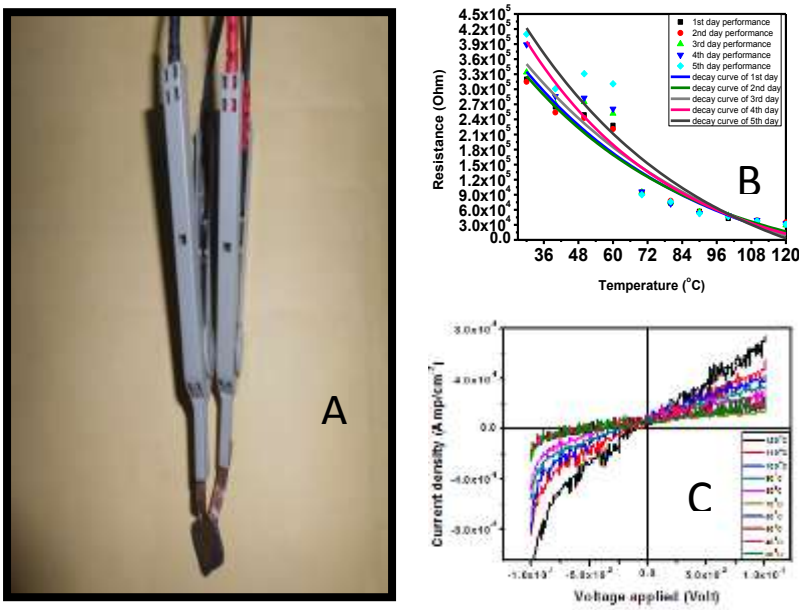
Selective detection of PA from nitroaromatic compounds.



Fluorescence quenching efficiency for CIG and CG.

(b) Study of fluorescence active PVA-Carbazole semiconducting polymer and its use as negative temperature coefficient thermistor

This work reports the development of a temperature responsive PVA-Carbazole polymer synthesized via thermal polymerization process. The resistance of the polymer decreases significantly with the rise in temperature. This is evident from the resistance vs temperature plot where the decay occurs exponentially within a temperature range of 30-120^{o}C and determination of the device constant (B) from Steinhart-Hart equation which confirms Negative temperature coefficient (NTC) property of the system. The electrical conductivity and semiconducting nature of the polymer are investigated by I-V measurement at different temperature and I_{max} vs T plots were done at an applied maximum DC bias voltage of 5V. The typical HOMO-LUMO energy band gap is found to be 1.81eV and 1.80eV through the local domain molecular orientation from electrochemical mode. The conduction behaviour of the fabricated system using this polymer can also be explained with the help of I-V (current density vs temperature) plots at -0.1V to +0.1V within the temperature range of 30^{o}C-120^{o}C. A prototype of the thermistor device with electrical circuit was fabricated to demonstrate the thermistor effect of the polymer which was sandwiched between two Cu-plates.

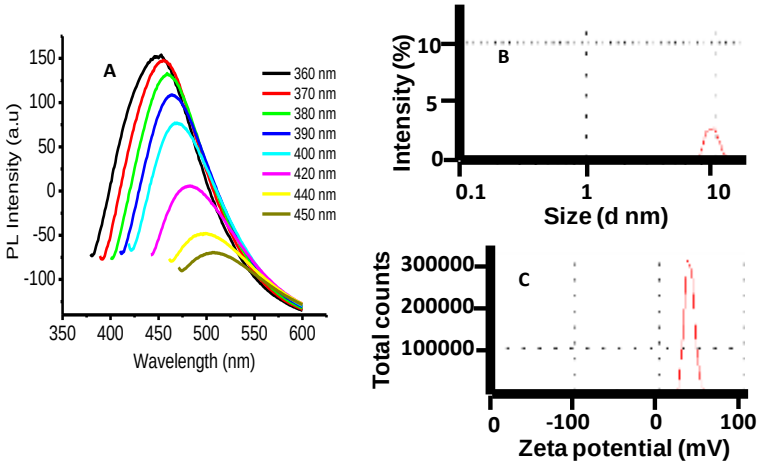


A. The thermistor device, B. Resistance Scatter diagram and Exponential decay curve with temperature showing NTC thermistor property of the device using P2 polymer and C. Current density vs Voltage plot at different temperature from the range -0.1V to +0.1V from the temperature range 30°C-120°C.

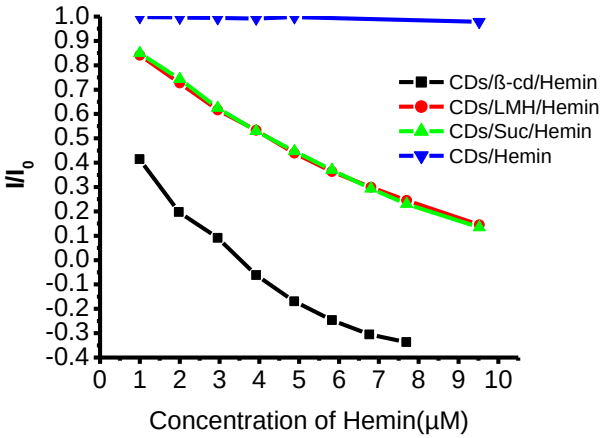
(C) Capped Fluorescent Carbon Dots for Detection of Hemin

Efforts have been made to make a fluorescent detector of hemin. **Hemin** is an iron-containing porphyrin. More specifically, it is Protoporphyrin IX containing a ferric iron ion (Heme B) with a chloride ligand. Structural resemblance with heme makes it an important biological model system. Carbon dots which belong to the family of carbon based nanomaterials have been synthesized from chitosan gel. The characteristic properties of carbon dots include (i) their unique small size (3-10 nm) (ii) the ease of passivation of their particle surface by organic or other molecules via covalent linkages or by chemical adsorption (iii) their ready solubility in water, (iv) their characteristic bright blue or green fluorescence under irradiation with UV light, (v) biocompatibility and (vi) good photostability. The gradually increasing attraction towards carbon dots may be attributed to availability of source, resistance to photobleaching, inexpensive nature and strong and tunable photoluminescence. All these properties make them wonderful fluorescent sensor material. Carbon dot surface were modified by capping with β-cyclodextrin (β-cd), lactose monohydrate (LMH) and sucrose (Suc). These modified carbon dot were then used as fluorescent sensor for detection of hemin. In the presence of hemin, the capped carbon

dot show quenching of photoluminescence (PL). It was also observed that PL quenching of capped carbon dot systems in the presence of hemin is dependent on the number of –OH groups in the capping agent. The minimum detection limit was determined to be ~ 1μM.

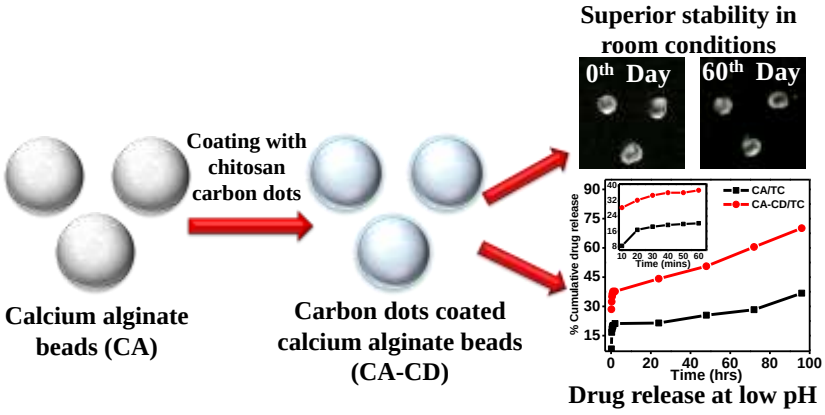


A *The stacked photoluminescence (PL) spectra of CDs excited at different wavelengths (from 370 nm-450 nm),* ***B*** *the particle size distribution graph of CDs (av. size~ 9.7 nm),* ***C*** *zeta potential graph of CDs (ZP = 36.2 mV)*



Plots of the donor fluorescence intensity against the concentration of hemin.

(c) Carbon coated Alginate beads with improved stability and drug delivery application



Novel carbon dot coated alginate beads (CA-CD) exhibiting superior stability and swelling properties have been successfully prepared. CA-CD show exceptional stability in ambient

condition and are stable at room atmosphere and temperature even after 60 days. Then CA-CD beads were successfully used as pH dependent sustained drug delivery vehicle taking tetracycline (TC) and tetracycline associated with β-cyclodextrin (ß-TC) as model drug systems. Such system can be suitably used as an effective drug delivery vehicle with maximum release obtained at pH 1 emphasizing its use in gastro-intestine where pH is low. Also, the use of β-cyclodextrin with drug as inclusion complex renders its use for slow and long-term drug administration.

Soft Nano Materials

Structures, patterns and related properties of organic molecules, biomolecules, nanoparticles etc at the air-water and air-solid interfaces have been studying to get interesting physicochemical properties. Interactions among molecules in bulk have also been investigating. X-ray and neutron scattering techniques together with microscopic and spectroscopic methods are using to explore such behaviors.

Studies on thin films on solid surfaces

Structure and stability of fatty acid salts Langmuir-Blodgett (LB) films on solid surfaces have been studied using X-ray reflectivity and atomic force microscopy techniques to see their structural modifications with the variation of the different physicochemical parameters.

Prolonged reorganization behaviour of layered structures of Au nanoparticle films have been studied by using X-ray scattering techniques. Out-of-plane structural studies show that although at the initial stage the reorganization occurs through the compaction of the films keeping the layered structure unchanged but finally all layered structures modify to monolayer like structure. Due to this reorganization the Au density increases within the nanometer thick films. In-plane studies shows that inside the reorganized films Au nanoparticles are distributed randomly and the particle size modifies as the metallic core of Au nanoparticles coalesces.

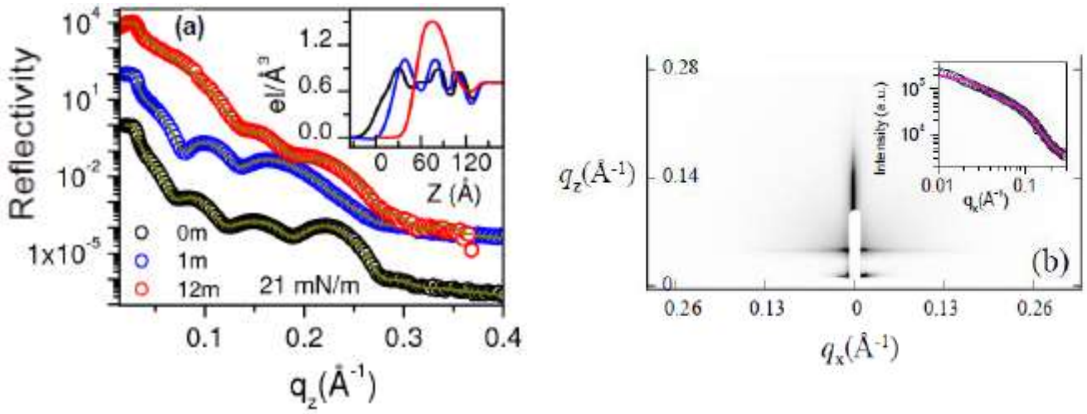


Figure 1.3.1: *(a) Time evolution X-Ray reflectivity data (different symbols) and analyzed curves (solid line) of trilayer Au-nanoparticle film deposited on Si substrate. Data and curves are shifted vertically for clarity. Inset: corresponding EDPs showing a possible structure (b) Grazing incidence X-ray scattering plot from the same sample. Inset: Intensity plot as a function of* q_x.

Interactions among protein molecules in bulk

Interactions among protein, bovine serum albumin (BSA) molecules have been studied in solutions in presence of different valent ions using small angle neutron scattering technique. BSA molecules, at physiological pH, shows a short-range attraction and in addition a long-range electrostatic repulsion among them. These interactions are modified in presence of different counterions. Small angle neutron scattering (SANS) study shows that for the equal ionic strength, the interactions are largely modified by the tri-valent (Fe^{3+}) and di-valent (Ni^{2+}) ions and comparatively less by the mono-valent (Na^{+}) ions. The effect is nearly similar for the di- and tri-valent ions in comparison with the mono-valent one. The strength of the attractive and repulsive interactions depends strongly on the type of the dissolved ions and salt concentrations.

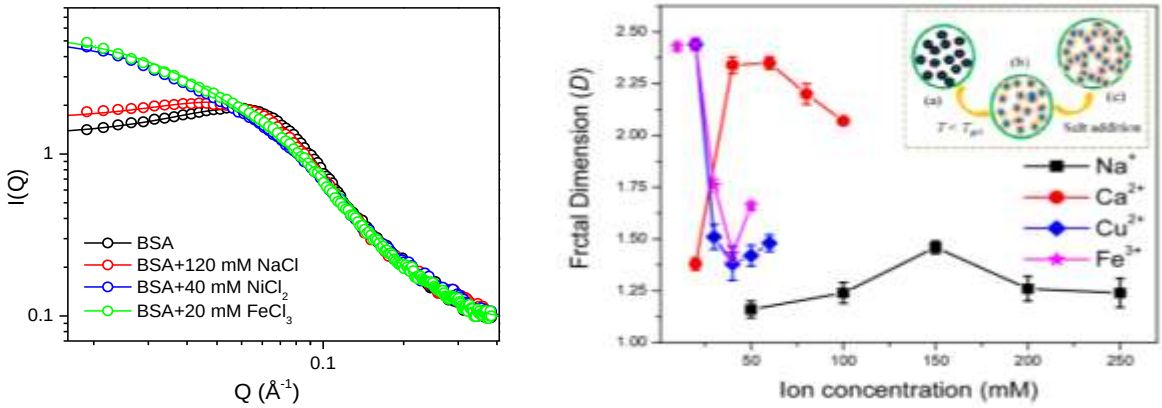


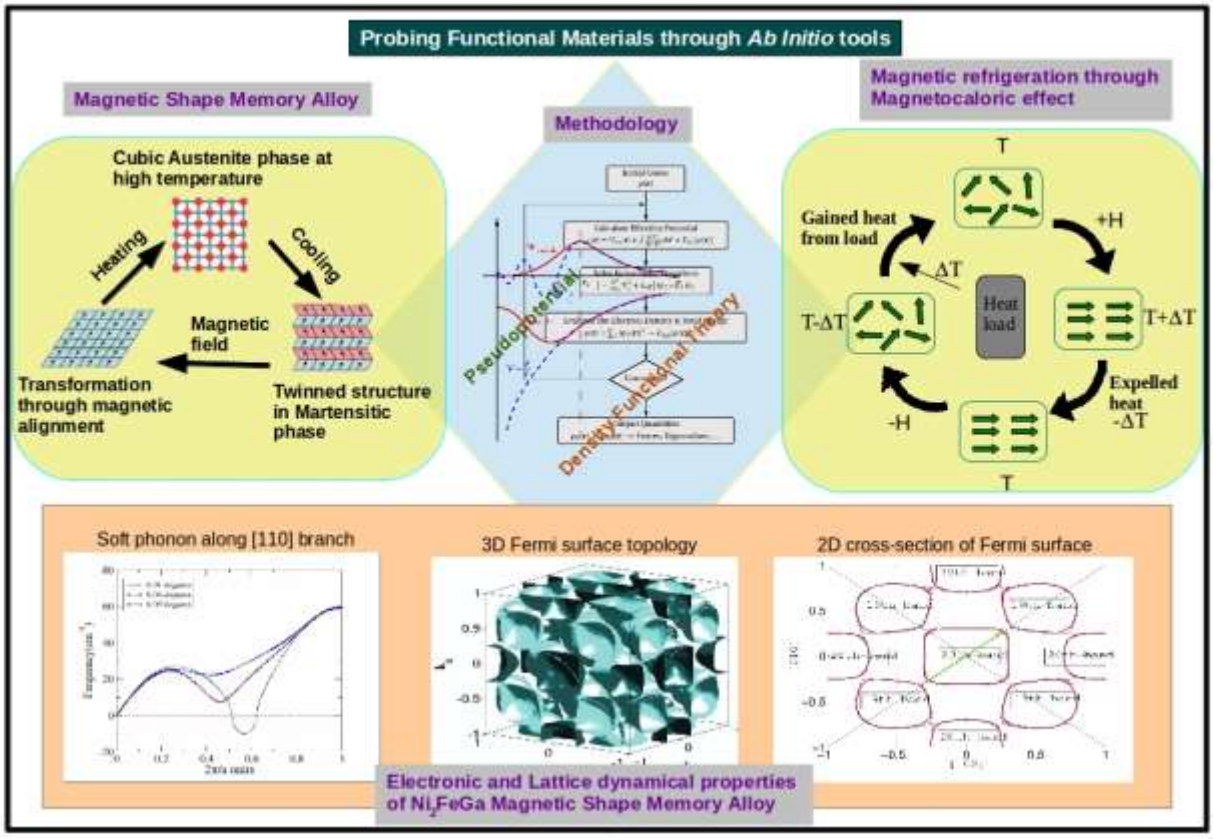
Figure 1.3.2: *Left: SANS data (open circle) and fitted curves (solid line) for 10 wt% BSA in aqueous solution in presence of salts having equal ionic strength, i.e., 120, 40 and 20 mM NaCl, $NiCl_2$ and $FeCl_3$ respectively. Right: Variation of fractal dimension with the Na^{+}, Ca^{2+}, Cu^{2+} and Fe^{3+} ion concentration. Inset: Schematic representation of the cold gelation. Gelation occurs in presence of salts from the intermediate state of aggregated structures below the gelation temperature (T_{gel}).*

Cold gelation behavior of BSA protein has also been studied mixing with mono-, di- and tri-valent ions at *p*D ≈ 7.0. SANS studies show that for the heat treated BSA fractal structure grows with the addition of salts. Heat treated BSA without salt shows intermediate range electrostatic repulsion and long range attraction. However, in presence of salts, cold gelation occurs but the fractal dimension depends upon the salt type and salt concentration. Variation of fractal dimension with salt concentration is nearly similar for Cu^{2+} and Fe^{3+} ions however similarity exists between Na^{+} and Ca^{2+} ions.

Theoretical approach to understand functional properties of Heusler alloys

Functional materials or smart materials are registering significant advances in current science in order to meet the technology requirement of today's generation. Heusler alloy is one particular class of materials showing multifunctional behaviour like shape memory effect, magnetocaloric effect, half metallicity etc.

Shape Memory Alloys (SMA) assume importance owing to their diversing applications in the field of Medical Science, Robotics, Automobile Industry, Home Appliances etc. They are characterized by the property that they can memorize the shape of their high temperature phase and can undergo structural transformation from low temperature Martensite to high temperature Austenite phase simply on raising the temperature. At low temperature phase, the system can be strained by applying mechanical forces in case of ordinary shape memory alloys. Combining this shape memory property with ferromagnetism makes Ferromagnetic Shape Memory Alloys (FSMA) of Heusler type where the range of applications increases due to the presence of magnetic ordering as an aditional driving force. In FSMA, the crystallographic change can be made with the application of an external magnetic field which enables the system to respond much faster and get better controlled than the ordinary Shape Memory Alloys. FSMA materials



are primarily used in actuator devices. Current emphasis is on predicting systems with raised structural transformation domain which are suitable for technological applications.

Heusler alloys have also made it to the focus of intensive research due to the presence of unique magnetic properties like giant magnetocaloric effect leading to their application in solid state magnetic refrigeration. A first order magnetostructural transformation is an essential condition for an alloy to show magnetocaloric effect (MCE). Also, the maximum MCE is obtained when structural and magnetic transition temperatures lie close to each other. So a systematic search of alloys showing improved magnetocaloric property requires fair estimate of the structural and magnetic transformation temperatures.

The computational condensed matter group at IASST is engaged in doing calculations on various Heusler alloys to understand their shape memory property and magnetocaloric effect. The macroscopic properties of these systems are understood through a non-empirical description of their microscopic structure. Quantum mechanical Density Functional Theory (DFT) is used to describe the motion of the electrons and their various interactions. The effective Hamiltonian is built using these explicit electronic terms along with other terms averaged out. This is the so-called *ab-initio* or *first-principles* approach of formulating condensed matter problems. The problem is then solved using methods like plane wave pseudopotential method. With the present day computer memory and speed accompanied by efficient algorithms, it is now possible to characterize and design new materials through such simulation techniques.

Ni_2FeGa system in its stoichiometric as well as off-stoichiometric composition are under investigation as a prospective Magnetic Shape Memory Alloy. A previous study on the electronic structure properties of this alloy along the transformation path from high temperature Austenite to low temperature Martensite phase has revealed high electron density in the vicinity of the fermi level. This suggested interesting electronic behaviour at the fermi level which can be verified by mapping the fermi surface. At the same time it is required to understand the dynamical instability of the system in its Austenite phase leading to martensitic transformation by calculating the full phonon spectrum.

Both the fermi surface as well as phonon spectrum have been computed for the Austenite phase of Ni_2FeGa in its stoichiometric composition. The spin down electronic states in the system show fermi surface nesting behaviour for a particular wave vector. On the otherhand, the phonon spectrum exhibit phonon anomaly in one particular branch with a minimum dip at one particular wave vector. Interestingly, the fermi nesting vector and the soft phonon wave vector matches exactly. This confirms that the two microscopic parameters, i.e. the Fermi nesting vectors and acoustic phonon anomaly are well connected and might play a major role in destabilizing the premartensitic behaviour.

Electronic and magnetic properties of another Heusler alloy Ni_2MnIn is also being studied with an aim to understand the microscopics of the system which shows very good magnetocaloric effect. Attempt is being made to have systematic results on how the electronic and magnetic properties of the system vary as the composition of the system is varied. Future plan is to dope the system with other elements with the aim of enhancing the magnetocaloric effect for better efficiency as solid state cooling device.

3. Computational and numerical sciences

The Central Computational and Numerical Studies Division (earlier known as Mathematical Sciences Division) is carrying out basic research on selected thrust areas and some database research work has been done on the problems related to the North-East region time to time from its inception. At present the members of the division are engaged in investigating certain problems in the areas of Sequence Spaces, Summability Theory, Spectral Theory, Fuzzy Set Theory and Applications, Applied Stochastic Process, Image Processing of Medical Data, Theoretical Condensed Matter Physics, Numerical Computations.

(a) WORK DONE ON SEQUENCE SPACES, SUMMABILITY THEORY, TOPOLOGY, FUZZY SET THEORY AND ITS APPLICATIONS

The work done on Sequence spaces, Series, Summability Theory, Fuzzy set theory and Topology is under basic research and theoretical in nature. New classes of sequences and series are introduced and their different algebraic and topological properties are studied. The spectra of different matrix maps on sequence spaces have been investigated. Fuzzy set theory has been applied in introducing new class of sequences of fuzzy numbers and different types of fuzzy topological spaces. Different properties of bitopological spaces have been investigated.

Fuzzy Set Theory and its Applications

Sequences of Fuzzy Numbers

A fuzzy real number X is a fuzzy set on R, more precisely a mapping X: $R \to I$ (= [0, 1]), associating each real number t, with its grade of membership $X(t)$. We have considered the class of *upper-semi-continuous*, *normal*, *convex* fuzzy real numbers, denoted by $R(I)$ for our investigations.

The notion of n-normed sequences $\left(m(\varphi), \|.,.,....,.\|_n\right)$ related to p-absolutely summable sequence space have been introduced in [B.C. Tripathy and S. Borgogain, *Boletim da Sociedade Paranaense de Matemática*, 31(1)(2013), 167-173.],. It is shown that this is an n-Banach space, is solid, monotone, symmetric but not convergence-free. Some inclusion relations involving this sequence space have been established.

The concept of lacunary bounded variation sequence of fuzzy real numbers have been introduced in [B.C. Tripathy and A. J. Dutta, *Journal of Intelligent and Fuzzy Systems*, 24(1)(2013), 185-189.]. It is shown that this class of sequences is closed under addition and scalar multiplication. It is observed that it is neither solid nor monotone nor symmetric nor convergence free. Some inclusion results have been established involving this class of sequences.

On considering f a modulus function and a given multiplier sequence $\Lambda=(\lambda_k)$, the classes of sequences $c^F(f, \Lambda, \Delta_m, p)$, $c_0^F(f, \Lambda, \Delta_m, p)$ *and* $\ell_\infty^F(f, \Lambda, \Delta_m, p)$ of fuzzy real numbers we have been introduced in [B.C. Tripathy and S. Debnath, *Acta Scientiarum Technology*, 35(1)(2013), 117-121.]. Further considering the notion of ideal of N, the set of natural numbers, the classes of sequences $m^{I(F)}(\Delta^n) = c^{I(F)}(\Delta^n) \cap \ell_\infty^F(\Delta^n)$ and $m_0^{I(F)}(\Delta^n) = c_0^{I(F)}(\Delta^n) \cap \ell_\infty^F(\Delta^n)$ have been introduced in [B.C. Tripathy and M. Sen, *Journal in Intelligent and Fuzzy Systems*, 25(3) (2013), 643-647.]. It is shown that these classes are closed under addition and multiplication, neither solid nor monotone nor symmetric nor convergence free in general.

The class of sequences $m(M,\phi)^F$ of fuzzy real numbers is introduced in [B.C. Tripathy and S. Borgogain, *Kyungpook Math. Journal*, 53(3)(2013), 319-332.]. It is shown that this is a complete fuzzy metric space. Its other properties like solidity, monotone, symmetricity and convergence free have been examined with the help of fuzzy metric. The notion of statistically convergent difference sequence spaces of fuzzy real numbers defined by Orlicz functions have been introduced in [B.C. Tripathy and S. Borgohain, *Thai Jour. Math*. 11(2) (2013), 357-370.]. It is shown that the spaces $m^F(M)$ and $\left(m_0\right)^F\left(M\right)$ are complete metric spaces. It is verified that these classes of sequences are neither solid nor monotone nor symmetric nor convergence free.

Fixed Point Results in Fuzzy Metric Space

A sequence $\{x_n\}$ is a fuzzy 2-metric space $(X,M,*)$, where X is an arbitrary set, * is a continuous Hadzic type t-norm and M is a fuzzy set in X^3 x $[0,\infty)$ is said to converge to x in X if and only if $\lim_{n\to\infty} M(x_n,x,a,t) = 1$ for all $a\in x$ and $t>0$.

Common fixed point theorems in fuzzy 2-metric spaces have been established in the paper [B.C. Tripathy, S. Paul and N.R. Das, Proyecciones J. Math., 32(4), (2013), 363-379.], which generalizes the Banach Contraction mapping principle and the Kannan's fixed point theorem respectively in fuzzy 2-metric spaces.

Fuzzy Topological Space

In the paper [B.C. Tripathy and S. Debnath, *Journal of Intelligent and Fuzzy Systems*, 24(3)(2013), 631-635.] we have introduced the notion of γ-open sets and γ-continuous functions in fuzzy bitopological spaces. We have examined some basic properties and prove some characterization theorems for the said functions. It is observed that every pairwise fuzzy γ-continuous functions is pairwise fuzzy precontinuous but the converse not true.

In the paper [B.C. Tripathy and G.C. Ray, *Applied Mathematics and Computations*, 220(2013), 602-607.] we have introduced a new concept of fuzzy δ-*I*-continuity between mixed fuzzy ideal topological spaces. Its different properties have been investigated, which includes, every fuzzy regularly *I*-open set is fuzzy δ-*I*-open and every fuzzy δ-*I*-open set is the union of a family of fuzzy regularly *I*-open sets.

Spectra of Matrix Operators

The infinite matrices transforming one class of sequences into another class of sequences have been considered. In the article [B.C. Tripathy and P. Saikia, *Math. Slovaca*, 63(3)(2013), 563-572.], the point (discrete) spectrum, the continuous spectrum and residual spectrum of the Cesàro operator C_1 which is regarded as an operator on the space $\overline{bv_0}$, the space of statistically null bounded variation sequences have been investigated.

The point (discrete) spectrum, the continuous spectrum and residual spectrum of the operator $D(r,0,0,s)$ over the sequence space c_0 and c have been obtained in [B.C. Tripathy and A. Paul, *Kyungpook Math. Journal*, 53(2)(2013), 247-256.]. The point (discrete) spectrum, the continuous spectrum and residual spectrum of the operator $D(r,0,s,0,t)$ over the sequence spaces

c_0 and c have been investigated in [B.C. Tripathy and A. Paul; Journal of Math.; vol. 2013, (2013), Article ID 430965, 7 pages.]. These results generalize and unify several existing results.

The infinite matrix of operators $B(f, g)$ on the vector valued sequence space $c_0(X)$ is considered and its different spectra have been studied in [B.C. Tripathy and A. Paul, *Boletim da Sociedade Paranaense de Matemática*, 31(1) (2013), 105-111.].

Bitopological Spaces

Different properties of weakly *b*-continuous functions in Bitopological spaces have investigated in a bitopological space (X, τ_1, τ_2) in [B.C. Tripathy and D. J. Sarma, *Acta Scientiarum Technology*, 35(3)(2013), 521-525.]. Further in the article [B.C. Tripathy and D. J. Sarma, International Journal of Modern Mathematical Sciences; 7(3)(2013), 276-286.], the notions of pairwise strongly *b*–open and pairwise strongly *b*–closed functions in bitopological spaces have been introduced and some interesting properties have been examined.

Sequence Spaces in Probabilistic Normed Space

The notions of *I*-limit superior and *I*-limit inferior of sequences in probabilistic normed space have been introduced in [B.C. Tripathy and M. Sen, Internat. Jour. Modern Math. Sci., 7(1)(2013), 1-7.] and some *I*-analogue of properties of statistical limit superior and limit inferior for sequences in probabilistic normed space have been investigated. The concept of *I*-limit points and *I*-cluster points in probabilistic normed spaces are also introduced and some of their properties have been investigated.

On Multiple Sequences

The notion of triple asymptotic density of subsets of NxNxN have been introduced in [B.C. Tripathy, A. Esi and A.J. Dutta, J. Math. Analysis, 4(2)(2013), 16-22.]. With the help of this notion the notion of statistically convergent triple sequences defined by Orlicz functions in (X, f) a semi-normed space, semi-normed by f have introduced. It is shown that the classes of sequences are seminormed linear spaces.

(b) WORK DONE ON APPLIED STOCHASTIC PROCESS

Queueing theory is an important area of Applied Stochastic Processes Its progress and development both in methodology and in applications are ever growing. As a result of which it is an important area of current research. In this context, some important contributions have been made on different branches of queueing theory as given bellow:

Work done on Retrial Models

During last two decades there have been considerable attention paid to the analysis of queueing systems with repeated attempts (or retrial queues).Retrial queues are characterized by the following feature that a customer who finds the server busy upon arrival is obliged to leave the service area to repeat his demand after some random amount of time called ***retrial time***. Between

trials, the blocked customer joins a pool of unsatisfied group of customers called "***orbit***" or "***retrial group***". The pioneering studies of retrial queues are to present the concept of retrial time as an alternative to the classical model of telephone systems. In this context each block customer generates a stream of repeated requests independently of the rest customers in the retrial group.. This type of model has been studied by ***Yang and Templeton*** **[*QUESTA,* 2 (1987), 201-233]** and ***Falin*** **[*QUESTA,* 7(1990), 127 – 168]**. In this context, we have investigated various stochastic processes such as orbit size distribution and system size distribution for an $M^X/G/1$ queue with two phases of service under Bernoulli vacation schedule under ***Linear retrial policy***, where the interval between successive repeated attempts are exponentially distributed with parameter $\theta_n = n\theta + \alpha(1-\delta_{n,0})$(say), [where θ can be considered as the retrial rate per customer and α the rate at which the server seeks service for customer whenever he is idle and $\delta_{i,j}$ denotes Kronecker's delta function] when the number of customers in the retrial group (orbit) is '*n*'. in ***Choudhury andDeka [# Acta Mathematica Applicatae Sinca,*** **29(1),15 -34, (2013)].**

Work done on Control of Queues and vacation models

Control of queue is one of the most significant area of research. It is customary to classify models into two general categories: ***descriptive*** and ***prescriptive*** models. *Descriptive models* are models which describe some current real world situation, while prescriptive models are models which prescribe what real world situation should be, that is, optimal behavior at which to aim. The determination of an optimal policy for a queueing system is an important issue. This is usually done by developing the total expected cost function per unit time for the system and then deriving the relevant optimal system parameters. In this context, ***Tadj and Choudhury[# Applications and Applied Mathematics:An International Journal,8(2), 346-365, (2013)]*** have designed an optimal management for the $M^X/G/1$type of queueing system with two phases of service for unreliable server under $T-$ *policy .#]*.Further, we have developed a recursive scheme for computation of limiting probabilities for an multi-thresholdSynchrous vacation model in**Wu, Ke and Choudhury*[# Journal of Testing and Analysis,41(2), 366- 373,(2013)#]***.

Data Analysis related works for Status of Students of school in Guwahati

Research in every field and more so in the field of education is the demand of the day. Without systematic research, and its applications, there would have been very little progress. The present century has seen great advancement in scientific and technical knowledge as a result of exploration of knowledge. In order to keep place with modernization, the Indian Education Commission (1964-66) suggested the Education should awaken curiosity, develop interest, attitudes, and build up essential skills as independent study and capacity to think and judge for one self. Hence, we have investigated performance of students for Mathematics of Guwahati based on result of students of Class VIII – IX.

(C) WORK DONE ON IMAGE PROCESSING, PATTERN RECOGNITION AND DISTRIBUTION THEORY

Some work on image processing techniques on pathological images of brain, lung and cervix cancer were done. Based on the results a Decision Making software was developed using

MATLAB. Some image processing works were also done on some relevant and important Biometric topics like Handwritten Offline Signature. Also some Epidemiological study was done related to prevalence, incidence and survival factor of Ca.breast in Assam.

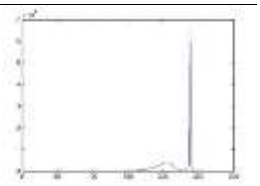
IMAGE PROCESSING AND PATTERN RECOGNITION

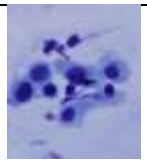
Medical image processing, particularly, has been selected as the area of interest. Early detection of tumours provide the first and most important step towards its treatment. Radiological and histopathological images are used for diagnosis of tumours, and maybe further classified as benign or malignant. The purpose of the area of interest is to provide a Decision Support System (DSS) to the radiologists or pathologists for quick and accurate diagnosis of the images using different techniques of image processing and pattern recognition. Few important regions of interest (ROI) have been selected for the study.

CERVIX: We are trying to develop an automated system for detection and segmentation of abnormal cervical cells using the help of Pap smear images. There are many features which identify a cell as benign or malignant, viz. Area of Nucleus, Perimeter of Nucleus, Eccentricity of Nucleus, Hyperchromasia, N/C ratio, Texture Analysis etc.

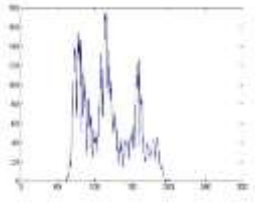
Some study have been done on analysis of abnormality in the cervical cells based on Texture and presence of Hyperchromasia, which are two important morphological features based on which one can distinguish between normal and abnormal cervical cells. The proposed approach is implemented in MATLAB®, a high level, interactive environment for data visualization, analysis and computation. For Texture analysis the Histogram Approach and GLCM Approach have been studied.

(Source: Dr B.Barooh Cancer Institute)

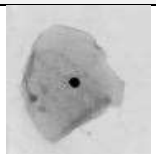
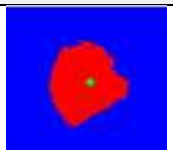
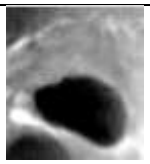
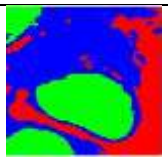




(Source: Dr B.Barooh Cancer Institute)



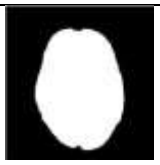
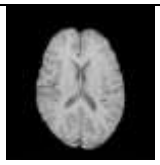
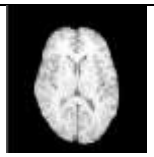
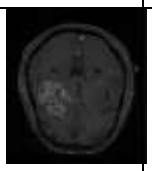
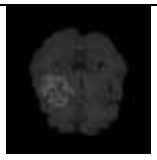
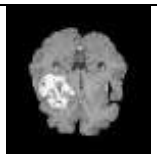
Some studies have been done on extraction of features of area and eccentricity of the nuclei, employing segmentation based on the K-means clustering algorithm. A database composed of images with single cells [13], from the Herlev University Hospital, Denmark has been made available as an open source for research and educational purposes. 20 Pap smear images each of normal and abnormal set has been considered for experimental purposes.

Case type	Original image	processed image	Segmented image(using K-means)	Edge detection	Nucleus extraction
Normal cell					
Abnormal cell					

BRAIN: Medical image processing is a very important and challenging task and tumor detection from MRI plays a crucial rule. Artifact removal and Segmentation both are two fundamental steps in processing brain MRI slides. To understand the image more clearly and reduce the manual segmentation time a computer aided system is required. Our first study is a morphological based preprocessing method and then a segmentation of the image using K-means algorithm and finally tumor volume calculation.

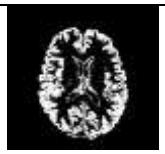
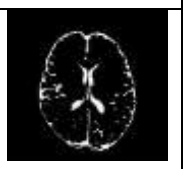
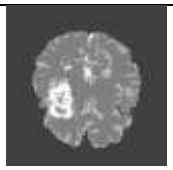
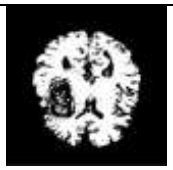
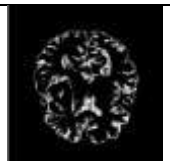
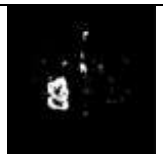
Results of Pre-processing steps:

Input images are Axial T1 normal and abnormal cases. The results are shown step by step in Table 1.

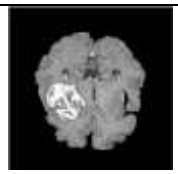
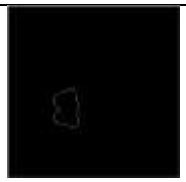
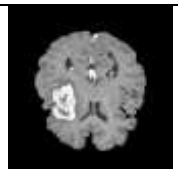
Case Type	Original Image	Binary Image	After Morphological Operation	Image Without Artifacts	Image After Enhancement
Normal Case					
Abnormal Case					

Results of Post-Processing:

a) Segmentation using k-means algorithm:

Case Type	Segmented Image	Cluster 1	Cluster 2	Cluster 3
Normal				
Abnormal 1				
Abnormal 2				

b) Extracting the Tumor Portion:

Case Type	After Morphological Operation and filing holes	Tumor Edge using Sobel edge operator	After removing the area less than threshold value	Final image marking the tumor boundary
Abnormal 1				
Abnormal 2				

3.3.5. LUNG. Lung cancer is the leading cause of cancer related death around the world. Early/proper diagnosis can improve the effectiveness of treatment and increases patients chance of survival. CT(HRCT), PET, LDCT are most common noninvasive imaging modalities for detection and diagnosing lung nodules. The prognosis requires that the radiologist/oncologist need to form a perspective of the patient based on many CT images.

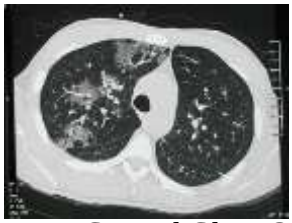


Fig-2: Ground Glass Opacity

Fig 3: Lung Fibrosis

Figures 2 and 3 show the variability of lung cancer images and difficulty in creating a CAD system for such an image.

The difficulty in analysing images as given above are due to the fact that they do not have a solid nodule to show the prognosis properly. This kind of difficulty may be addressed by using a mathematical technique called Wavelet analysis. Our research is based on the study of this methodology to validate the claim of its usefulness in such cases and also to develop it further to utilise as a successful method of prognosis. Some Preliminary results show different capability of different wavelets as for DB20 wavelet.

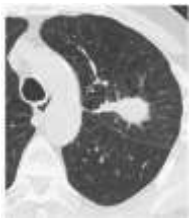


Fig 5: original image

Fig 6: Outline using DB20 Wavelet

❖ **Biometrics**

Handwritten Signature is a biometric measure. Both verification and identification mode can be operated by a biometric system. For any signature verification system, detection and correction of skew and slant angles are two important factors in preprocessing stage. To make an efficient verification system, the input signature image should be perfectly preprocessed as far as possible so that we can properly extract the required features. In correction of skew angle, attempt is made that word orientation of the signature is parallel to horizontal direction. On the other hand, in slant angle correction, operations are performed to make all the vertical strokes erect.

A snapshot of the resultant of such a preprocessing technique is shown below.

Fig 1: Slant signature

Fig 2: Slant free signature

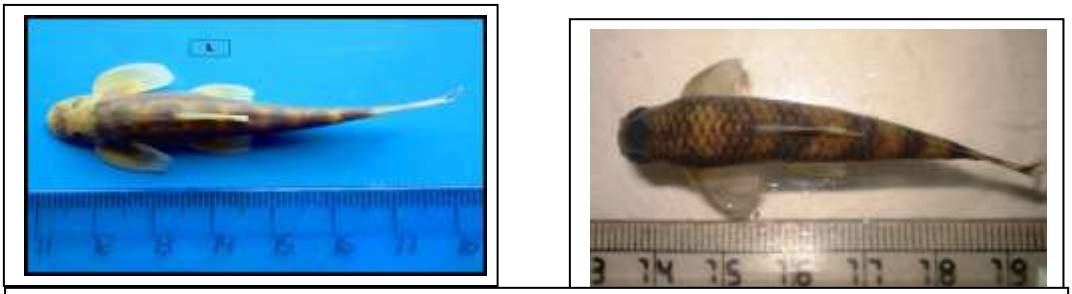
4. Biodiversity & Ecosystem research

Research focus in this programme has been limited to survey and characterization of few selected life form as component of biodiversity mostly in selected pockets of North East Indian part of Indo-Burma biodiversity hotspots. This includes both microscopic bacteria, actinomycetes and fungi and macro fauna such as fish and aquatic life forms and silkworms. Fish is abundant in flowing river and other water bodies such as ponds, reservoir, lakes and different types of wetland including marshy/sunny areas. Other unique feature of North Eastern region biodiversity is anthropogenic fabric which includes rich culture of harmonious living with nature, judicious harvest from nature for food and natural health care. Unique knowledge on health care including most of medicinal herbs and formulations, confined within 250 tribes of the region as a result of experiences of thousand years of their co-habitation with nature. Scientific validation of these knowledge in cure of metabolic syndromes is part of IASST research programme.

It is well known that anthropogenic activities such as excess waste generation, extensive oil drilling, chemicals and pesticides use in agriculture and synthetic drug use in health sector threaten biodiversity, ecosystem function and environmental health. While individual scientists in past had generated data in isolation along with their level best efforts to generate technology from bioresources relevant to the niche areas listed above, a need is felt to relook at individual efforts from an ecosystem perspective and reorganize the programme to make it holistic. Presentation of the result of this programme reflects an attempt of scientists in engaging themselves as a group for synergy and enhanced output from research efforts.

Exploration of diversity of fish and aquatic mites in new habitats of North-East India

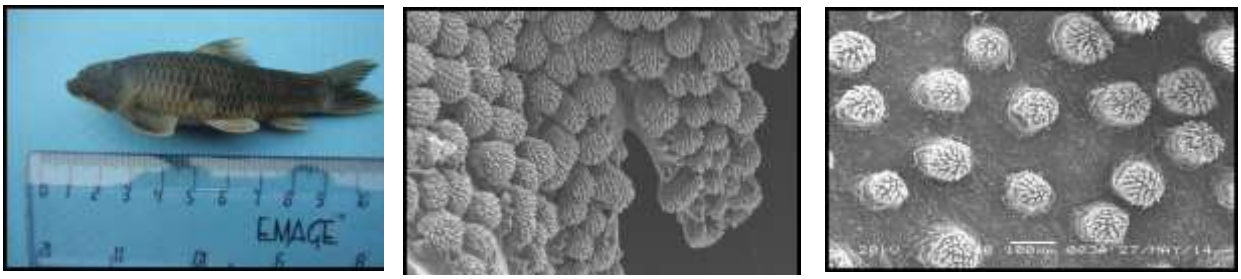
Efforts on exploration of fish diversity during the last decade have resulted in fresh collection of 115 species from the lotic and lentic systems of Assam including two new records of occurrence. During 2013-14, a total of 64 species belonging to 6 orders and 17 families were recorded from Lakhimpur district, Assam. Two fishes *Balitora brucei* and *Psilorhynchus balitora*, (Fig. 1. A and B) were selected for studying detailed biology and to develop length-weight relationship as an indicator of ecosystem health. Positive allometric growth (*B. brucei* =3.338, *P. Balitora* =3.449) in both the fishes signifies that the habitat Ranganadi is conducive for the growth of the two fishes.



A **B**

Figure 1: *Balitora brucei* (A) and *Psilorhynchus balitora* (B) collected from Ranganadi River of Lakhimpur district

During the year 2013-14, icthyofaunal diversity in the river Basistha, a torrential river flowing through the Basistha hills of Guwahati, was studied. For the same habitat, the icthyofaunal diversity was determined about 16 years ago. This study has provided data for a comparison and reflection of changes. Altogether, a total of 21 species belonging to 15 genera and 9 families have been recorded in the present study against a record of 16 species belonging to 11 genera and 5 families found in 1997. Icthyofaunal diversity of Basistha river comprises of torrential and riverine fishes. *Garra nasuta*, a torrential species with SEM image of its upper lip and suctorial disc showing adaptive modifications to the fast flowing water, are shown in Fig. 2.



A **B** **C**

Figure 2: *Garra nasuta* (A) showing Scanning Electron Micrograph of the upper lip (B) and suctorial disc (C). These features are used for adaptation in fast flowing water

Eco-biological study of *Botia Dario* collected from Majuli, Assam

Eco-biological study was initiated with *Botia Dario* (Hamilton, 1988) (Fig. 3) collected from a floodplain wetland (beel) in the river island Majuli, Assam. Gut content of the fishes were analyzed and in one of the fishes nine water mites were recorded. These mites were studied and identified using standard taxonomic keys. The mites belong to two families, Torrenticolidae and Hygrobatidae. Of these species, *Torrenticola episce* is a species discovered for the first time in this study. Of the remaining species, three species namely, *Torrenticola haliki* Pesic and Smit 2010, *Monatractides oxystomus* (K.Viets, 1935) and *Hydrobates cf. sinensis* Uchida & Imamura, 1951 are new records for India.

Figure 3: ***Botia dario*** (Hamilton, 1822) collected from river island Majuli, Assam representative species of mites isolated from its gut

Biomagnification of heavy metals in fishes of Deepor beel (Ramsar site, No. 1207) contaminated with seepage from Municipal Solid Waste disposal site (MSWDS)

Heavy metal content in surface water, groundwater, sediment and fish in Deepor beel were studied in an area stretching upto 3000m away from the MSWDS. Highest concentration was found in the samples nearest to the dump site and the gradual decrease in concentration further away. The concentration of heavy metals (for example: Mn-0.91-2.72 ppm) in surface water was found to be higher than the permissible limit of Bureau of Indian Standards (BIS), 2012 i.e 0.3 ppm. In sediment, the concentration of heavy metals (for example: Mn-9.23-12.77 ppm) was higher than the World Average Shale Value (WASV) i.e. 0.85 ppm. Fish as tertiary consumers, accumulate these heavy metals from their surrounding environment and their concentration (for example: Cu-2.22-3.74 ppm, Cd-1.70-3.12 ppm) was more than the permissible limit suggested by Food and Agriculture Organization (FAO). This indicated bio-magnification of the heavy metals in the food chain. The Bioaccumulation Factor (BAF) in fish for Cd was 7.35 ppm and for Cu was 4.1 ppm. BAF value greater than1 indicates that bioaccumulation has taken place in fish.

Muga silkworm genetic diversity, improved degumming of *muga* silk cocoons and utilization of *muga* silk as biomaterial

Genetic diversity and phylogeny among four color morphs of *Antheraea assamensis* Helfer were investigated by using RAPD, mitochondrial *16s rRNA* and *coxI* gene sequence. Three semi-domesticated color morphs i.e. green, blue, and orange and another wild morph of *A. assamensis* were used in this study (Fig. 4). Analysis of both RAPD and mitochondrial gene indicated a demarcation between the semi-domesticated and wild morph of *A. assamensis* Helfer. Wild morph was genetically divergent from the remaining three semi-domesticated morphs (Fig.4). This result warrants more research on *A. assamensis* Helfer diversity and conservation measure which will finally assist in efficient breeding programme for important but dwindling *A. assamensis* culture in North east India.

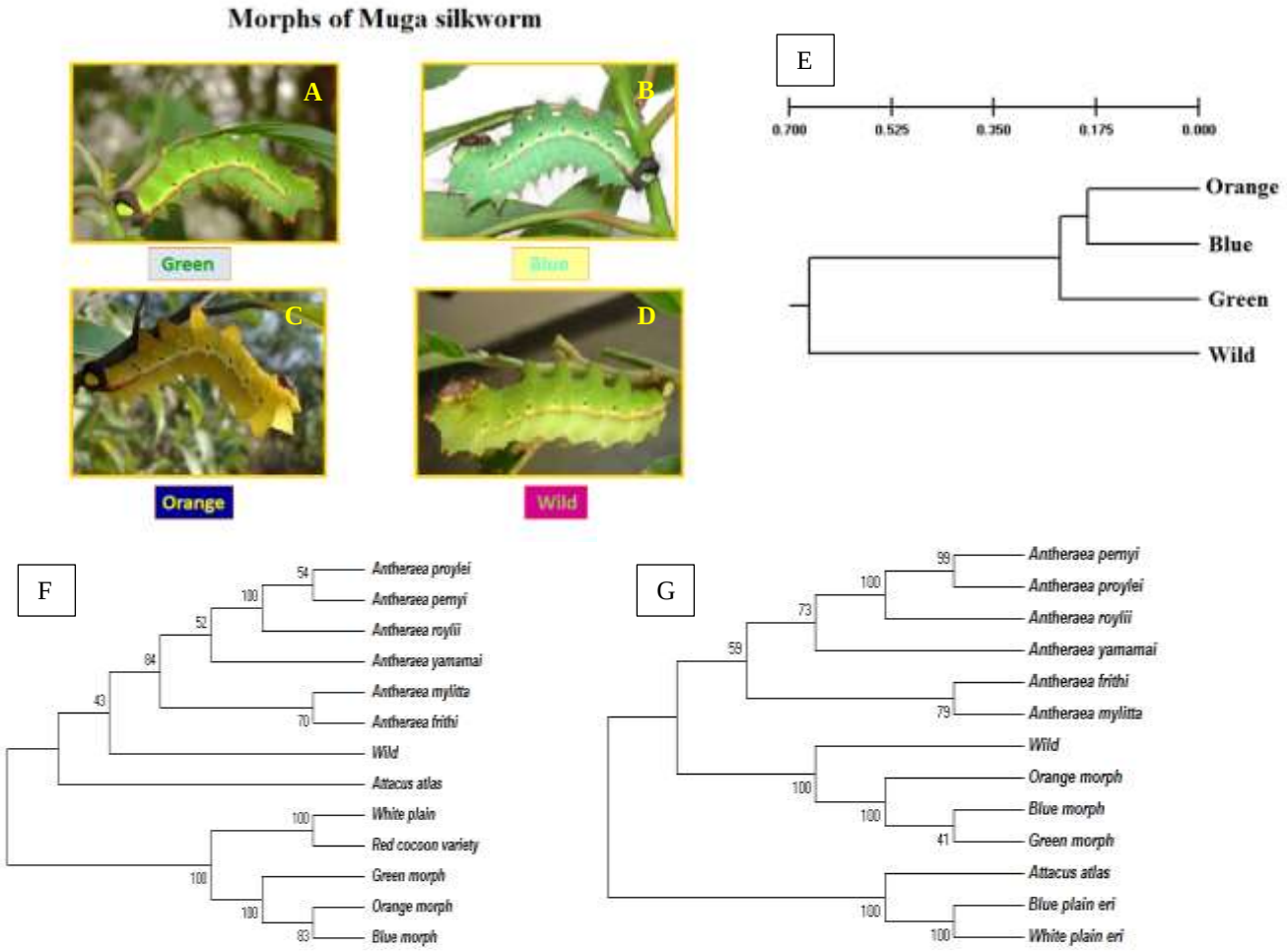


Figure 4: Appearance of the three color morphs (A,B and C) of the semi domesticated and one wild morphs (D) of *Antheraea assamensis* Helfer. Dendrogram of four morphs showing their relatedness based on RAPD marker (E), 16S rRNA (F) and coxI gene (G). Note that in 16S rRNA and coxI gene analysis several other silkworms were tested along with the semi-domesticated and wild morph of *A. assamensis*.

Degumming of *muga* silk cocoon

Silk is a biopolymer which is engineered by the silkworm from its paired salivary glands. Silk is derived from cocoons produced by selected silkworm. Silk fibre in silkworm cocoon is a complex of fibroin (73-75%) and sericin (25-27%). Sericin is responsible for harsh and rigid feeling in the cocoon fibre and removal of sericin through alkali hydrolysis from the complex ensure typical lustre, softness, brightness, elasticity and other functional properties. Although 0.3% aqueous solution of sodium carbonate for 1g cocoons has been developed as a standard method for degumming, the right concentration is hardly used by *seri* farmers. Traditionally, banana rhizome/pseudo-stem derived alkali (locally known as *kolakhar*) and extract of fruit locally called *reetha* have also been used by *seri*-farmers for enhancing smoothness of *muga* silk fabric. In this study, these traditional degumming materials i.e. *kolakhar, reetha* and *lemon* were evaluated at pH range of 2.5-10.5 for their effectiveness in degumming *muga* cocoon fibre. The treated fibres were characterized using FTIR, SEM, TGA, DSC and XRD. Quality of fibres in terms of attributes listed above was found to be better when treated with the traditional materials compared to these treated with sodium carbonate (Fig. 5).

Grafting of *muga* silk fiber to mitigate adverse effect of chemical degumming:

Chemical (sodium carbonate) degumming may lead to hydrolytic degradation of fibroin affecting of the silk generated. Grafting has been suggested as an eloquent mechanism to mitigate the loss in the attributes as a result of chemical degumming. The commonly used materials for grafting are chemical such as vinyl monomers like MMA, MAA, acrylic acid etc. In this study, we tested effect of two naturally found low cost i.e. BSA (bovine serum albumin) and casein (milk protein) along with for radical mechanism initiator 2, 2′ azobisisobutyronitrile (AIBN). The tensile properties of the protein-grafted *muga* silk were improved by grafting. Casein grafted silk shared better tensile properties then the BSA grafted (Table.1).

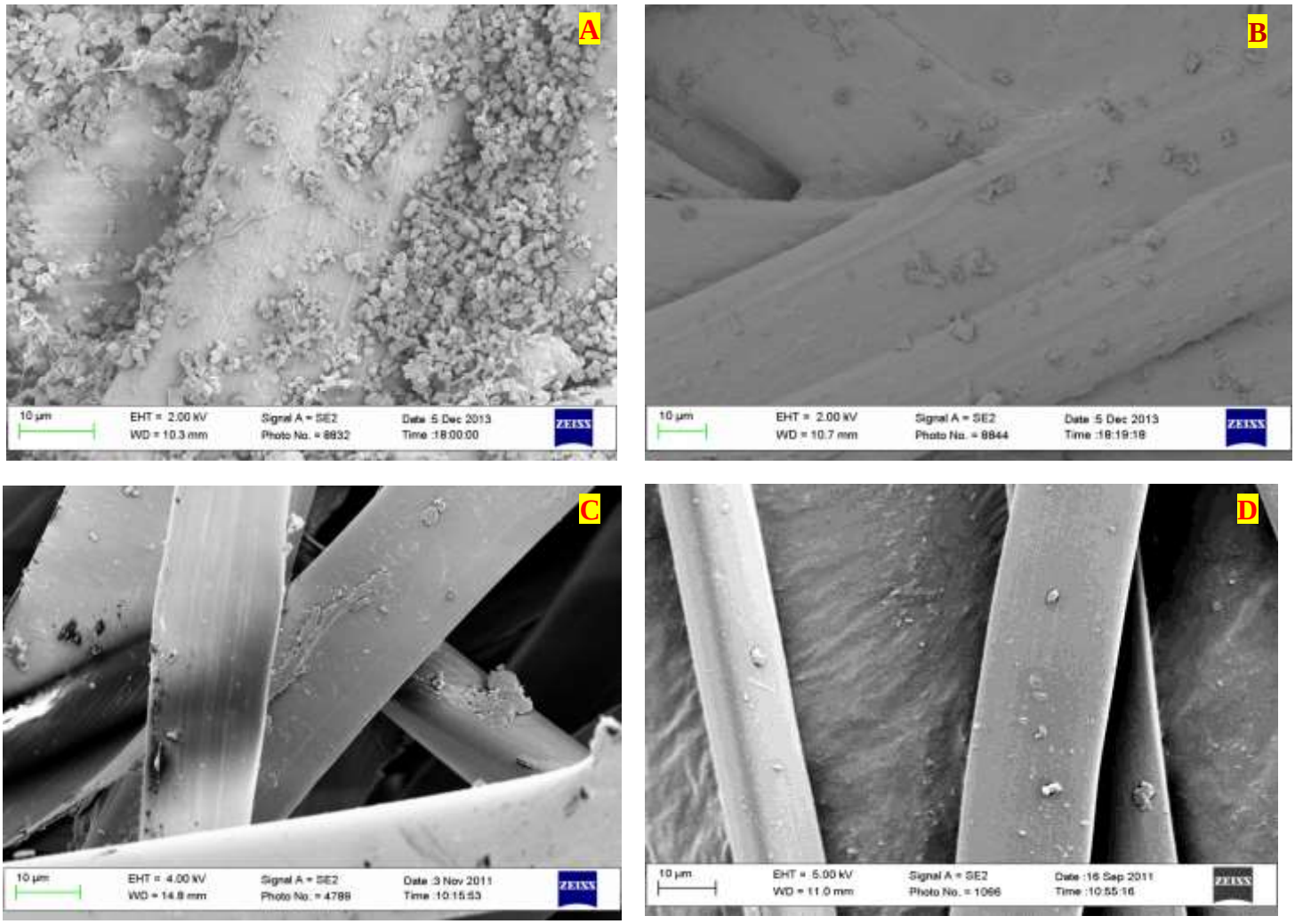


Figure 5: SEM images of untreated (A), Na_2CO_3 (B), lemon (C) and *kolakhar* (D) treated silk cocoon fiber.

Table 1: Tensile properties of control and grafted *muga* silk fibers

Degummed condition	Strain (%)	Tenacity (g/den)	Young's Modulus (g/den)	Toughness (g/den)
Sodium carbonate	31.20 ± 0.35	4.101 ± 0.180	70.44 ± 4.40	0.890 ± 0.350
Without chemical	33.53 ± 0.30	4.56 ± 0.30	85.30 ± 3.09	0.994 ± 0.56
Grafted with casein	39.50 ± 1.65	4.976 ± 0.211	111.29 ± 3.67	1.882 ± 0.010
Grafted with BSA	35.86 ± 3.37	4.737 ± 0.369	81.45 ± 5.76	1.133 ± 0.264

Data are Means ± SD of 10 replicates.

Non-mulberry silk as a potential biomaterial for application in tissue engineering:

Most commonly known silk protein (fibroin and sericin) produced by *Bombyx mori* (mulberry silk) has been explored as a versatile biomaterial for the formation of films, fibers, microspheres, porous scaffolds, hydrogels etc. for various biomedical applications, due to its biocompatibility, slow degradability and robust mechanical properties. However *muga* silk, the traditional and endemic silk of higher quality found in North East India has not been explored as biomaterial for these applications.

i. Non-mulberry silk fibroin based microparticles as biomaterial for tissue engineering applications:

In our research, a forward top down approach was used to produce micro and nano sized silk particles *vis-a-vis* bottom up approach via dissolution of fibers and then regeneration. Micro structures of regenerated silk fiber by botton-up approach are difficult to reform. Furthermore this approach requires use of chemical such as lithium salts and organic solvents which are not environment friendly. Physico-chemical properties and cytocompatibility of non mulberry silk fibroin based microparticles of A. *assamesis, A. mylitta* and *P. Ricini* along with well-established *B. mori* micro-particle fiber were determined. The relative visibility of fibroblasts (L919) cells in three different size micro-particles shown in Fig. 6. Particle size of 100 µg/ml was better in

ensuring higher cell viability of fibroblast cells. *B. mori* silk fiber microparticles were inferior than non mulberry silk fibre and *A. assamensis* was best among them. Phase contrast microscopic images of microparticles treated with fibroblast cells are shown in Fig. 6 B. Microparticles of *A. assamensis* fibre suggest non uniformity of the matrix.

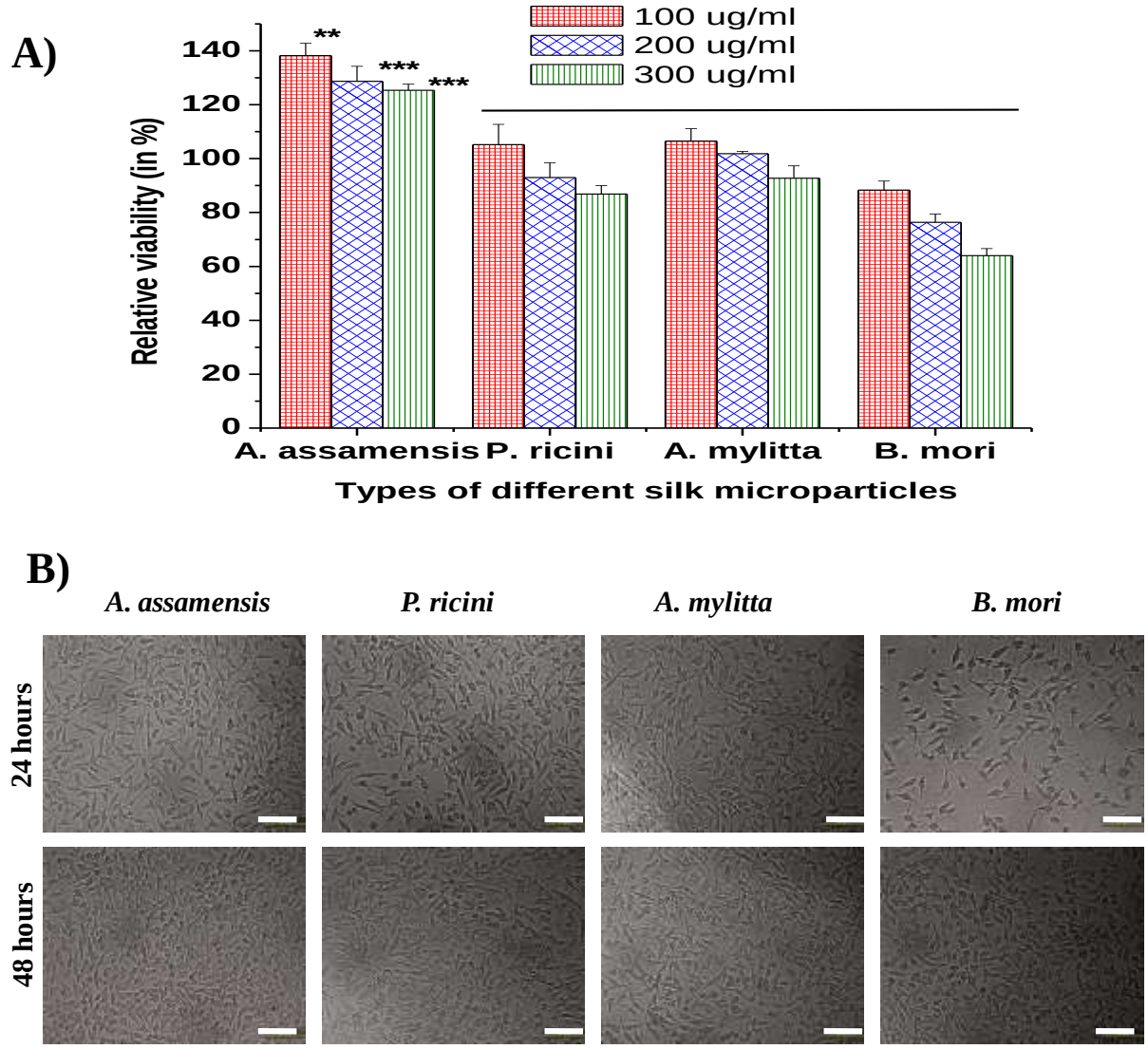


Figure 6 : Represents relative cell viability of cells in the microparticles of three sizes by hand milling of silk fibre of 3 non mulberry and one mulberry silkworm (A), phase contrast microscopic images of microparticles after 24 hours and 48 hours of incubation (B).

ii. Fabrication of silk fibroin nanoparticles from *Antheraea assamensis* Helfer and their characterization:

Silk fibroin nano particles from *A. assamensis* were prepared using de-solvation procedure. Briefly, silk fibroin was isolated from the gland of matured fifth instar larvae and dissolved in 1% (w/v) SDS containing 10 mM Tris (pH 8.0) and 5 mM EDTA. A 2% (w/v) fibroin solution was used after dialysis and was dried using lyphilization. Nano-particles were fabricated using acetone de-solvation procedure. A cross linking agent, gluteradehyde (2% v/v) was added to stabilize the protein nanoparticles. Glycine (5mg/l) was added to the solution to inactivate any free gluteraldehyde molecules. The nanoparticles were then harvested by centrifugation at 10000 rpm for 15 min at 4^0C and analyzed for their size distribution, morphology and structural characteristics using zeta potential, FTIR, SEM measurements, respectively.

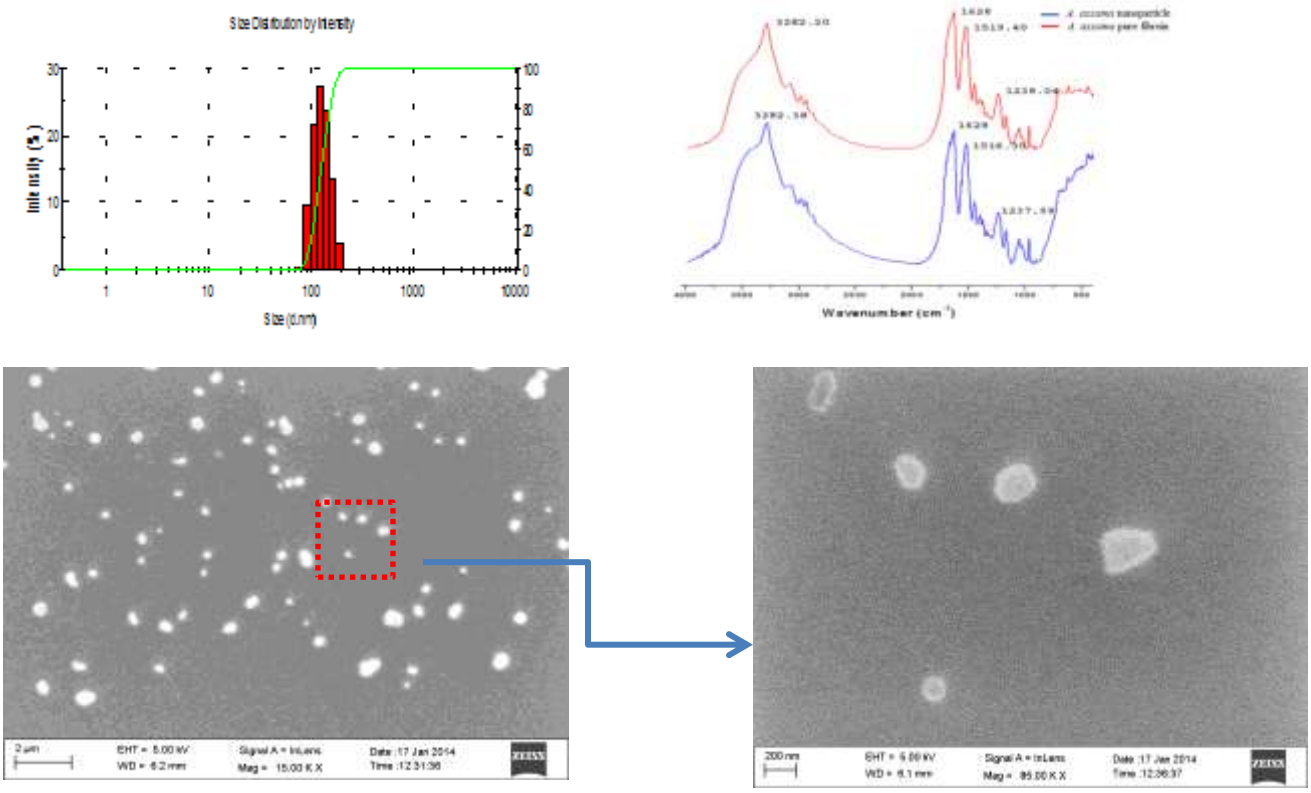


Figure 7: Pictures showing particle size distribution (A) FTIR based morphology (B) and SEM images at lower (C) and high (D) magnification of *A. assamensis* silk fibroin nano particle.

iii. Development of *muga* silk scaffold based 3-D model for cartilage tissue repair:

Cell based tissue engineering technique is employed in regeneration of damaged tissues. For development of effective technique and to apply *in-situ*, one needs to understand all factors that control orderly growth of fragmented tissue. In this research, we used *Muga* silk based 3D scaffold in a 3-D co-culture model to understand cell-cell interaction in repair of cartilage. This novel co-culture model actually mimic the initial point of contact between a tissue engineered cartilage construct populated with chondrocytes and Mesenchyme stem cells (MSCs) upon implantation. It was observed that scaffold ratio AAd14 and PRd14 (Fig. B) holds higher amounts of glycosaminoglycan (GAG) per unit of scaffold in the matrix and comparatively higher cell growth as evident from quantity of DNA (Fig. 8C). The desired cell growth and attachment were evident from SEM images (Fig. 8 A,D).

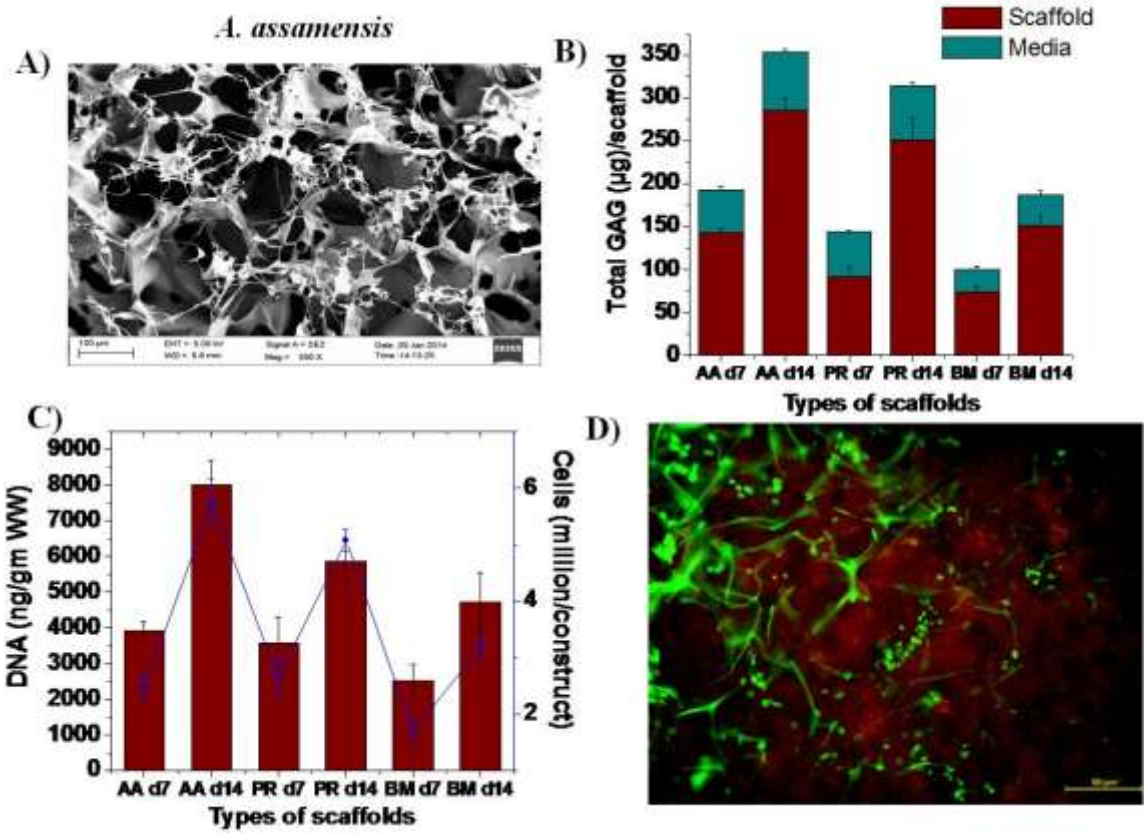


Figure 8: Scanning electron microscopy (SEM) image of untreated *muga* silk scaffold (A), content of glycosaminoglycan GAG) in extracellular matrices formed by mixing of GAG with *muga* silk fibre in different ratios (B), cell proliferation (C) and SEM images of chondrocytes growth and attachment on *A. assamensis* (*muga*) silk fibroin 3D scaffolds.

Microbial diversity and Biotechnology Research by classical and molecular approach

Exploration of microbial diversity in soil and roots of reserved forest ecosystem (disturbance free), high value commercial crops, including tea, fruit plants, hydrocarbon polluted fields, water bodies and gut of representative individual of the ethnic communities of north east India has been a major research programme of the Institute. Assessment of diversity has been done both by classical and molecular approach, including metagenomics approach and several other DNA based techniques.

Bacterial diversity of medicinal plant *Houttuynia cordata*

During the year, 183 bacteria of distinct morphology were isolated from the root, rhizome and rhizosphere of *Houttuynia cordata*, a medicinal plant whose extract is used for curing stomach problem. The isolates were characterized for various metabolic, plant growth promoting and other biotechnologically useful activities, based on which they were clustered into four groups by principal component analysis. Based on restriction fragment length polymorphisms, the isolates were grouped into 12 phylotypes; the isolates belonged to *Proteobacteria* and *Firmicutes* groups. Functionally, isolates in *Proteobacteria* group showed both plant growth promoting and antibacterial activities, while *Firmicutes* group exhibited predominantly hydrolytic enzyme activity. The 16S rDNA gene sequences obtained from one representative isolate from each of the 12 phylotypes were deposited to GeneBank (Accession numbers KJ021706 to KJ021717).

Diversity of rhizospheric microorganisms of tea (*Camellia sinensis*)) and evaluation of their plant growth promoting (PGP) substances and antifungal metabolite/s for use against fungal pathogens of tea

Rhizosphere associated microflora from the soils of conventional and organic tea gardens of Assam and Darjeeling (WB), India were isolated and screened for PGP and antifungal activities. A total of 217 bacteria, 30 fungi and 38 actinomycetes strains from Assam tea estates and 150 bacteria, 20 fungi and 23 actinomycetes strains from Darjeeling (WB) tea estates were isolated. 106 (48.8%) bacteria of Assam tea estates isolates showed phosphate solubilizing ability, 44 (20.2%) siderophore production ability, 164 (75.5 %) ammonia production, 66 (30.4%) indole acetic acid production ability and 178 (82%) nitrate reduction ability. Similarly, out of 150 bacterial isolates obtained from Darjeeling tea gardens, 65 (43.3%) were phosphate solubilizers, 58 (38.6%) siderophore producers, 131 (87.3%) ammonia producers, 62 (41.3%) indole acetic acid producers and 111 (74%) nitrate reducers.

50 numbers of Actinomycetes isolates were screened for *in-vitro* antifungal activity against tea fungal pathogens, namely, *Colletotrichm camelliae, Colletotrichum gloeosporioides, Pestalotia theae* and *Glomerella cingulate* and 30-67% of the isolates were effective in inhibition of the fungal pathogens of tea *in-vitro*. Actinomycetes isolate TT-3 was effective against all the test tea fungal pathogens and appeared to be very promising.

Bacterial diversity in high value crop king chilli (KC) and Mandarin Orange (MO)

As many as 856 bacterial isolates were obtained from non-rhizosphere and loosely adhered (LARS), highly adhered rhizosphere soil (HARS) and root resident endophyte (RRE) using three selective growth media, namely, Pikovskya's agar for phosphate solubilization, King's B for fluorescent pseudomonads and Rojo Congo for Nitrogen fixing *Azospirillum*. The population density as cfu/gm of the sample materials in different niches of the root rhizosphere zone of MO and KC is shown in Table 2. RRE bacteria density was lowest and HARS bacteria density was highest, irrespective of the crops (Table 2). These isolates have been deposited in the Microbial Repository Centre for NE India at IBSD, Imphal. On screening of limited number of HARS and RRE bacterial isolates, it was found that phosphate solubilization, IAA production and ACC deaminase activity range from 6.2 to 213.8 µg ml^{-1}, 1.26 to 12.0 µg ml^{-1} culture filtrate and 2.3 to 82.4 µmole α-ketobutyrate (mg protein)$^{-1}h^{-1}$ respectively. Magnitude of these parameters indicates the extent of plant growth promoting activity of bacterial isolates.

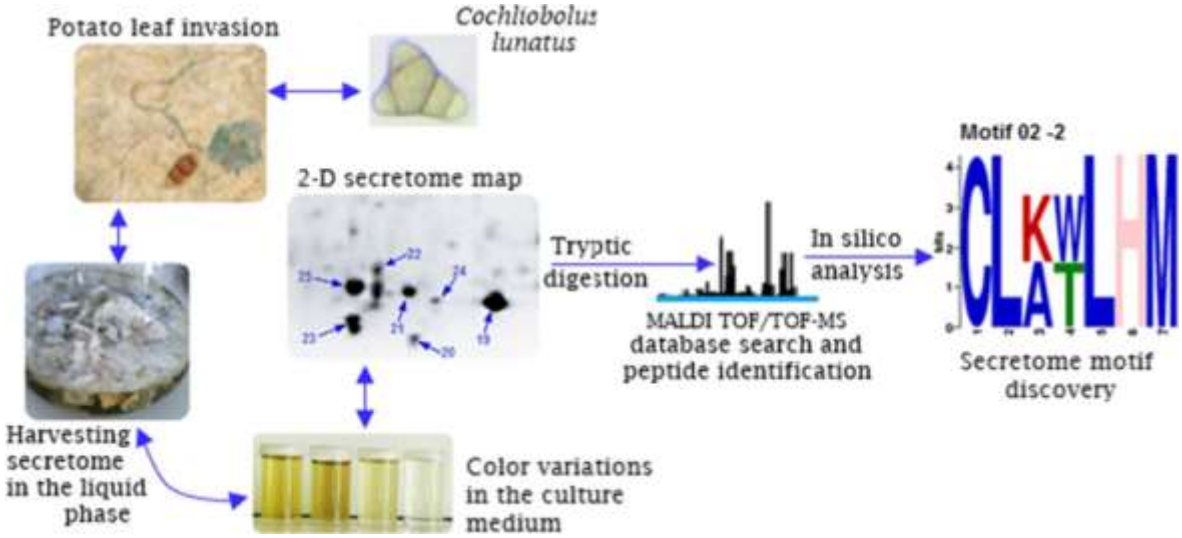
Table 2: Population density (cfu/gm dry material) of bacteria in 4 niches of Mandarin orange and king chilli grown in two sites of north east India.

Crop	Soil/root region*	Growth media/bacterial group (Log colony forming unit)		
		RC/azospi	PA/PSB	KB/FP
King chilli				
	Non-RS	6.40(±0.45)	6.83(±0.06)	6.84(±0,023)
	LARS	6.79(±0.07)	7.05(±0.08)	7.004(±0.17)
	SARS	7.86(±0.61)	7.89(±0.65)	8.04(±0.60)
	Inside root	3.64(±1.43)	3.78(±0.83)	3.52(±1.35)
Mandarin orange	Non-RS	7.52(±0.06)	7.011(±0.76)	7.25(±0.26)
	LARS	8.15(±0.60)	8.15(±0.58)	7.94(±0.90)
	SARS	8.32(±1.11)	8.72(±0.63)	8.72(±0.50)
	Inside root	4.79(±0.28)	5.40(±0.39)	5.02(±0.36)

*Non-RS=Non-rhizosphere soil, LARS=Loosely adhered rhizosphere soi, SARS=Strongly adhered rhizosphere soil MO=mandarin orange

Mechanisms of interaction of a human pathogen *Cochliobolus lunatus* with potato:

Cochliobolus lunatus (Nelson and Hassis), a member of Dothideomycetes predominantly produces four-celled conidia primarily disseminated by air. *C. lunatus* causes several diseases in human as well as in food crops such as rice (*Oryza sativa* L.), wheat (*Triticum aestivum*), potato (*Solanum tuberosum* L.), sorghum (*Sorghum bicolor*), cassava (*Manihot esculenta*) and maize (*Zea mays*). Proteomics analysis of virulence variations in *C. lunatus* strains revealed that melanin synthesis-related proteins and heat stress-related proteins (HSP70) are the basic virulence-growth factor during invasion in maize. Although only intracellular protein from mycelia was used in these studies, the data indicated that a large repertoire of functional proteins of *C. lunatus* is unknown. 'Secretome' refers to a set of secreted proteins at a given physiologic condition; which plays a key role in cell signaling, intracellular trafficking and migration of invasive weaponries (i.e. candidate effectors) in pathogenic interactions. *C. lunatus* has attracted the interest of many workers on various aspects viz., induce-virulence variation, virulence differentiation and heat-dependent aggressiveness. To understand the mechanism better, we dissected the secretome of *C. lunatus* interacting with potato (*Solanum tuberosum* L.) leaf at different temperature regimes. *C. lunatus* produced melanized colonizing hyphae in and on potato leaf, finely modulated the ambient pH as a function of temperature and secreted diverse set of proteins. Using two dimensional gel electrophoresis (2-D) and mass spectrometry (MS) technology, we observed discrete secretomes at 20°C, 28°C and 38°C. A total of differentially expressed peptide spots and 10 unique peptide spots (that did not align on the gels) matched with unique protein models predicted from *C. lunatus* m118 v.2 genome peptides. Furthermore, *C. lunatus* secreted peptides via classical and non-classical pathways related to virulence, proteolysis, nucleic acid metabolism, carbohydrate metabolism, heat stress, signal trafficking and some with unidentified catalytic domains. We have identified a set of 5 soluble candidate effectors of unknown function from *C. lunatus* secretome weaponries against potato crop at different temperature regimes. Our findings demonstrate that *C. lunatus* has a repertoire of signature secretome which mediates thermo-pathogenicity and share a leucine rich "CL[xxxx]LHM"-motif. Considering the rapidly evolving temperature dependent-virulence and host diversity of *C. lunatus*, this data will be useful for designing new protection strategies



Exploration of *Actinomycetes* spp. from protected forest soil of Assam for antimicrobial secondary metabolites against Methicillin-resistant *Staphylococcus aureus* (MRSA):

Methicillin-resistant *Staphylococcus aureus* (MRSA) is a bacterium responsible for several difficult-to-treat infections in humans. MRSA is any strain of *Staphylococcus aureus* that has developed, through the process of natural selection, resistance to beta-lactam antibiotics, which include the penicillins (methicillin, dicloxacillin, oxacillin etc.) and the cephalosporins.

Using selective media and controlled cultivation conditions, a total of 131 morphologically different actinomycetes strains were isolated from 30 soil samples collected from Deepor Beel Wildlife Sanctuary, Kaziranga National Park and Pabitora Wildlife Sanctuary, Assam. Ninety one actinomycetes isolates were tested for the production of antimicrobial secondary metabolites *in-vitro* against disease causing test bacteria including 2 Gram positive (*M. luteus, S. aureus*), 4 Gram negative (*E. coli, K. pneumonia, P. aeroginosa, S. marcescens*) and *C. albicans*. 51 isolates (56%) showed activity against at least one test pathogen. The maximum activity was seen against *E. coli* and minimum activity against *K. pneumoniae*. The active isolates when subjected to submerged culture showed result different from those observed from prliminary screening experiment. Only 20 out of 51 isolates (22%) showed activity when grown in the liquid medium. These active isolates were further tested against MRSA strain ATCC 43300 procured from American Type Culture Collection (ATCC) and only 10 isolates showed promising activity against the MRSA strain. Three strains designated as P77, ac10 and P46 showed clear and high size of inhibition zones in agar assay plates (Fig. 9).

Figure 9: Inhibition of growth of MRSA strain ATCC 43300 by Actinomycetes strains isolated from protected forest soil of Assam.

Genetic diversity of the antimicrobial compound producing actinomycetes isolates prevalent in different protected forest ecological niches of Assam were done by amplifying 16S-rDNA region of the genomic DNA and by developing fingerprinting patterns through Hinf 1 restriction enzyme digestion (Fig. 10). The restriction PCR-RFLP profiles were transformed to genetic distances and a dendrogram was constructed from binary data using the unweighted pair group method with arithmetic mean (UPGMA).

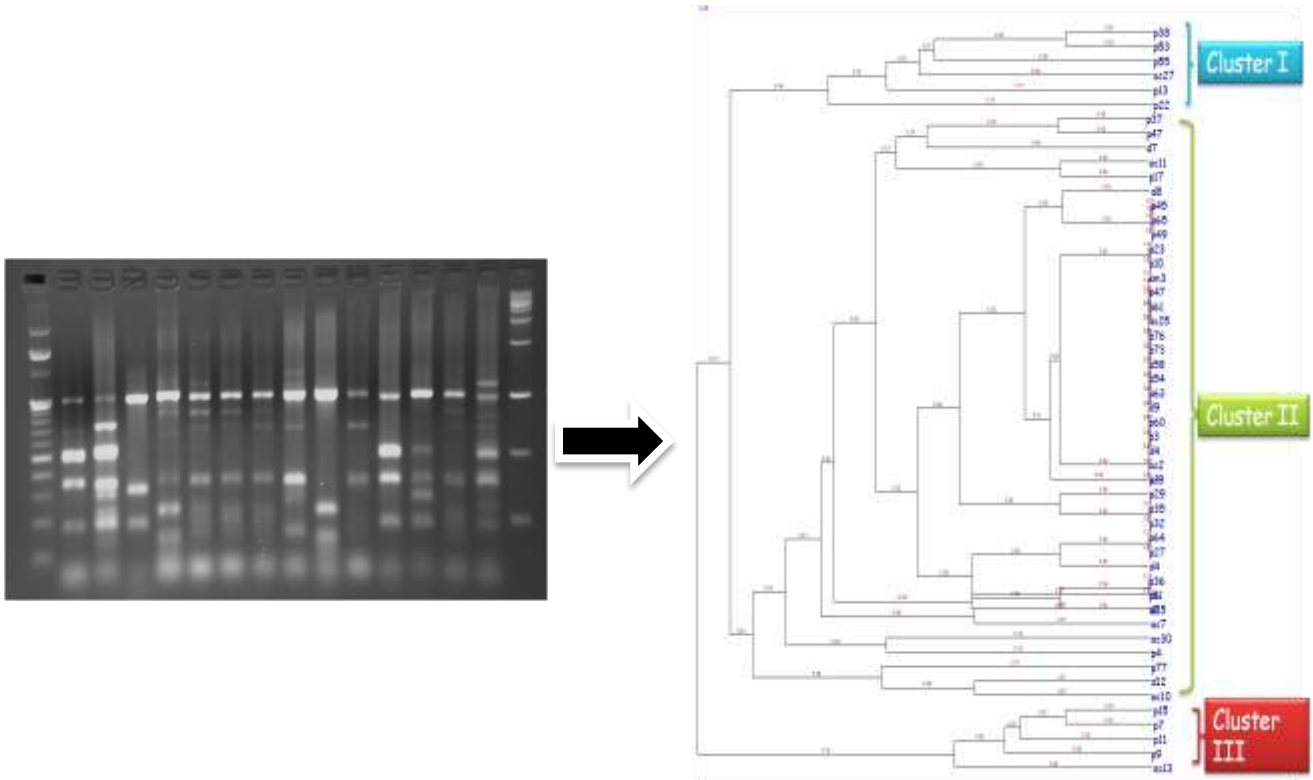


Figure 10: Hinf 1 restriction digestion pattern shows 16S rRNA-RFLP of the PCR products of antimicrobial compound producing actinomycetes isolated from protected forest soil of Assam.

Diversity of genes for cellulases in a metagenomic DNA bank

A metagenomic DNA bank comprising of metagenomic DNA of 132 soil and water samples of north-east India has been generated. These samples are now being explored for the genes, such as cellulases for industrial use (Fig. 11). Efficient cellulases have great industrial importance for conversion of lignocellulosic materials of diverse origin to sugars as substrate for fermentation to produce alternative fuel, ethanol.

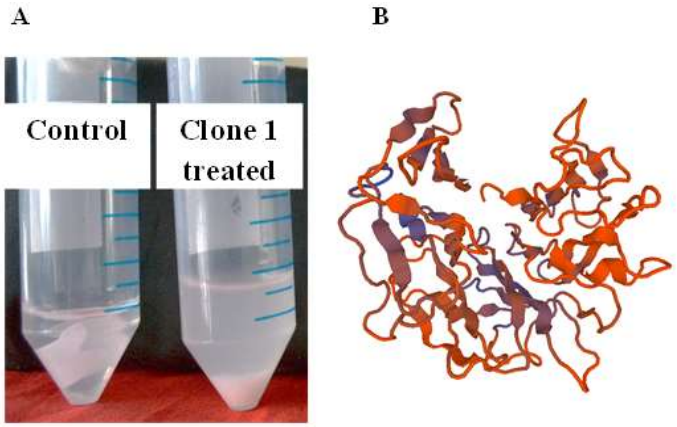


Figure 11: Cellulase degrading genes from metagenomic DNA. (A) A clone harboring cellulolytic gene(s) having cellulose degradating activity. Filter paper in the clone 1 treated tube is completely converted and (B) putative protein structure of a novel gene of clone 1 having homology with glycosyl hydrolase.

Gut microbial diversity and human health

Research on this subject in IASST is directed towards understanding the role of host factors such as ethnicity, food habits and lifestyles on gut microbial profile of an individual and its influence on human health. A pilot scale study indicated that gut bacterial profile is influenced by the type (brand) of whisky consumed (Figure 12). Research is also underway to reveal diversity in gut microbial profile of diverse tribal population of India and see if ethnicity (both genetic relationship and environment they live) plays a role in gut microbial diversity.

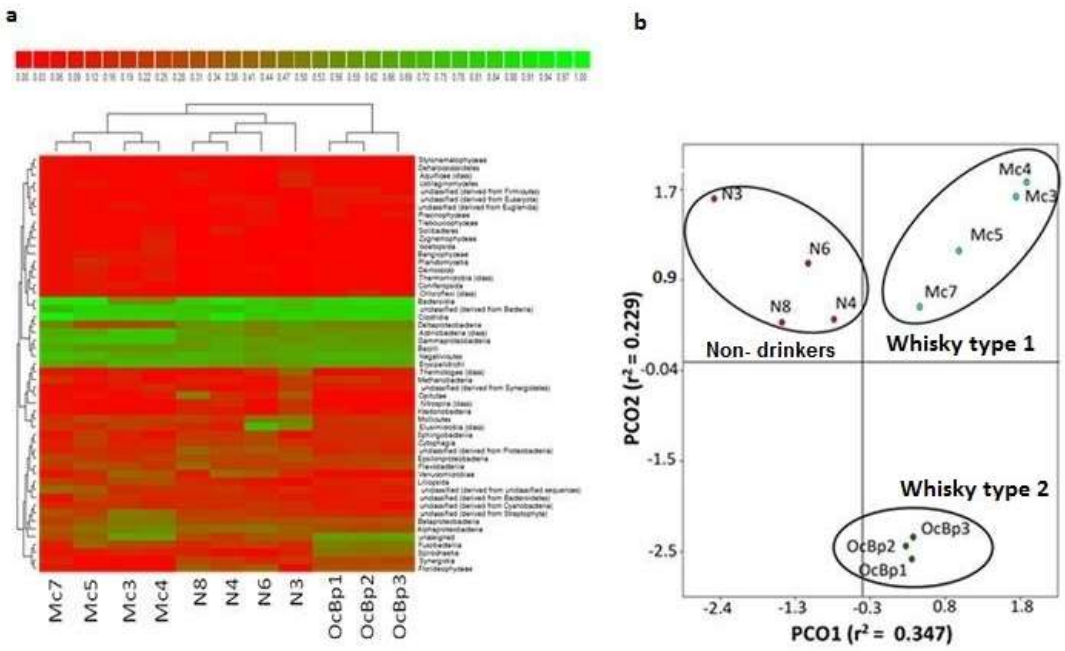


Figure 12: Gut bacterial profile is altered differently based on the whisky types (brand). (**a**) Heatmap was generated within MG-RAST server using Ribosomal Database Project (RDP) resource with 97% homology match and (**b**) PCoA plot based on the gut bacterial profile of the volunteers. Codes: 'N', non-drinkers; 'Mc', Whisky type 1; 'OcBp', Whisky type 2.

Biosurfactant from bacteria of hydrocarbon polluted field origin with bio-control potentialities

From among a pool of bacterial isolates of hydrocarbon polluted soils, bio-surfactants which are also known as detergents, were isolated and characterized in our previous research. Biosurfactants as alternate to chemical detergents are preferable because of ease in their biodegradability, lower toxicity, lower irritancy, compatibility with human skin. Potential applications of biosurfactants are in microbial enhanced oil recovery, hydrocarbon degradation in soil environment and hexachloro cyclohexane degradation, heavy metal removal from contaminated soil and aquatic environment. Besides these, one of the most widely studied biosurfactant i.e. rhamnolipids is reported to exhibit antimicrobial and antifungal properties. Currently, we are investigating antifungal properties of biosurfactants and their application in fungal diseases of field crops

The antifungal activity of biosurfactant (produced by *Pseudomonas aeruginosa* JS29) against *Alterneria solani* (Ellis & Martin), the causal organism of the most destructive diseases, the early blight of tomato (*Solanum lycopersicum* L.) was tested *in-vitro* (Fig. 13). The growth of *A. solani* was inhibited to the extent of 73% when added at the rate of 3 gL^{-1}. However, in field condition 1.5 gL^{-1} concentration of crude biosurfactant was sufficient for complete inhibition of *A.solani*. The biosurfactant produced by *Pseudomonas aeruginosa* JS29 was characterized as rhamnolipid using fourier transform infrared spectroscopy (FTIR) and Liquid chromatography-mass spectroscopy (LC-MS). This is the first report of complete inhibition of early blight disease of tomato using a rhamnolipid biosurfactant in field condition.

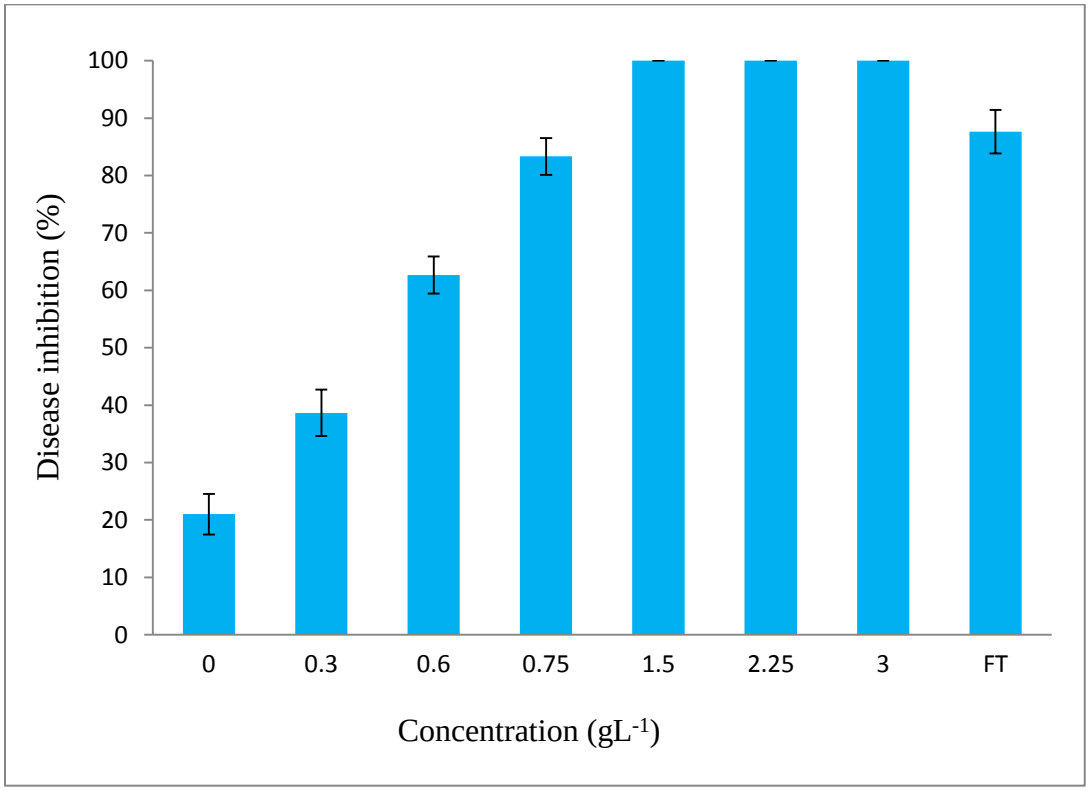


Figure 13: Disease inhibition (%) activity of different concentrations of crude biosurfactant extracted from *Pseudomonas aeruginosa* JS29 and fungicide treated FT (Bavistin 50% WP carbendazim) after 30 days of inoculation of *Alternaria solani*. Standard deviations of the mean are shown in columns. Results are statistically significant ($p < 0.05$)

Antifungal activity of biosurfactant against *Colletotrichum falcatum*- the causal organism of red rot of sugarcane

Inhibitory effect of biosurfactants from a total of 12 biosurfactant producing bacteria was tested against *Colletotrichum falcatum*, the causal organism of red rot of sugarcane, in another experiment. In this test also, biosurfactant produced by the bacterial strain *Pseudomonas aeruginosa* DS9 was found as an effective inhibitor of the fungus. It was interesting to note that biosurfactant obtained from the culture grown with glucose substrate showed lowest surface tension and highest antifungal activity. We also evaluated the efficacy of the biosurfactant extracted from whole culture (WC), cell-free culture supernatant (CCS), crude extract (CE) and column purified extract (CPE) against the test fungus. Biosurfactant from CPE was the most effective with highest (86.6%) inhibition of the mycelial growth of *C. falcatum* (Fig. 14). Thin layer chromatography (TLC), fourier transform infrared spectrometry (FTIR) and liquid chromatography-mass spectrometry (LC-MS) analysis confirmed that the biosurfactant recovered from *P. aeruginosa* DS9 is rhamnolipid in nature.

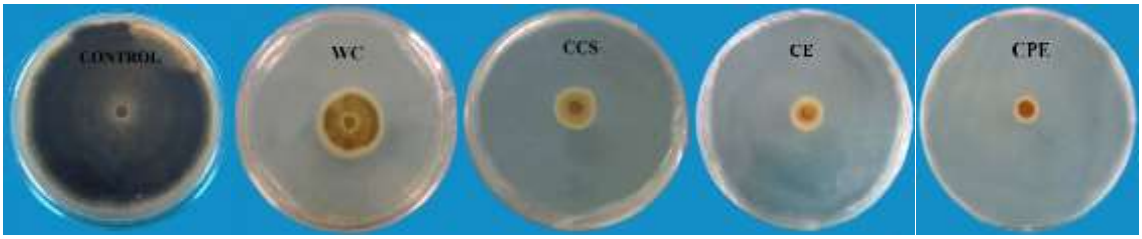


Figure 14: Efficacy of the biosurfactant extracted from whole culture (WC), cell-free culture supernatant (CCS), crude extract (CE) and column purified extract (CPE) against the test fungus *Colletotrichum falcatum*, causal organism of red rot disease of sugarcane.

Hydrocarbon pollution in oil field of Assam and their remediation by chemical and biological methods

Exploration of crude oil in Assam has resulted in inevitable and undesired side effects viz, contamination of a large area with hydrocarbons. Currently, about 5 hectares of area mostly in upper Assam has been estimated to have hydrocarbon pollution. Particulate material of specific size with hydrocarbon contaminants is also likely to be suspended in air above this area and potentially hazardous to the ecosystem components including crops and animals. IASST, in the past, had been carrying out research on isolation, characterization and utilization efficient hydrocarbon degrading bacteria from this area and also determining hydrocarbon profile along with heavy metal content in the soils of this area. During the current year, we assessed the extent of toxic hydrocarbons such as saturates, aromatics, asphaltenes and resins in 10 km lentic ecosystems in and around oil fields. An assessment of magnitude of atmospheric inhalable and respirable particles of oil field areas was also done. We also employed chemical and biological agents for optimization of processes of remediation of hydrocarbon polluted soil and also flocculation for removal of heavy metals from oil-field formation water.

Concentrations of hydrocarbons during winter season (December-January) in water samples of lentic ecosystem was from 158.3 to 452.3mg/l and during summer (June-August) from 530.6 to 843 mg/l. Post monsoon season (September), lentic water sample contained lowest average ∑TPH (80.3 – 218.3mg/l) concentration. With respect to the sediment samples, ∑TPH concentration was highest in summer (59194.4mg/kg) samples and lowest in (9843.3mg/kg) post monsoon samples. Concentrations were also determined in roots and shoots of 10 plant samples collected from sites where they grow abundantly. ∑TPH concentration in plants was found in the order *Cyperus scariousus* > *Cyperus rotundus*> *Cyperus cyperoides*> *Cyperus brevifolius*> *Cyperus odoratus*> *Cyperus esculentus*> *Cyperus laevigatus*> *Cyperus iria*> *Cyperus difformis*> *Cyperus helferi*. TPH content in shoot (295.7 to718.2mg/kg) was higher than in root (231.3 to 499.8mg/kg) in the plant species studied.

Remediation of Petroleum-Contaminated Soil by Advanced Oxidation Process

Fenton oxidation was employed for removal of hazardous organic carbons from contaminated soil and the reaction of Fenton's reagent with the organic carbon is highly pH dependent. We employed Fenton’s reaction for determining extent of removal of aliphatic fraction of petroleum

hydrocarbons (C14 to C16) at three different pH of the reaction mixture. Comparison of chromatograms of sample treated at each pH with the controlled sample is given in Fig. 15. Degradation of aliphatic hydrocarbons at pH 3 and pH 5 was more and at pH 8 is negligible.

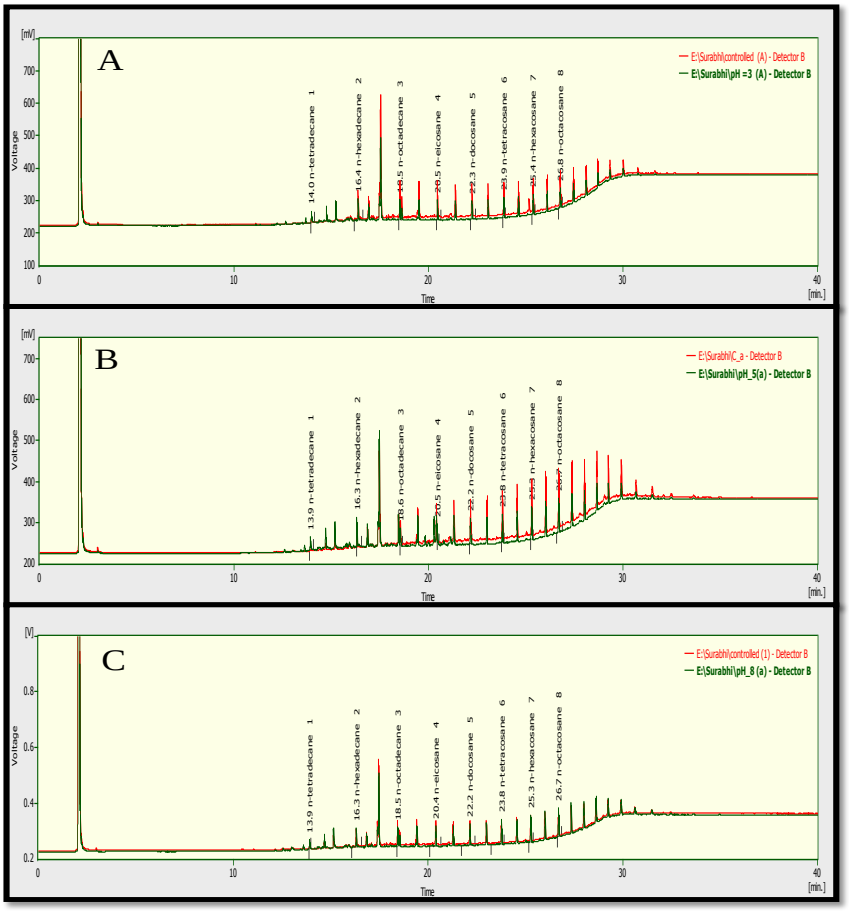
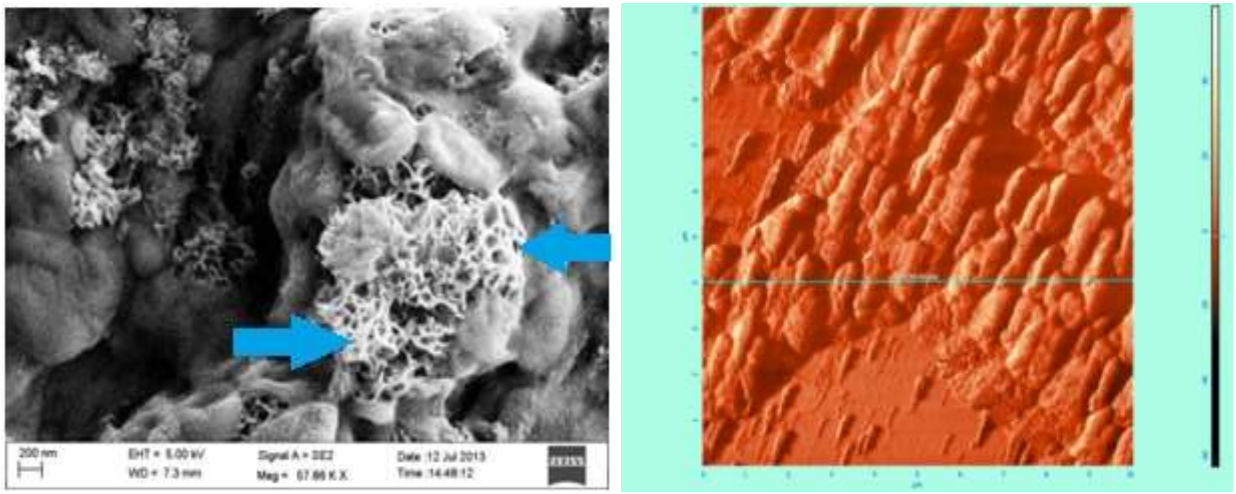


Figure 15: Comparative GC chromatograms of aliphatic hydrocarbons at A. pH 3, B. pH 5 and C. pH 8 with a control generated by injecting Fenton's reagent in the flasks containing contaminated soil after 5 days of incubation.

A Systematic study of utilization of bacterial bioflocculant for the treatment of oil-field formation water and heavy metal removal

Crude oil mixture which is pumped out after injecting water in the oil reservoir well contains a large proportion of water. This water known as oil-field formation water (OFFW), contains organic and inorganic loads. We have isolated and screened microorganisms from activated sludge samples for their activity to produce bioflocculants. Bioflocculants have the ability to

remove the organic and inorganic load of OFFW. Bioflocculating activity to the extent of 89.8% was exhibited by *Pseudomonas aeruginosa* strain IASST201 among 22 bacterial isolates. The yield of bioflocculant from this strain was 2.68g l^{-1} and was found to be highest at 96th hours of incubation in the optimized production media. The bacterial aggregates in the production media were collected and observed under Scanning Electron Microscope (SEM) and Atomic Force Microscope (AFM). Extracellular bioflocculants were visible in SEM images (Fig. 16A) and AFM images showed bioflocculants as evident from the topography of the bacterial cells (Fig. 16 B). Application of the bioflocculant of 0.5ml (conc. 2.68g l^{-1} highest at 96th hours of incubation in the OFFW resulted in separation of 68.7% (compared to the control) of aliphatic hydrocarbon contents of the formation water after 10 minutes of the treatment which was further analyzed through Gas-chromatography (Fig. 17).



(A) **(B)**

Figure 16: (A) SEM images of adhesion and clumping of bacterial cells with extracellular bioflocculant (arrow) and **(B)** AFM images showing topography and clumping of *Pseudomonas aeruginosa* strain IASST201with extracellular bioflocculant within biofilm.

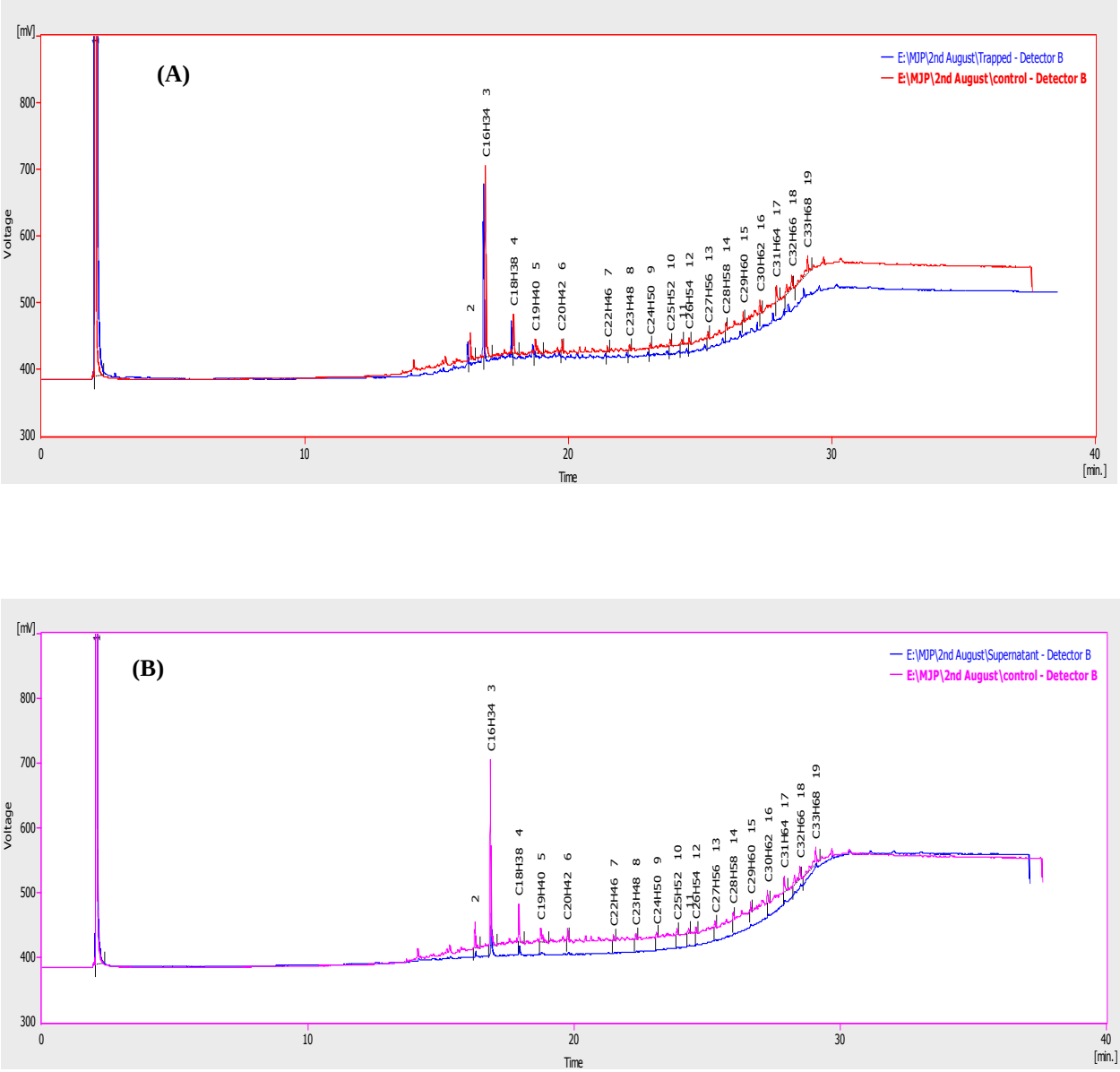


Figure 17: GC-chromatograph showing dichloromethane extracted hydrocarbon portion from **(A)** settled aggregates of OFFW and **(B)** supernatant remaining in OFFW after treatment compared with untreated OFFW as control. Hydrocarbon contents in control portion were shown as red line and the test portion as blue in the chromatograph.

Few common heavy metals like Pb, Ni, Zn,Cu,Cd, etc were also estimated in the untreated OFFW and in the supernatant of the bioflocculant treated OFFW and it is evident that substantial amount of heavy metals were removed from the OFFW by the process of bioflocculation along with the hydrocarbons (Fig. 18)

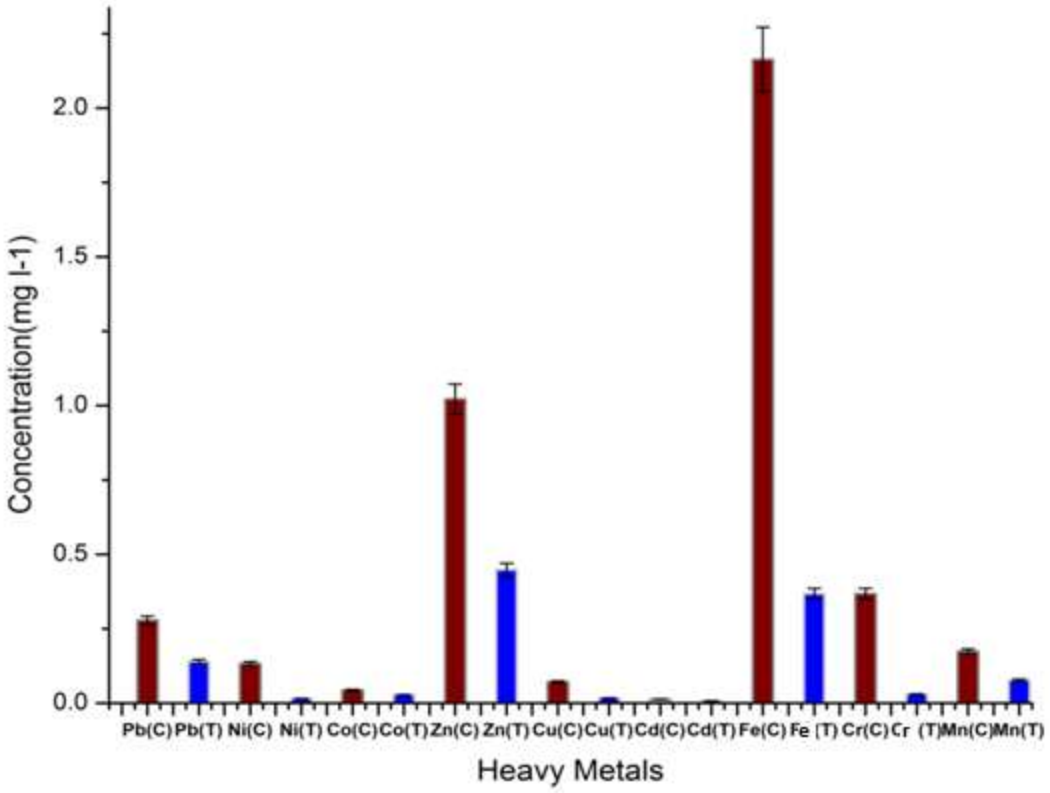


Figure 18: Concentration of heavy metal in oil-field formation water before(C) and after (T) application of bioflocculant.

Diversity of Hydrocarbon degrading bacteria for biosurfactant production and their utilization in hydrocarbon pollution mitigation:

In this investigation, a total of 24 bacterial strains were isolated from petroleum contaminated soil and screened for the production of biosurfactants. Among them, 6 strains (three biosurfactant producer) of most efficient hydrocarbon degraders were selected for the development of best consortium to reclaim hydrocarbon polluted soil. Consortia 5 showed best result in degradation of crude oil. In gravimetric assay, it showed highest crude oil degradation in 14 days of incubation (0.718 g from 1.5612 g, i.e. 46%). In GC analysis, 23 peaks were present in control sample, whereas in sample treated with consortium 5, only 8 peaks were present, which was the best degrader when compared to the other consortia. Therefore, consortium 5 has been selected as the best for further studies.

Particulate matter in air over an oil-field of upper Assam

Analysis of the levels of PM2.5 in an oil field area of upper Assam showed that the daily average concentration of PM2.5 (18.5 to 77µg/m^3) was higher at the site A which is located 50m away from the GGS) than at site B (10 to 51.5 µg/m^3) which is located 200m away from the Gas Gathering Station (GGS) shown in Fig. 19. Collected particulate matter of PM2.5 size were subjected to SEM analysis to dwtermine the level of loadings at two sites located at two different distances from GGS. The SEM images suggest higher density of the particulate matters per unit volume in the site close to GGS than in the site away from GGS (Fig. 20). SEM results indicate the absorption of PM2.5 and revealed the high loadings (Site A) and low loadings (Site B) of PM2.5 on the filter paper.

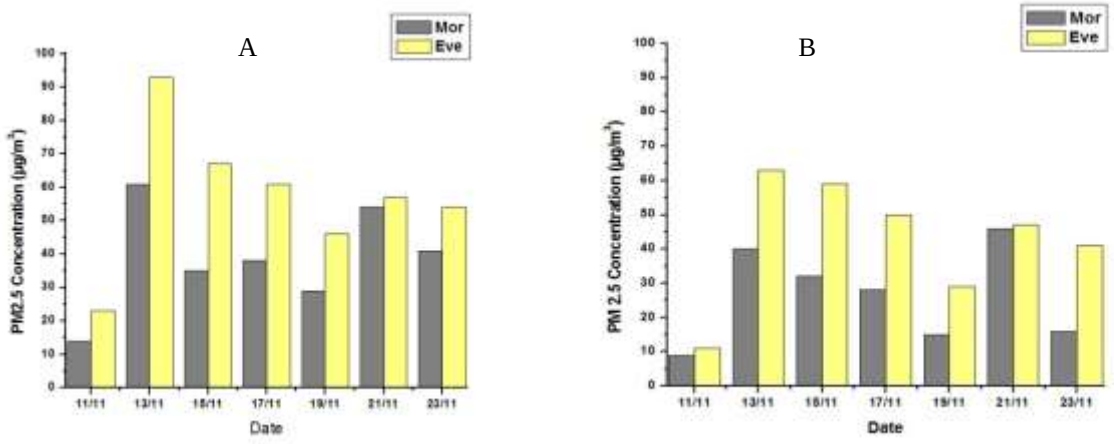


Figure 19: Daily variation of PM2.5 at sites which is located 50 m away (A) and another site which located 200 m (B) away from the Group Gathering Station.

Site A Site B

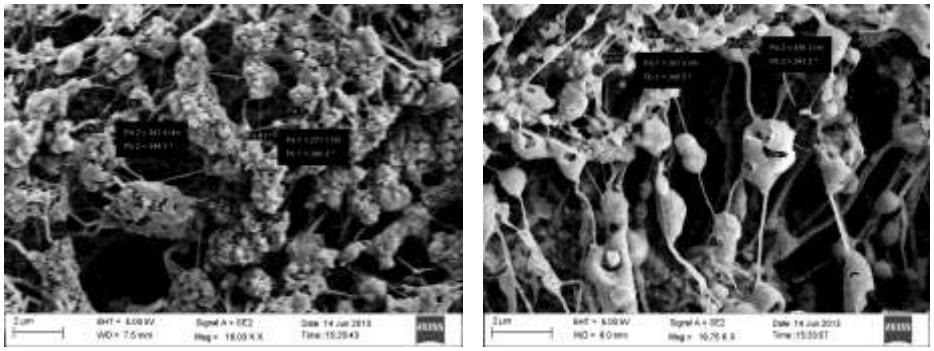


Figure 20: SEM images of PM2.5 concentrations at Site A (high loadings) and Site B (low loadings)

The particulate matters were also analyzed for the presence of heavy metals in it. The concentrations of 10 heavy metals present in PM2.5 of the site located 50m away from the GGS shows a trend of Mg > Zn > Cr > Fe > Mn > Ni > Co > Pb > Cu > Cd.

5. Traditional knowledge based drug design, development and delivery

Northeast India is very rich in biodiversity because of different climatic conditions that range from tropical to alpine zone. This rich biodiversity includes medicinal plants with potential for treatment of several diseases as suggested by strong tradition of herbal medicine that is widely used by the local population. More than 250 tribes of the region have been carrying with them an evolving traditional knowledge for health care. However, beneficial effect of herbal formulation has not been validated for nature of their effect or mode of action. Chemical composition of these formulation are also unknown. Therefore, there is a need for conversion of the belief based traditional herbal medicine to evidence based through rigorous scientific method. IASST is carrying out research for scientific validation of the medicinal plants/ formulations for treatment of metabolic disorder such as diabetes and cancer.

Antioxidant and antidiabetic activity of *Musa balbisiana*

Diabetes mellitus (DM) is a major endocrine disorder and growing health problem in most countries. According to "the report of World Health Organization (WHO), 2013 about 347 million people were suffering from diabetes worldwide. *Musa balbisiana* is a seeded banana of northeast India and is well known for its beneficial effect on health and several pharmaceutical properties. We evaluated the *in- vitro* antioxidant and anti-diabetic activity of juices collected from three different parts of this fruit plant based on the reports of local health practitioner.

DPPH and H_2O_2 scavenging activity

Three juices collected from three plant parts were tested for *in-vitro* antioxidant activity using two *in-vitro* models (DPPH and H_2O_2 scavenging methods). In DPPH radical method, the three juices showed volume dependent scavenging activity (Fig. 21). At 160 µl/ml dose, root juice (RJ), shoot juice (SJ) and inflorescence juice (IJ) showed high antioxidant activity with IC_{50} value of 32.96µl/ml, 42.4µl/ml, 38µl/ml, respectively and these values were comparable with the standard (ascorbic acid) used as the positive control.

Antioxidant activity of the three juices in *in-vitro* H_2O_2 scavenging activity method also varied in a dose dependent manner with IC_{50} value of 57.6µl/ml, 36.8µl/ml, and 40.8µl/ml for juices from root, shoot and inflorescence, respectively against IC_{50} value 42.8µl/ml of trolox used as the positive control. Trend of antioxidant activity of three juices in both the methods was similar with highest level of activity observed at 160 µl/ml volume of juice from root part (Fig.21).

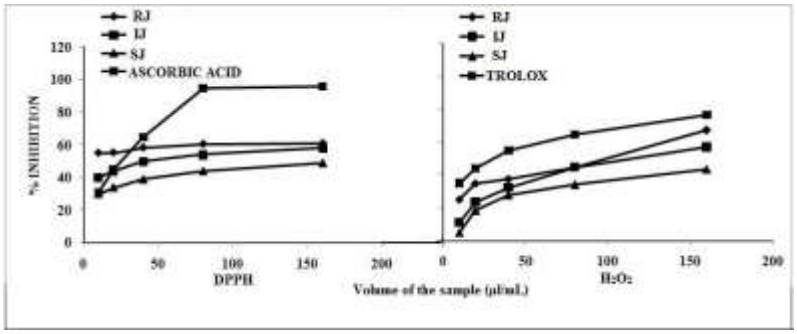


Figure 21: Effect of root juice (RJ), shoot juice (SJ) and Inflorescence juice (IJ) of *Musa balbisiana* on 1, 1 Di phenyl 2 picryl hydrazyl (DPPH) and H_2O_2 radical *in-vitro* with standards ascorbic acid (DPPH) and trolox (H_2O_2).

In vitro lipid peroxidation inhibition assay

Based on the results of the *in vitro* antioxidant assay, the ability of the three juices to reduce oxidative stress was tested in $FeCl_3$ induced oxidative stress rat liver homogenate by adding known volume of the juices in an *in-vitro* assay. This assay determines the inhibition of lipid peroxidation due to addition of the juices. A high % of inhibition indicates high reduction in oxidative stress. (Fig. 22).

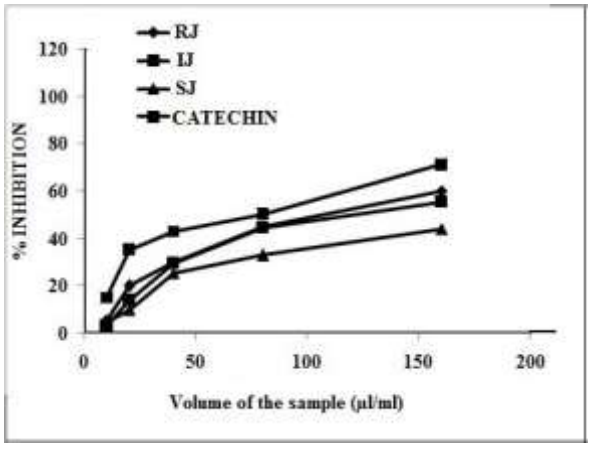


Figure 22: *In vitro* lipid peroxidation of root juice (RJ), shoot juice (SJ) and Inflorescence juice (IJ) of *Musa balbisiana* and catechin.

Antidiabetic effect of Root, Shoot, Inflorescence juices of *Musa balbisiana* in *in-vitro* model

The *in-vitro* glucose diffusion model was used to mimic the intestinal glucose absorption due to peristaltic movement and then effect of the juices on glucose in intestine. In this model system, a movement was generated by gentle shaking to observe the diffusion of glucose molecule out of the dialysis tube. Without plant extract (control) in the model, glucose movement out of dialysis tube had reached maximum level (0.16 ± 0.009 mg/ml), whereas in presence of the root juice glucose diffusion was significantly decreased after 2 h and external glucose concentration was 0.099 ± 0.004 mg/ml after 30 hrs. (Fig. 23) Therefore, the root juice of *Musa balbisiana* was the most potent inhibitors of glucose movement in the model system followed by shoot juice and inflorescence juice.

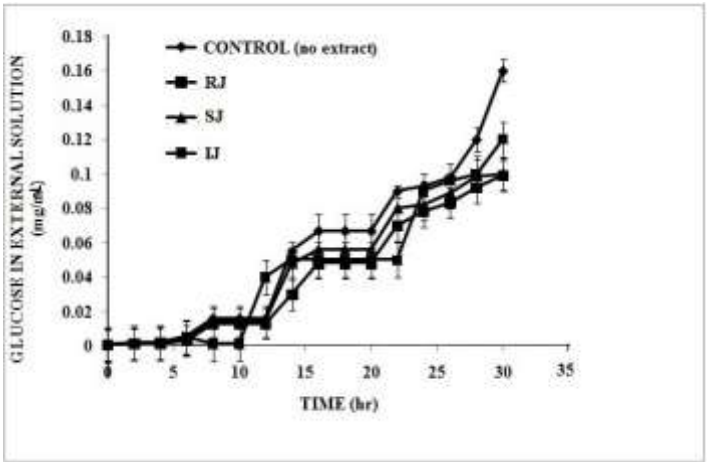


Figure 23: Effect of RJ, SJ and IJ of MB on the glucose diffusion out of dialysis tube. Values are mean ± SEM for groups of 3 observations with their standard error indicated by vertical bars, which were compared with the control at different subsequent times.

Antioxidant activity and bioactive phytochemical contents of *Garcinia pedunculata* (GP)

Garcinia pedunculata (GP) commonly known as *Borthekera* (Assamese) is an important high valued medicinal species. This species is abundant in north east India. The fruit is used as a system of medicine by local healers, traditional hakims to cure many ailments particularly relating to gastrointestinal diseases (GDs) like diarrhea, jaundice and dysentery.

From the literature survey it could be known that *Garcinia* species are rich in Polyisoprenylatedbenzophenone derivatives such as garcinol, which is very potent antioxidant compound. Garcinia is the source for a natural diet ingredient (-) hydroxycitric acid. HCA (1,2

dihydroxypropane-1,2,3-tricarboxylic acid) is an anti-obesity compound which is present in the fruit and is known to inhibit lipid and fatty acid synthesis in living system.

In Assam, a traditional practice of making slice of ripe fruit followed by drying and long term storage for consumption is very common. The local people believe that aging of dried slice increases its medicinal value. Through a questioner based survey in six districts of Assam we gathered that almost 70% respondent were aware of the beneficial effect of GP. During the survey, sundried samples at varying period of was also collected for experiments. Initially chloroform, hexane and methanol extract of one year old samples were tested for DPPH free radical scavenging activity and the IC_{50} of methanol extract of GP (4.01±0.00 µg Ascorbic acid/ml) was significantly lower than that of chloroform and hexane extract. Hexane extract of GP fruit found to be exhibited excellent antioxidant activity by scavenging $ABTS^{+}$ (0.86±0.2 µg Trolox/ml), NBT (0.05±0.04 µg Ascorbic acid/ml) and Hydrogen peroxide (2.18±0.020 µg/ml) radicals.

Table 2: Free radical scavenging activity of *Garcinia pedunculata* fruit fractions (IC_{50} µg/ml)

Fractions	DPPH	ABTS	NBT	Hydrogen peroxide	NO scavenging
Chloroform	53±0.00	1.15±0.00	0.07±0.03	2.80±0.01	0.297±0.01
Hexane	26±0.4	0.86±0.2	0.05±0.04	2.18±0.02	1.49±0.03
Methanol	4.01±0.00	1.18±0.1	1.184±1.19	5.53±0.015	4.77±0.015

Phytochemical of the extract, compound presence of Anthraquinone, Flavonoid, Saponin, Tannin, Steriod, Reducing sugar and Cardiac glycosides but did not show presence of the Alkaloids. The antioxidant activity of those compounds are known and we suggest the GP antioxidant activity may be due to these compounds.

Androgen receptor mediated drug development to treat prostate cancer

Androgen stimulates the development and maintenance of male characteristics in vertebrates by binding to Androgen receptor (AR)**,** which is activated by either of androgenic hormones, testosterone (T) or 5α-dihydrotestosterone (DHT) in the cytoplasm then translocation into the

nucleus. AR is a DNA-binding transcription factor, which belongs to nuclear receptor sub-family, regulates gene expression. Carbamide **[**$CO(NH_2)_2$**]**, Thiocarbamide **[**$SC(NH_2)_2$**]** and Sulfonamide **[**SO_2NH_2**]** derivatives, which are the basis of several groups of drugs, have very good biological activities against prostate cancer. Few plants in the Lamiaceae family in northeast India are used traditionally for the treatment of such diseases.

On the basis of these binding information designed (in Dry lab) and synthesized (based on the lead from Natural sources) the hybrid molecules through the combination of different pharmacophores in one structure and evaluated against PC Cell lines to develop better therapy for Prostate Cancer.

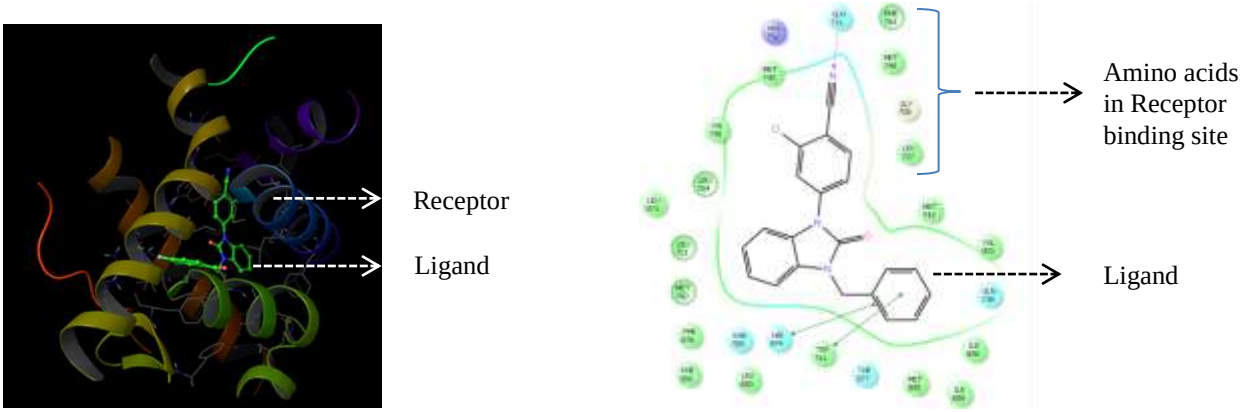
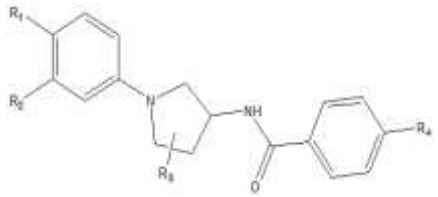


Fig 24. Androgen receptor with ligand interaction in binding site

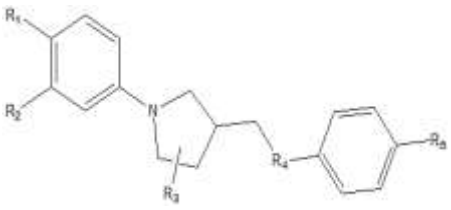
Drug Design (Docking Studies) resulted in design of few drugs based Schrodinger software and the following series were selected for their synthesis in the wet lab.

Amide link series *(Pharmacophore based, Less rigid molecules)*



R_1 – hydrophilic
R_2 - Acceptor group
R_3 - hydrophilic or hydrophobic substituent
R_4 - F or H

Bicalutamide analogs *(Pharmacophore based, Flexible)*



R_1 – hydrophilic
R_2 - Acceptor group
R_3 - hydrophilic or hydrophobic substituent
R_4 – Acceptor group
R_5 - F or H

Subsequently, the schemes of synthesis for the finalized best fit molecules were designed. So far methods for the synthesis of new chemical entity (s) (NCEs) have been standardized and

twenty molecules synthesized and their spectral analysis completed. Currently, *in vitro* studies of these molecules to test their effect on prostate cancer cell lines are in progress.

Bio-synthesized Gold Nanoparticle conjugated with Broad spectrum antibacterial Amoxicillin and its activity evaluation in both *in-vitro* and *in-vivo* model

The development of resistance against antibiotics by pathogen pose problem in long-term effectiveness of antibiotic. Metallic nanoparticles can also be used for its antibacterial activities, but they are also cytotoxic. However, coupling with antibiotic may reduce cytotoxicity towards mammalian cells as there are used in low doses and enhance bactericidal activities. In this study gold nanoparticles (GNPs) were fabricated and functionalized with β lactam antibiotic Amoxicillin and their effect tested against eight numbers of pathogenic bacterial strains including MRSA for any possible enhanced bactericidal activity. It was observed that GNPs alone did not exhibit any antibacterial activity, but the GNP-Amox conjugation significantly enhanced the bactericidal activities. The reason behind the enhanced activity might be because of an increase in the concentration of antibiotics at the site of bacterium–antibiotic interaction, and facilitating the binding of antibiotics to bacteria. On penetrating into the bacterial cell, nanoparticles can alter the functions of cell membranes such as permeability and respiration as well as can disturb the functions of sulfur-containing proteins and phosphorus containing compounds such as DNA by effectively reacting with them.

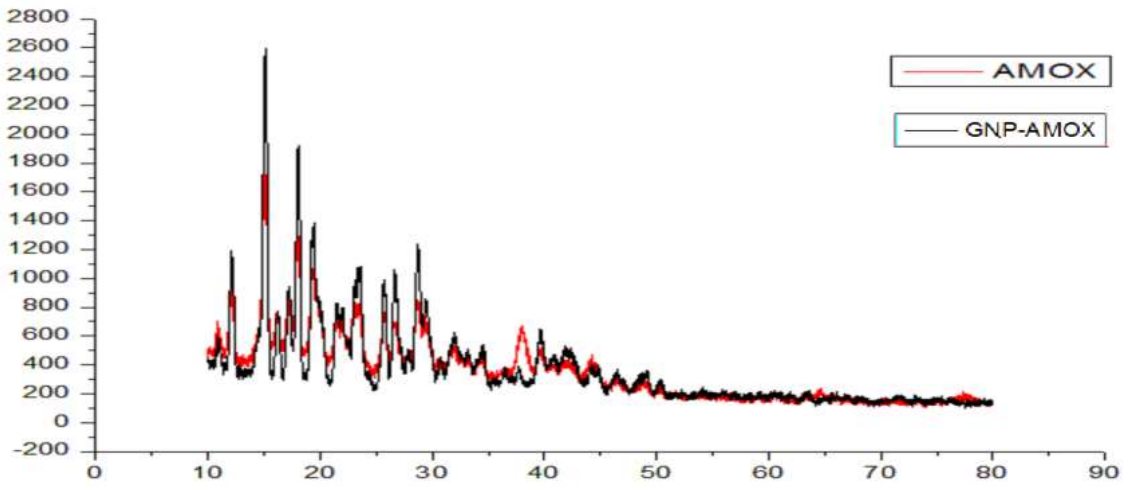


Fig.25. Conjugation of Amoxicillin on GNPs surface confirmed by enhanced intensity of bragg peaks of GNP-AMOX compared to free Amoxicillin in XRD analysis

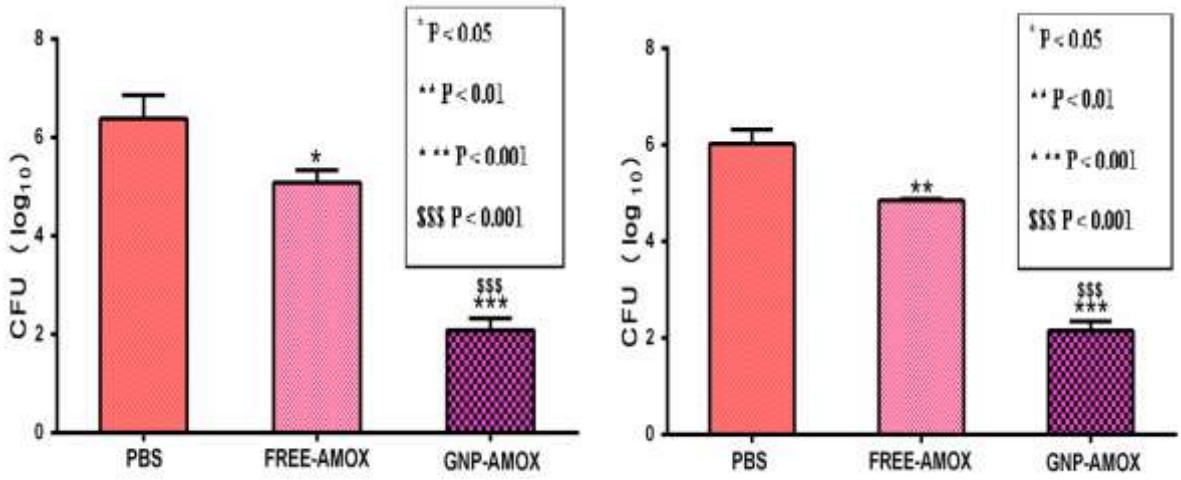


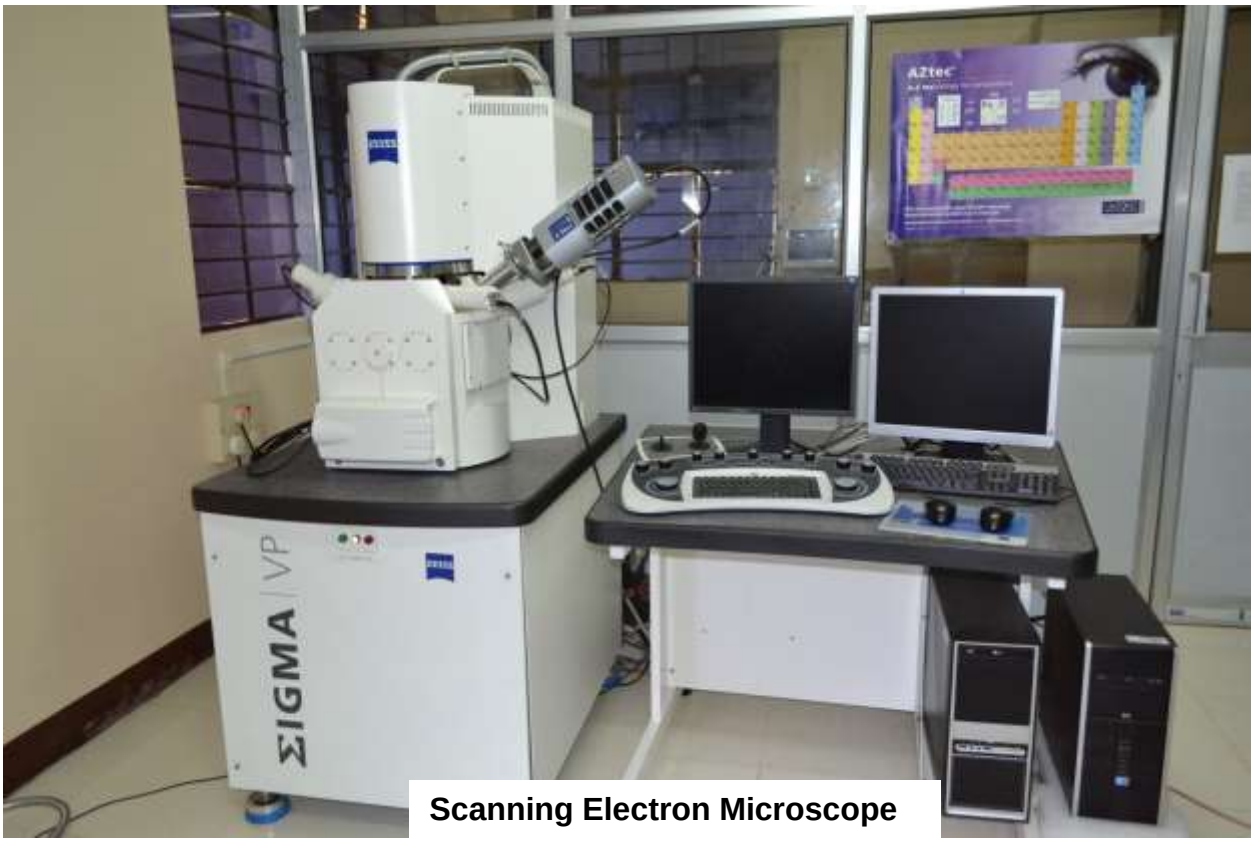
Fig. 26. Efficacy of free Amoxicillin and GNP-Amox in the treatment of MRSA systemic infection. Albino mice were infected intraperitoneally with 3.9×10^6 cfu of MRSA1. Mice were treated 1 h later with PBS, GNP-AMOX and free Amox. (a) Kidney bacterial burden after 24 h. P values were 0.001 for PBS versus GNP-Amox, 0.05 for PBS versus free Amox, and 0.001 for GNP-Amox versus free Amox. (b) Spleen bacterial burden at 24 h. P values were 0.001 for PBS versus GNP-Amox, 0.05 for PBS versus free Amox and 0.001 for GNP-Amox versus free Amox.

R & D Facilities at IASST

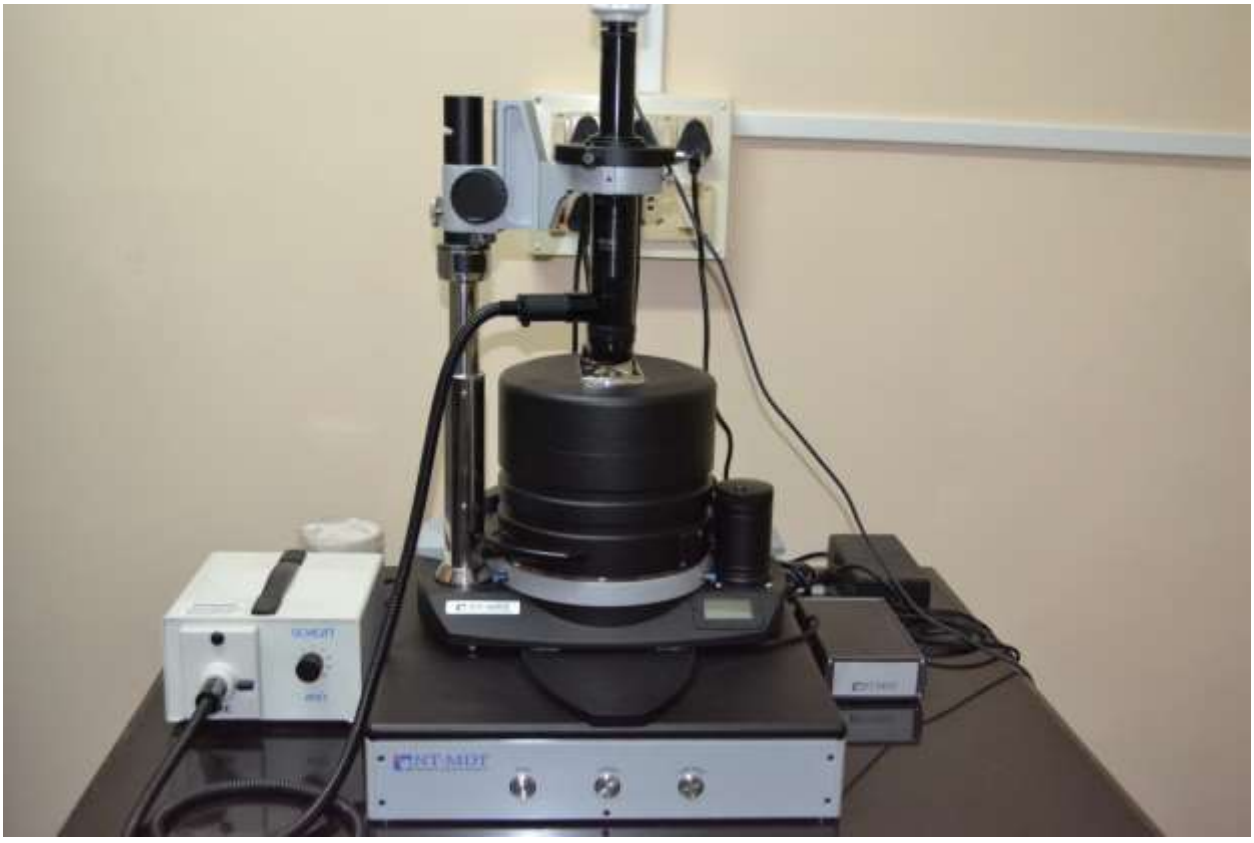
Central Instrumentation Facility

Central Instrumentation Facility (CIF) of IASST includes sophisticated equipments to center to the need of scientists and students of physical, chemical and biological sciences and also for analysis of samples of other researchers of scientific organizations and universities on outsourced basis. Since the time of setting up of this facility. A large number of researchers have been benefited by these equipments including the new additions of this year. The major instruments available in the CIF are Scanning Electron Microscope, *Carl Zeiss, Σigma VP;* X-Ray Diffractometer, *Bruker, D8-Advance;* FT-IR, *Bruker, Vector 22;* Gel Permeation Chromatography (GPC), *Waters 2414;* Differential Scanning Calorimetry (DSC), *Perkin Elmer DSC 6000;* Differential Scanning Calorimetry (DSC), *Perkin Elmer DSC 6000;* Thermogravemetric Analyzer (TGA), *Perkin Elmer TGA 4000;* Tensiometer, *Dataphysics DCAT-11;* Optical Emission Spectrometer, *Andor Technology, Shamrock SR303i;* Microwave digester, *Milstone, Ethos-900;* Ion Chromatograph, *Cecil;* UV-Vis Spectrophotometer, *Shimadzu-1800;* Atomic Absorption Spectrophotometer, *Shimadzu, AA - 7000;* Flame Photometer, *Elico, CL-378;* Biochemical Analyzer, *Merck;* Contact Angle Analyzer, DSA 30E (KRŰSS); DNA-Sequencer, Backman Coulter; Scanning Probe Microscope-NTEFGR Prima, NT-MDT Company and LC-MS-MS, Thermo Fisher. GC-MS-MS is the latest addition to the facility which facilitates determination of known and unknown compounds in environmental samples, food, beverages and microbial and plant metabolite samples.

DNA Sequencer



Scanning Electron Microscope



Atomic Force Microscope

LC-MS/MS

FT-IR

Bioinformatics Infrastructure Facility (BIF)

Bioinformatics center at Institute of Advanced study in Science and Technology came into existence in the year 2011 with full financial assistance from the Department of Biotechnology, Govt. of India under DBT-BIF scheme. It is the latest addition to the BTISNet and NEBINet network of DBT, Govt. of India to fulfil the requirements of Bioinformatics tools for research in the life sciences, molecular biology and biotechnology.

The objective of the center is to provide training on bioinformatics both at basic and advanced level research in the field of Bioinformatics. The centre organized seminars, workshops and training programmes in order to spread latest knowledge on bioinformatics among the students, teachers and scientist of the entire northeast as a whole. The first activity of the DBT-BIF of IAAST was one workshop on Basics of Bioinformatics. The center has also organised two lectures on application of softwares (LeadIT FlexX Basis, LeadIT flex Pharm, LeadIT Corina_F).

The DBT-BIF is well connected to 100MBPS NKN connectivity of the institute with 24hr high speed Internet connectivity, lecture hall and power backup with 5KV UPS.
The hardware facilities of the centre include HP High End Server, HP Desktop PCs, HP Laser Jet CM1415fn color MFP, Linux Enterprise Edition, MS Office 2010. Software facilities include LeadIT FlexX Basis, LeadIT flex Pharm and LeadIT Corina_F.

Participants at seminar organized as a part of activities of Bioinformatics Infrastructure Facility at IASST

Institutional Biotech Hub

A Biotech hub has been set up in the Institute in 2012 with the financial support from Department of Biotechnology, Govt. of India. Research scholars of the life science division of IASST and undergraduate and postgraduate students of other institutes are imparted training on regular basis on basic techniques of microbiology and molecular biology.
Two training programmes were organized in the year 2013 where 42 students of IASST, Gauhati University (Guwahati, Assam), IIT Guwahati and Cotton College (Guwahati, Assam) participated. In the year 2013-14, 1 M.Sc., 9 Ph.D. and 3 post-doctoral researchers have used this facility full time to carryout part of their research. Dr. Hariom Yadav, NAFBI, Mohali delivered a lecture on 'Probiotic Biotherapy for Obesity/Diabetes' on 27th November 2013.

Activities of Institutional Hub of IASST. Students busy in practical exercises in the institutional biotech hub laboratory (A), Participants attending theory session on principles of practical exercises (B), Dr. Hariom Yadav, National Agri-Food Biotechnology Institute NAFBI, Mohali delivering a lecture on probiotic biotherapy for obesity/diabetes (C).

Medicinal Plant Conservatory (MPC)

IASST life science research programme includes traditional knowledge based drug discovery and development specially using those plants which are used against metabolic syndroms such as diabetic neuropathy and cancer. In the medicinal plant conservatory of IASST, the medicinal plants used in various experiments for scientific validation are planted, multiplied and maintained. Expert plant botanists regularly identify and support in this effort. Currently, the following species of medicinal plants maintained in MPC of IASST: *Ambellica officinalis, Citrus grandis, Citrus morella, Clerodendron colebrookianum, Clerodendron viscosum, Terminalia chebula, Vinca rosea, Eugenia jambolana, Punica granatum, Ocimum sanctum, Cuinamomum tamala, Murrya koenigii, Pepar longum, Rauwalfia serpentina, Terminalia arjuna.*

Animal house

Animal house of IASST is situated in the premises of IASST and it maintains five types of animals viz, Albino rats (Wistar), Albino mice (Swiss) Guinea pigs (Duncan Hartley) and Rabbits (New Zealand white) for use in pre-clinical testing of effect of extracts of herbal formulation, medicinal herbs and also *in-silico* designed synthetic drug on metabolic syndrome, induced in animals model. An Animal Ethics committee constituted as per guideline of Purpose of Control and Supervision of Experiments on Animals (CPCSEA) oversees clinical issues in animal experiment. This Animal House is registered with CPCSEA, Government of India, Animal Welfare Division.

Central Computational and Numerical Laboratory

A Central Computational and Numerical laboratory has been established with the aim to provide a up-to-date facility for the students and faculty members of IASST on computation related research work. At present one research group is working on image processing, pattern recognition, simulation of predictive models of epidemiology of lenses and another research group on ab initio electronic structure calculations which require high performance cluster computations.

The laboratory currently has 20 all-in-one PCs each configured for high class performance. Out of these, 14 number of PCs have LINUX Operating system while the rest run on WINDOWS. The laboratory is also equipped with a blade server system presently populated with four number of blades operating on LINUX and is specifically meant for doing cluster computations. The chassis of the blade server system is capable of accommodating up to fourteen numbers of blades to meet future requirements. The entire laboratory is networked internally through switches and is further connected to institute's, network server for external connectivity. The laboratory has some high end softwares like MATLAB-R2012a, Quantum Espresso and VASP (Vienna Ab Initio Simulation Package), apart from the common softwares for data analysis, graphics and documentation.

Knowledge Resource Center (KRC):

The Knowledge Resource Center (KRC) is an invaluable resource for use in research and development by students, researchers and faculties of the institute. The KRC is also resource of faculty members, research scholars and students of other institutes, colleges and universities located in Assam and other parts of North East India. Since its inception in the year 1979, the center has been playing an important role in the development of learning and research activities. The KRC has over the years built a robust collection of books, bound volumes, current subscription to journals (print & online), newspapers, working papers, and many other resources like thesis, project reports, CDs and videos. The KRC spread over 4,500 sq. ft. and provides access to the best of science and technology related digital resources through its subscription to various databases of scholarly and research oriented content.

Resources of KRC

The resources of KRC are strong in the areas of physical sciences, life sciences, environmental sciences, mathematical & statistical sciences and instrumentation sciences. Apart from these subjects, there are books on computer sciences, electronics, scientific biographies, general science, literature, short stories, novels, drama, bibliographies, nature and fine arts. In addition, the Center gets access to a wide range of online journals through National Knowledge Resource Consortium. It has also a collection of non-book materials like CD-ROMs and DVDs. The KRC participates in interlibrary networking activities and has a good rapport with the libraries/ KRC in the Guwahati city and outside.

Services Offered

The Center provides reading facility to its members as well as outside visitors. The books and bound volumes are issued only to the institute members. Besides this, the Center provides reference service, OPAC service, Internet service, CAS service, referral service, reprographic service, resource sharing activities and holds book exhibition.

Institutional Digital Repositories (IDR)

The Knowledge Resource Center (KRC) has an Institutional Digital Repositories (IDR) of research papers, annual reports and important multimedia collections of the institute.

Consortia Service

The KRC is a member of National Knowledge Resources Consortium (NKRC). The KRC is getting wide range access of text E- journals from IOP, ACS, AIP, CUP, Elsevier, T&F, Emerald and database services of SciFinder, Web of Science etc. through NKRC.

Statistics of collection and activities of Knowledge Resource Center during 2013-14

Factors	Quantity
New Books procured	184
Print Journals Subscribed	42
Total Collection of Books	8556
Total Bound periodicals	2202
Visitors (Institute)	970
Visitors (Outside Institute)	141
Circulation of Books	477
Circulation of Bound Periodicals/Journals	167
Photocopy	118668
Number of Annual Reports mailed	95
No. of INTERNET Search provided	157
Current Awareness Service	177
Selective Dissemination Information Service	67
Referral Service	88
Resource Sharing (Journal Article/ Chapter in Book)	33
Preparation of serials holding list	65
No. of Books Received as Gratis	40
No. of Annual Report/ New Letter Received as Gratis	87
No. of Paper Published by KRC Staff	02
No. of Seminar/ Workshop/ Training Attended by KRC Staff	02

Projects

Ongoing Projects

Sl No.	Title of the project	Funding Agency	Duration	PI/ Coordinator
1	*Development of Polymer Based Sensors*	MCIT, DIT, GoI.	2011-2014	Dr. Neelotpal Sen Sarma
2	*Development of proton exchange membrane for fuel cell by plasma process*	Ministry of New and Renewable Energy, GoI.	2011-2014	Prof. Joyanti Chutia
3	*Investigating physic-chemical properties of new hybrid carbon nanomaterials and its applications as sensors.*	DST, GoI	2013-2016	Dr. Devasish Chowdhury
4	*Stimuli Responsive Polymeric surfaces*	CSIR, GoI.	2011-2014	Dr. Devasish Chowdhury
5	*Investigations on rogue waves in multicomponent plasma with negative ions*	DST, GoI	2013-2016	Prof. Heremba Bailung
6	*Study of single step synthesis of magnetic material containing aligned carbon nanotubes by plasma based chemical vapour deposition process and effect of externally applied magnetic field during growth on the aligmnent and properties of the nanotubes.*	CSIR, GoI	2011-2014	Dr. Arup Ratan Pal
7	*Development of atmospheric pressure glow discharge plasma system for growth of vertically aligned carbon nanotubes*	BRNS-DAE, GoI	2013-2016	Dr. Arup Ratan Pal
8	*Self-assembly in Nanomaterials and Biomaterials: An SANS and SAXS Study*	UGC-DAE CSR, GoI.	2012-2013	Dr. Sarathi Kundu
9	*Impact assessment of Jhumming on native plants and soil microbiota and restoration of sustainable Jhum agro-ecosystem in North East India*	DBT, GoI	2012-2017	Dr. N. C. Talukdar

10	*Endophytic diversity in wild verus cultivated rice across the environmental gradients in North East India*	DBT, GoI	2012-15	Dr. N. C. Talukdar
11	*Evaluation of role of arbuscular mycorrhizal and PGPRs from diverse ecosystems of North East India for organic production of citrus and chilli*	DBT, GoI	2012-2015	Dr. N. C. Talukdar
12	*Study on intestinal microbiota of ethnically diverse tribal population of India: enhancing our understanding on effect of host genotype, diet and ecology*	DBT, GoI.	2011-2014	Dr. N. C. Talukdar Dr. Mojibur R. Khan
13	*Androgen receptor mediated drug development to treat Prostate Cancer*	DBT, GoI.	2012-2015	Dr. Jibon Kotoky
14	*Studies on Structure of Enzymes and their interaction with Nanostructure Materials for Bioelectronics Devices and other Applications.*	DBT, GoI. (Twinning project)	2012-2015	Dr. Dipali Devi
15	*North Eastern origin silk protein based matrices and nano /microparticles for biomedical applications.*	DBT, GoI. (Twinning project)	2011-2014	Dr. Dipali Devi
16	*Study of Bio-Degumming and Chemical Deposition on Muga Silk (Antheraea assamensis Helfer) fibers of Assam*	DST, GoI.	2012-2014	Dr. Dipali Devi
17	*Infrastructure Development of Bioinformatics facility at IASST*	DBT, GoI	2011-2017	Dr. Dipali Devi
18	*North - East origin silk based co-culture 3-D model for cartilage tissue repair*	DBT, GoI.	2013-2016	Dr. Nandana Bhardwaj
19	*Pharmacological evaluation of some indigenous variety of citrus fruits of Northeastern region of India – a biomolecular approach*	ICMR, GoI.	2012-2015	Dr. Rajlakshmi Devi

20	*Identification and characterization of bio-active molecules from some indigenous medicinal plants of NE region of India with special reference to antioxidant and hypolipidemic properties*	DBT, GoI.	2013-2016	Dr. Rajlakshmi Devi
21	*Exploration of microbial diversity (culturable) associated with Tea Rhizosphere Soil of Assam and Darjeeling (WB), and utilization for the production of plant growth promoting substances and bio-control of prominent fungal diseases and pests in tea.*	DBT, GoI. (under RGYIscheme)	2012-2015	Dr. Debajit Thakur
22	*Exploration of Actinomycetes in soil of protected forest areas of Assam for antioxidant activity and its potential application against bacterial and fungal pathogens*	ICMR, GoI.	2013- 2015	Dr. Debajit Thakur
23	*Molecular Genetic diversity of Houttuynia Thunb. germplasms prevalent in North East India and screening for Antioxidant along with antimicrobial activity*	DBT, GoI (DBT-RA Scheme)	2012- 2014	RA: Dr. Sushmita Gupta Supervisor: Dr. Debajit Thakur
24	*A study on Hydrocarbon pollution in lentic ecosystems in and around oilfield areas and effect of Hydrocarbon contamination on flora and fauna*	North Eastern Council (NEC), Ministry of DONER, GoI.	2013-2015	Prof. Sabitry Choudhury Bordoloi
25	*Antifungal properties of biosurfactants produced by the native bacterial strains and their application to control certain fungal diseases of field crops of Assam*	DBT, GoI. (Twinning project)	2012-2015	Dr. Suresh Deka
26	*Biosurfactant Enhanced Bioremediation of PAHs Contaminated Soil of oil field situated at upper Assam. Funded by the DBT, Govt. of India*	DBT, GoI	2013-2016	Dr. Suresh Deka

27	*Plant assisted bioremediation for decontamination of Polycyclic Aromatic Hydrocarbons (PAHs) polluted soil*	CSIR, New Delhi, Govt. of India	2012-14	RA: Dr. Hemen Deka Supervisor: Dr. Suresh Deka
28	*Development of suitable plant-microbe consortia for remediation of polycyclic aromatic hydrocarbons (PAHs) contaminated soil of Assam with a special emphasis on high molecular weight PAH compounds*	DST, GoI (Fast Track Young Scientist)		Dr. Hemen Deka
29	*Oxidative degradation of typical petroleum hydrocarbons in soil through combined bioaugmentation and biostimulation processes*	DBT, GoI.	2011-2014	Dr. Arundhuti Devi
30	*Treatment of oil field formation water with in situ generated bioflocculant*	DBT, GoI.	2012-2015	Dr. Arundhuti Devi
31	*Exploration of microbial resources of north-east India: generation of metagenomic DNA bank, construction of metagenomic libraries and screening for genes of interest*	DBT, GoI. (under Ramalingaswami Fellowship)	2011-2016	Dr. Mojibur R. Khan
32	*Institutional biotech hub*	DBT, GoI.	2011-2014	Dr. Mojibur R. Khan
33	*Agrawood production from Aquilariaagallocha- studies from a biotechnological perspective on an ancient and important plant based industry of north east India*	DBT, GoI .	2012-2014	RA: Dr. S. Sen Mentor: Dr. Mojibur R. Khan
34	Electronic, Magnetic and Lattice dynamical properties of Magnetic Shape Memory Alloys	DST, GoI	2013-2016	Dr. Munima B. Sahariah

Completed Projects (2013-14)

Sl No.	Title of the project	Funding Agency	Duration	PI/ Coordinator
1	*Development of nanocomposite material based organic-inorganic hybrid flexible solar cell by magnetron sputtering and plasma polymerization combined process*	BRNS-DAE, GoI	2010-2013	Dr. A. R. Pal
2	*Assessment of Risk due to intake of artificial food colours through foodstuffs available in the N.E. Region including Sikkim*	North Eastern Council, Shillong, Ministry of DONEAR, GOI	2010-2013	Dr. Jibon Kotoky
3	*Assessment of impact of anthropogenic activities on soil/water and certain medicinal plants species in and around Bharalu River in Guwahati city*	Ministry of Environment & Forest, GOI	2010-2013	Dr. Jibon Kotoky
4	*Spectra and Pseudo-spectra of Euler Operator*	Council of Scientific and Industrial Research, New Delhi, GOI	2010-2013	Prof. B. C. Tripathy

Publications: 2013-2014

Scientific Research Articles in Journals

1. **S. K. Sharma, A Boruah, and H. Bailung** (2014): *Head on collision of dust acoustic solitons in a strongly coupled dusty plasma*, Physical Review E **89**: 013110.

2. **S. Kundu, K. Das, V. K. Aswal** (2013*): Modification of attractive and repulsive interactions among proteins in solution due to the presence of mono-, di- and tri-valent ions*, Chemical Physics Letters **578**: 115.

3. **S. Kundu, A. J. Chinchalikar, K. Das, V.K. Aswal, J. Kohlbrecher** (2013): *Fe^{+3} ion induced protein gelation: Small-angle neutron scattering study*, Chemical Physics Letters **584**: 172.

4. **S. Kundu, K. Das, O. Konovalov** (2013): *Prolonged reorganization of thiol-capped Au nanoparticles layered structures*, AIP ADVANCES **3**: 092130.

5. **S. Kundu, A. J. Chinchalikar, K. Das, V. K. Aswal, J. Kohlbrecher** (2014): *Mono-, di- and tri-valent ion induced protein gelation: Small-angle neutron scattering study*, Chemical Physics Letters **593**: 140.

6. **A P Misra, N C Adhikary** (2013), Electrostatic solitary waves in dusty pair-ion plasmas, Physics of Plasmas **20** (10): 102309.

7. **Mahananda Baro, Dolly Gogoi, Arup Ratan Pal, Nirab Chandra Adhikary, Heremba Bailung, Joyanti Chutia** (2014): *Pulsed PECVD for low temperature growth of vertically aligned carbon nanotubes*. Chemical Vapor Deposition, DOI: 10.1002/cvde.201307093.

8. **B. K. Nath, A. Khan, J. Chutia, A. R. Pal, H. Bailung, N. Sen Sarma, D. Chowdhury and N. C. Adhikary** (2014): *Enhancement of proton conductivity of sulfonated polystyrene membrane prepared by plasma polymerization process*, Bulletin of Materials Science *(In Press).*

9. **M. Agarwala, T. Barman, D. Gogoi, B. Choudhury, A. R. Pal, RNS Yadav** (2014): *Highly effective antibiofilm coating of silver–polymer nanocomposite on polymeric medical devices deposited by one step plasma process*, Journal of Biomedical Materials Research Part B, DOI: 10.1002/jbm.b.33106.

10. **Tapan Barman, A. R. Pal** (2013): *Contradictory ageing behaviour and optical property of iodine doped and H_2SO_4 doped pulsed DC plasma polymerized aniline thin films*, Solid State Sciences, **24**: 71-78.

11. **Dolly Gogoi, Arup Jyoti Choudhury, Joyanti Chutia, A. R. Pal, Mojibur Khan, Manash Choudhury, Pallabi Pathak, Gouranga Das, Dinkar S. Patil** (2013):

Development of advanced antimicrobial and sterilized plasma polypropylene grafted muga (antheraea assama) silk as suture biomaterial, Biopolymers, DOI 10.1002/bip.22369.

12. **Amreen Ara Hussain, A. R. Pal, Heremba Bailung, Joyanti Chutia, Dinkar S Patil** (2013): *Fabrication of heterostructure device with Au/PPani-TiO_2/ITO configuration and study of device parameters including current conduction mechanism*, J. Phys. D: Applied Physics, **46**: 325301.

13. **Bimal K Sarma, A. R. Pal, Heremba Bailung, Joyanti Chutia** (2013): *Effect of post-deposition annealing on the growth of nanocrystalline TiO2 thin films and elastic anisotropy of rutile phase at different temperatures*, Journal of Alloys and Compounds, **577**: 261-268.

14. **Samiul Hoque, Narendra Nath Dass, Krishna Gopal Bhattcharyya and Neelotpal Sen Sarma** (2014): *Synthesis of Sulfonated Cholesterol Derivatives; its Electrical, Thermal and Optical behaviors*, Molecular Crystals and Liquid Crystals, **592**: 149-162. DOI: 10.1080/15421406.2013.858011.

15. **Toka Swu, Chuba Akum Pongener, Dipak Sinha and Neelotpal Sen Sarma** (2013): *Effect of gamma radiation on dielectric properties of polyacetate polymer*, Der Chemica Sinica, **4(3)**:132-136.

16. **Bedanta Gogoi and Neelotpal Sen Sarma** (2013): *Enhanced fluorescence quenching of hemin detected by a novel polymer of curcumin*, RSC Advances, **3**: 7747–7750. DOI:10.1039/C3RA40549D.

17. **Priyanka Dutta, Narendra Nath Dass, Devasish Chowdhury* and Neelotpal Sen Sarma*** (2013): *Oil-sorbent to hydrosorbent switching in Poly-9-octadecenylacrylate and Poly-9-octadecenylacrylate/Au nanocomposites*, Chemical Engineering Journal, **225**: 202-209. DOI information: 10.1016/j.cej.2013.03.072.

18. **Upama Baruah, Neelam Gogoi, Gitanjali Majumdar and Devasish Chowdhury** (2013) : *Capped Fluorescent Carbon Dots for detection of Hemin: Role of number of –OH groups of capping agent in fluorescence quenching*, The Scientific World Journal **2013**: 529159.

19. **Neelam Gogoi and Devasish Chowdhury** (2014): *In-Situ and Ex-Situ Chitosan-Silver Nanoparticle Composite: Comparison of Storage/Release and Catalytic Properties*, Journal of Nanoscience and Nanotechnology, **14**: 4147-4155.

20. **Lakshinandan Goswami, Gitanjali Majumdar, and Devasish Chowdhury** (2013): *Optical Properties of Surface Passivated CdS Nanocrystals Bifunctionally Anchored to Ag Nanoparticles* Mater. Focus **2**, 378-385.

21. **Elizabeth Thokchom, Mohan Chandra Kalita, and Talukdar, N. C.** (2014). *Isolation, screening, characterization, and selection of superior rhizobacterial strains as bioinoculants for seedling emergence and growth promotion of Mandarin orange (Citrus reticulate Blanco).* Can J Microbiology **60**, 85-92.

22. **Bengyella Louis**, **Sayanika Devi Waikhom**, **Pranab Roy**, **Pardeep Kumar Bhardwaj**, **Mohendro Wakambam Singh**, **Sailendra Goyari**, **Chandradev K Sharma** and **Talukdar, N. C. (2014).** Secretome weaponries of *Cochliobolus lunatus* interacting with potato leaf at different temperature regimes reveal a CL[xxxx]LHM – motif. BMC Genomics **15,** 213 doi:10.1186/1471-2164-15-213

23. **Bengyella Louis,Sayanika Devi Waikhom,1 Pranab Roy, Pardeep Kumar Bhardwaj, Chandradev K. Sharma,1 Mohendro Wakambam Singh, and Talukdar, N. C.** (2014). *Host-Range Dynamics of Cochliobolus lunatus: From a Biocontrol Agent to a Severe Environmental Threat*. Biomed Research International http://dx.doi.org/10.1155/2014/378372

24. **Kaustuvmani Patowary, Rashmi Rekha Saikia, Mohan Chandra Kalita and Suresh Deka** (2014): *Degradation of polyaromatic hydrocarbons employing biosurfactant-producing Bacillus pumilus KS2*. Ann Microbiol. (Springer), DOI 10.1007/s13213-014-0854-7.

25. **Debahuti Goswami, Pratap Jyoti Handique and Suresh Deka** (2013): *Rhamnolipid biosurfactant against Fusarium sacchari – the causal organism of pokkah boeng disease of sugarcane*. Journal of basic microbiology (Wiley), DOI 10.1002/jobm.201200801.

26. **Rashmi Rekha Saikia and Suresh Deka** (2013). *Removal of Hydrocarbon from Refinery Tank Bottom Sludge Employing Microbial Culture*. Environ. Sci Pollu. Res. (Springer), **20**, 9026–9033.

27. **Rashmi Rekha Saikia, Hemen Deka, Debahuti Goswami, Jiumoni Lahkar, Siddhartha Narayan Borah, Kaustuvmani Patowary, Plabita Baruah, Suresh Deka** (2013): *Achieving highest glycolipid biosurfactant by selecting proper carbon nitrogen ratio*. Journal of Surfactant and Detergent. (Springer), **17,** 563-571.

28. **Jiumoni Lahkar, Giyasuddin Ahmed and Suresh Deka** (2013): *Isolation of potent biosurfactant producing bacterial strain from hydrocarbon contaminated soil of Assam*. Research Journal of Contemporary Concerns. **8**, 63-69.

29. **Plabita B., P. P.Baruah and S. Deka.** (2013). *Removal of Hydrocarbon from Crude oil Contaminated Soil by Cyperus bravifolius.* Bull. Environ. Pharmacol. Life Sci., **2(6)**, 123-130.

30. **K.I. Ansari, S. Doyle, J. Kacprzyk, M.R. Khan, S. Walter, J.M. Brennan, C. Arunachalam, P.F. McCabe and F.M. Doohan** (2014): *Light Influences How the*

Fungal Toxin Deoxynivalenol Affects Plant Cell Death and Defence Responses. Toxins (MDPI), **6**, 679-692.

31. **S.S. Ali, S. Kumar, F.M. Doohan, M.R. Khan** (2013): *Brassinosteroid enhances resistance to Fusarium diseases of barley.* Phytopathology (APS) **103**(12):1260-1267.

32. **M. Saikia Y. Chaudhari M. Khan and D. Devi** (2013): *Strains of Philosamia ricini Differ in their Mitochondrial 16S Ribosomal RNA and Cytochrome Oxidase Subunit I Gene Sequences. Int. J. Pure Appl. Sci. Technol.* (IJPAST) **18** (1): 93-101.

33. **S.S. Ali, M.R. Khan, E. Mullins and F.M. Doohan** (2013): *Identification of Fusarium oxysporum Genes Associated with Lignocellulose Bioconversion Competency*. Bioenerg. Res. (Springer) DOI: 10.1007/s12155-013-9353-0.

34. **D. Gogoi, A. J. Choudhury, J. Chutia, A. R. Pal, M. Khan, M. Choudhury, P. Pathak, G. Das and D. S. Patil** (2013): *Development of advanced antimicrobial and sterilized plasma polypropylene grafted muga (Antheraea assama) silk as suture biomaterial*. Biopolymers **101** (4):355-365.

35. **Surabhi Buragohain, Dibakar Chandra Deka and Arundhuti Devi** (2013) : *Fenton oxidation and combined Fenton- microbial treatment of crude oil contaminated soil in Assam-India.* Environmental Science: Processes and Impacts (RSC), **15**: 1913-1920.

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26. **Munima B. Sahariah, Satyananda Chabungbam and Subhradip Ghosh (2014):** *Exploring Ni- Fe-Ga as a ferromagnetic shape memory alloy,* oral presentation in *Asia Sweden meeting on understanding functional materials from lattice dynamics (ASMFLD),* held at Department of Physics, IIT Guwahati, India, January 09-11, 2014 .

27. **Satyananda Chabungbam and Munima B Sahariah (2014):** *Phonon anomaly enhanced electron-phonon coupling in ferromagnetic Ni2FeGa alloy from first principles calculations*, poster presentation in *Asia Sweden meeting on understanding functional materials from*

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29. **Mrinal Kumar Das & Sabitry Bordoloi (2013):** "*Fish diversity of streams in two watersheds of West Kameng district, Arunachal Pradesh*" presented in the National Seminar on "*Recent trends in Bioresources Management & Biodiversity Conservation"* held at Rajiv Gandhi University, Arunachal Pradesh during November 17-19, 2013.

30. **Gitartha Kaushik & Sabitry Bordoloi (2013):** "*Ichthyofaunal diversity of Ranganadi river of Assam, India*" presented in the National Seminar on "*Recent trends in Bioresources Management & Biodiversity Conservation"* held at Rajiv Gandhi University, Arunachal Pradesh during November 17-19, 2013.

31. **Chatoan Tesia & Sabitry Bordoloi (2013):** "*Report on Amphibian fauna of Khonsa circle,Tirap district, Arunachal Pradesh, India*" presented in the National Seminar on "*Recent trends in Bioresources Management & Biodiversity Conservation"* held at Rajiv Gandhi University, Arunachal Pradesh during November 17-19, 2013.

32. **Mihirjyoti Pathak, Hridip Kumar Sarma and Arundhuti Devi (2014):** " *An application of bioflocculant producing bacteria Pseudomonas aeruginosa strain IASST201 in treatment of oil-field formation water*" presented as an author in the International conference on *"Harnessing Natural Resources for Sustainable Development: Global Trends"*,held at Cotton College, Guwahati, Assam during January 29-31, 2014.

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35. **Pranjal Tamuly and Arundhuti Devi (2014):** *"A Comparative Study on Heavy Metal Pollution of Roadside Soils in Different Areas Along NH-37 of Upper Assam, India"* in the International conference on "*Harnessing Natural Resources for Sustainable Development: Global Trends"*, held at Cotton College, Guwahati, Assam during January 29- 31, 2014.

36. **Pranjal Tamuly and Arundhuti Devi (2014):** "Assessment of Heavy Metal Contamination in Tea Leaf Samples of Five Roadside Tea Gardens of Upper Assam, India" in the National

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37. **Sanjeeb Kalita, Kaustav Kalyan Sharma, Jibon Kotoky**, "*Microwave mediated green synthesis of metal nanoparticles using medicinal plant and their bioactivity evaluation*" in International conference on natural product utilization, Bulgaria.

38. **Sanjeeb Kalita, Kaustav Kalyan Sharma, Jibon Kotoky**, "*Adiantum philippense mediated green synthesis of Gold and Silver Nanoparticles by Microwave Irradiation Method and their Bioactivity Evaluation*". International Conference on Harnessing Natural Resources for Sustainable Development- Global Trend.

39. **Raghuram Kandimalla, Sanjeeb Kalita, Bhaswati Choudhury, Jibon Kotoky**, "*Evaluation of plant based formulation for the treatment of Diabetic neuropathic pain*". International Conference on Harnessing Natural Resources for Sustainable Development- Global Trend.

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41. **Sanjeeb Kalita, Kaustav Kalyan Sharma, Jibon Kotoky,** "*Encapsulation of Chloramphenicol in to Poly-epsilon-caprolactone-pluronic nanoparticles and its Physiochemical characterization*". Assam Science Society National seminar on "Current trends in Research".

42. **Nandana Bhardwaj, Dipali Devi, Nam-Joon Cho, Biman B. Mandal (2013):** "*Silk fibroin–keratin 3D scaffolds as a dermal substitute for skin tissue engineerin".* Tissue Engineering and Regenerative Medicine International Society Meeting (TERMIS-AP), 23rd-26th October, 2013, Wuzhen, China.

43. **Monikankana Kalita and Dipali Devi (2013):** "*Determination of LC50 value of the organophosphate Chloropyrifos on Philosamia ricini and its impact on protein concentration*" at National seminar on "Recent trends in bio resource and bio diversity conservation," 17th to19th October 2013, Rajiv Gandhi University, Itanagar, Arunachal Pradesh.

44. **Monikankana Kalita and Dipali Devi (2014):** "*Effect of pesticide pollution in mortality, biochemical composition and amylase enzyme activity on Eri silkworm (Philosamia ricini)*" at International conference on "Harnessing natural resources for sustainable development; Global trend," 29th to 31st January 2014 at Cotton College, Guwahati, Assam.

45. **Manasee Choudhury and Dipali Devi (2013):** "*Effects of bio-degumming on muga silk fibre*" at National seminar on "Recent trends in bio-resource and biodiversity conservation," 17th to19th October 2013, Rajiv Gandhi University, Itanagar, Arunachal Pradesh.

46. **Manasee Choudhury and Dipali Devi (2014):** "*Effect of bio-resources on the degumming of muga silk fibres of Assam*" at International Conference on "Harnessing natural resources for sustainable development: Global trend," 29th to 31st January 2014, Cotton College, Guwahati, Assam.

47. **R. Devi** presented a paper entitled "*Role of ripe pulp of Musa balbisiana fruit in High carbohydrate, High-fat Diet–induced Metabolic Syndrome and Cardiovascular Remodeling in Rats*" in the 2nd quolloquium of DBT overseas associates on 9th Dec at NEHU, Shillong, 2013**.**

48. **Meetali Deori and R. Devi** presented a paper entitled "*Antioxidant, antityrosinase, total phenolic content and nutrient composition of muga silkworm pupae*" in the "International conference on harnessing natural resources for sustainable development: global trends" organized by cotton college, Guwahati on 29-31th Jan, 2014.

49. **Himadri Kalita and R. Devi** presented a paper "*Antioxidant Activities and Mineral composition of juices collected from different parts of Musa balbisiana*" in the "International conference on harnessing natural resources for sustainable development: global trends" organized by cotton college, Guwahati on 29-31th Jan, 2014.

50. **Sima Kumari and R Devi** presented a paper " *Antioxidant Activities and total Polyphenolic Content of three medicinal plants of North Eastern region of India*" in the "International conference on harnessing natural resources for sustainable development: global trends" organized by cotton college, Guwahati on 29-31th Jan, 2014.

51. **D. C. Boruah and R. Devi** presented a paper "Anti-hyperlipidemic effect of citrus grandis juices in cholesterol fed rats" in the "International conference on harnessing natural resources for sustainable development:global trends" organized by cotton college, Guwahati on 29-31th Jan, 2014.

52. **A. Hazarika and R. Devi** presented the parer "*Anti-hyperlipidemic activity of a di-herbal formulation on Triton-WR-1339 induced hyperlipidemic rat*" in the "International conference on harnessing natural resources for sustainable development: global trends" organized by cotton college, Guwahati on 29-31th Jan, 2014.

53. **Ranjita Das, Priyanka Sharma, Debajit Thakur** presented the paper **"***Exploration of forest soil* microflora for the production of antimicrobial metabolites against drug resistant pathogens" in the National Seminar on "Recent trends of research in science and technology" organized by Assam Science Society, hosted by Cotton College, Cotton College State University, Guwahati, Assam, 29th March, 2014. (Oral Presentation).

54. **Priyanka Sharma, Ranjita Das, Jintu Dutta, Debajit Thakur** presented the paper "Antagonistic and extracellular enzymatic activity of Actinomycetes isolated from Pobitora Wildlife Sanctuary, Assam" in the National Seminar on "Recent trends of research in science and technology" organized by Assam Science Society, hosted by Cotton College, Cotton College State University, Guwahati, Assam, 29th March, 2014. (Oral Presentation).

55. **Jintu Dutta, Priyanka Sharma, Debajit Thakur** presented the paper "Exploration of Tea rhizosphere associated culturable Actinomycetes for plant growth promotion and biocontrol of fungal pathogens" in the National Seminar on "Recent trends of research in science and technology" organized by Assam Science Society, hosted by Cotton College, Cotton College State University, Guwahati, Assam, 29th March, 2014. (Oral Presentation).

Participation in Conferences/Workshops/Exhibitions

1. **Prof. Joyanti Chutia and Dr. A. R. Pal** attended the International Conference on Phenomena in Ionized Gases (ICPIG-2013), held at Granada Spain during July 14 -19, 2013.
2. **Dr. A. R. Pal** participated in the "*Emotional Intelligence at work place for Scientists /Technologists*" held at Center for Organization Development, Hyderabad during January 27-31, 2014.
3. **Dr. A. R. Pal** participated in the International Conference on Organic Devices: Future Ahead (ODeFA) 2014 held at BARC, Mumbai during March 3-6, 2014.
4. **Prof. Joyanti Chutia, Dr. S. K. Sarma, Ms. Dolly Gogoi and Ms. Amreen A. Hussain** attended the International Conference on Plasma Science and Application (ICPSA-2013) in Nanyang Technological University, Singapore during December 4-6, 2013.
5. **Mr. Aziz Khan and Mr. B. K. Nath** attended the *International Conference on Green Energy and Smart Material through Science, Technology and Management (GESM '14)*, jointly organized by Gauhati University and University of South Africa during January 21-23, 2014.
6. **Mr. M. Baro** attended the 3rd International Seminar on "Advanced Nanomaterials and Nanotechnology", held at IIT Guwahati, during December 1-3, 2013.
7. **Dr. S. Kundu** attended the "Conference on Neutron Scattering", held at IISER, Pune during February 10-12, 2014.
8. **Dr. S. Kundu** attended the "DAE-BRNS Conference on Organic Devices", held at Bhabha Atomic Research Centre, Mumbai during March 3-6, 2014.
9. **Dr. Nirab Chandra Adhikary** attended the "7th International Conference on the Physics of Dusty Plasmas" held in New Delhi, India during 3- 7 March, 2014.
10. **Dr. Neelotpal Sen Sarma,** attended the Third Euro-India International Conference on Nanomedicine and Tissue Engineering (ICNT 2013) held at Mahatma Gandhi University, Kottayam, Kerala, from 9-11 August 2013.
11. **Dr. Neelotpal Sen Sarma** participated in the Master Class on Bio-entrepreneurship with the theme "Accelerating innovations to market place" held at NII, New Delhi during September 21-23, 2013.
12. **Priyanka Dutta, Bedanta Gogoi and Sudeshna Chakravarty** attended the International Conference on Advanced Polymeric Materials (ICAPM 2013) held at Mahatma Gandhi University, Kottayam, Kerala, from **11-13 October 2013.**
13. **Priyanka Dutta** attended the 3rd International Conference on Advanced Nanomaterials and Nanotechnology (ICANN 2013) held at IIT Guwahati on 1st, 2nd and 3rd December 2013.
14. **Dr. Devasish Chowdhury** attended the International. Conference on Nanoscience and Nanotechnology (ICONN 2014) held at Adelaide (Australia) during 2 – 6 February 2014.

15. **Dr. Devasish Chowdhury** attended the Department of Science and Technology – Autonomous Bodies Conclave (ABC) held at S.N. Bose National Centre for Basic Sciences, Kolkata during 28 – 29 January 2014.
16. **Dr. Devasish Chowdhury, Ms. Neelam Gogoi and Ms. Upama Baruah** attended the 3rd International Conference on Advanced Nanomaterials and Nanotechnology (ICANN2013) held at Indian Institute of Technology Guwahati during 01-03 December 2013.
17. **Ms. Neelam Gogoi and Ms. Upama Baruah** attended **6th International Conference on Nano Science and Technology (ICONSAT) during 3-5 March 2014.**
18. **Prof. B.C. Tripathy** attended the national conference on "Non-linear Dynamics, Analysis and Optimization" organized by Department of Mathematics, Jadavpur University, held during January 9-10, 2014
19. **Mr. Santanu Acharjee** attended International conference and workshop on fractals and wavelets, held at Rajagiri school of engineering and technology, Kakkanad , Kerala during November 9 -16, 2013.
20. **Mr. Santanu Acharjee** attended the Instructional school for teachers on topology and geometry, held at Harish-Chandra research institute, Jhunsi, Allahabad during December 16-28, 2013.
21. **Dr. Munima B. Sahariah** attended the Computational exploration of atomistic structures and their interrelation with physical properties, held during November 04-08, 2013, IFW Dresden, Germany : Poster presentation on " Electronic and Magnetic properties of Ni-Fe-Ga Heusler alloy".
22. **Prof.Sabitry Bordoloi** attended the "International conference on Climate change and the Himalayas" New Delhi, 28 - 31 October, 2013.
23. **Mrinal Kumar Das, Chatoan Tesia and Gitartha Kaushik** attended the "National Seminar on Recent trends in Bioresources Management & Biodiversity Conservation" Rajiv Gandhi University, Arunachal Pradesh, 17-19 November, 2013.
24. Sonali Borpatra Gohain attended the "International conference on Climate change and the Himalayas" New Delhi, 28 - 31 October, 2013.
25. **Jafrin Farha Hussain** attended the workshop entitled "Writing and publishing in Scientific Journals" at DBT AAU Centre, Assam Agricultural University, Jorhat, 25-29 November, 2013.
26. **Mihirjyoti Pathak** presented a paper entitled "An application of bioflocculant producing bacteria Pseudomonas aeruginosa strain IASST201 in treatment of oil-field formation water" in the International conference on *"Harnessing Natural Resources for Sustainable Development: Global Trends"*, held at Cotton College, Guwahati, Assam during January 29-31, 2014.
27. **Gitumani Devi** presented a paper entitled "Characterization of PM2.5 particulate matter in the ambient air of oil field area of upper Assam, India" in the International conference on *"Harnessing Natural Resources for Sustainable Development: Global Trends"*, held at Cotton College, Guwahati, Assam during January 29-31, 2014.
28. **Himangshu Deka** presented a paper entitled "In-vitro degradation study of anthracene by Bacillus cereus strain IASST E01"in the International conference on *"Harnessing Natural Resources for Sustainable Development: Global Trends"*, held at Cotton College, Guwahati, Assam during January 29-31, 2014.
29. **Pranjal Tamuly** presented a paper entitled "A Comparative Study on Heavy Metal Pollution of Roadside Soils in Different Areas Along NH-37 of Upper Assam, India" in the

International conference on *"Harnessing Natural Resources for Sustainable Development: Global Trends"*, held at Cotton College, Guwahati, Assam during January 29-31, 2014.

30. **Pranjal Tamuly** a paper entitled"Assessment of Heavy Metal Contamination in Tea Leaf Samples of Five Roadside Tea Gardens of Upper Assam, India" in the National Seminar on "Recent Advances in Chemical Research", held at Department of Chemistry, Rajiv Gandhi University, Arunachal Pradesh during March 20-21, 2014.
31. **Dr. M. R. Khan** attended the "Ramalingaswami fellows' conclave". NCCS, Pune, 12th - 14th September, 2013.
32. **Dr. Jibon Kotoky** attended and delivered oral presentation in International conference on natural product utilization, Bulgaria.
33. **Dr. Jibon Kotoky** delivered a keynote lecture at College teachers' reorientation programme at Pub-Kamrup College, Baihata Chariali organized by UGC, Govt. of India, New Delhi.
34. **Dr. Jibon Kotoky** attended and chaired a Technical Session on 20th ISCB International Conference on Chemistry and medicinal plants in Traditional Medicine for Healthcare organized by Indian Society for Chemist and Biologist, Delhi University, New Delhi.
35. **Dr. Jibon Kotoky** delivered invited lecture (mentor) lecture at Inspire Internship camp at M.C College, Barpeta, Assam.
36. Seribiotech lab under the guideship of **Dr. Dipali Devi** has participated at two exhibitions held at Cotton State University and at Morigaon.
37. **Rahul Sarma** attended a UGC (SAP DRS-I) sponsored National Seminar on Plant Resources of NE region and their Bioprospecting, 30th March, 2013 at Department of Botany, Gauhati University.
38. **Rahul Sarma** attended a workshop on "Recent trends in Electron Microscopy of NEHU" Shillong on 5 - 8th March, 2013.
39. **Rahul Sarma** participated in the International Conference on "Head and Neck Cancer" held on 30 Nov. - 1 Dec, 2013 at North East Cancer Hospital and Research Institute.
40. **Rahul Sarma** attended a workshop on "Metagenomics" under Institutional Biotech Hub on 26-28th 2013Nov at IASST, Guwahati.
41. **Himadri Kalita** attended training on "PCR based Molecular Technique in Biological Research" at State Biotech Hub, Guwahati, Khanapara on 18-20th Sep, 2013.
42. **Himadri Kalita** attended a workshop on "Metagenomics" under Institutional Biotech Hub on 26-28th Nov2013 at IASST, Guwahati.
43. **Meetali Deori** attended a workshop on "Metagenomics" under Institutional Biotech Hub on 26-28th Nov 2013 at IASST, Guwahati.
44. **Sima Kumari** attended a workshop on "Metagenomics" under Institutional Biotech Hub on 26-28th Nov 2013at IASST, Guwahati.
45. **Ankita Hazarika** attended a workshop on "Metagenomics" under Institutional Biotech Hub on 26-28th Nov 2013 at IASST, Guwahati.

Ph.D. Awarded during the year 2013-2014

Sl No.	Name	Thesis title	Guide/Supervisor	University	Year
1	Mr. Koustav Kalyan Sarma	*Antidermatophytic properties of certain medicinal plants of Assam*	Dr. Jibon Kotoky	Gauhati University, Guwahati, Assam	2013
3	Mr Mukul Deka	*Season specific varieties of Philosamia ricini and nutritional impact on the growth and silk production*	Dr. DipaliDevi	Gauhati University, Guwahati, Assam	2013
4	Mr. Budhadev Basumatary	*A study on Phytoremediation of hydrocarbon and heavy metals contaminated soil with selected plant species*	Prof. Sabitry Bordoloi	Gauhati University, Guwahati, Assam	2013
5	Ms. Jwngma Narzary	A study on Diversity and Ecology of Amphibian fauna of Kokrajhar district, Assam with special reference to family *Microhylidae*	Prof. Sabitry Bordoloi	Gauhati University, Guwahati, Assam	2013
6	Mr. Manoranjan Mishra	*Studies on some Fuzzy Real Valuede Sequence Spaces*	Prof. B.C. Tripathy	Gauhati University, Guwahati, Assam	2013
7	Mr. Hemen Dutta	*Studies on Some Sequence Spaces Defined by Orlicz Functions*	Prof. B.C. Tripathy	Gauhati University, Guwahati, Assam	2013
8	Mr. Manoranjan Mishra	*Studies on some Fuzzy Real Valuede Sequence Spaces*	Prof. B.C. Tripathy	Utkal University, Bhubaneswar	2013
9	Ms. Dolly Gogoi	*Surface modification of muga silk (antheraea assama) by plasma polymerization process*	Prof. Joyanti Chutia Dr. A. R. Pal	Gauhati University, Guwahati, Assam	2014

Awards and Recognitions:

1. **Dr. Sumita Kumari Sarma**, Inspire Faculty, **Best Oral Presentation Award** in the *International Conference on the Physics of Dusty Plasma* held at New Delhi, India during March 3 – 7, 2014.

2. **Ms. Neelam Gogoi**, SRF, Material Nanochemistry Laboratory, **Best Poster Presentation Award** in the **6th International Conference On Nano Science and Technology (ICONSAT)** 2014 sponsored by Nanoscale, Royal Society of Chemistry (RSC), *London.*

3. **Ms. Dolly Gogoi**, SRF, **Best Poster Presentation Award** in Plasma Processing category in the International Conference on Plasma Science and Application held at Nanyang Technological University, Singapore during December 4-6, 2013.

4. **Dr. N. C. Talukdar,** Director
   (a) Member, Research Task Force, Tea Board, Govt. of India, Kolkata.
   (b) Senate Member, National Institute of Technology, Govt. of India, Manipur.
   (c) Member, Task Force for project evaluation for Unit of Excellence under DBT NEBRPMC, New Delhi.

5. **Dr. B.C. Tripathy,** Professor, CCNS
   (a) Vice President, The Indian Academy of Mathematics, Indore.

   (b) Member, The American Mathematical Society, USA.

   (c) Elected Editorial Board member of

   (i) The periodical "Journal of Advanced Research in Pure Mathematics" USA

   (ii) The periodical "Journal of Advanced Research in Fuzzy and Uncertain Systems" USA.

   (iii) The periodical "Frontier in Science" Scientific and Academic Publishing, USA.

   (iv) The journal "Journal of Analysis and Applications", KOSOVO.

   (v) The journal "Turkish Journal of Science and Technology", Firat University, TURKEY

   (vi) The periodical "Far East Journal of Mathematical Sciences" (Pushpa Publishing House), Allahabad.

(vii) The periodical "Surveys in Mathematics and Mathematical Sciences" (Pushpa Publishing House), Allahabad.

(viii) The periodical "Journal of Indian Academy of Mathematics" Indore.

(ix) The periodical "Computational Research": Horizon Research Publications Corp., USA.

(d) Elected Reviewer

(i) "Zentralblatt Math", GERMANY.

(ii) "Mathematical Reviews", USA.

6. **Dr. Neelotpal Sen Sarma,** Associate professor II, Physical Sciences

Chaired the Session on the sub-theme 'Nanotechnology' in the "International Conference on Harnessing Natural Resources for Sustainable Development- global Trends held in Cotton College, Guwahati during 29th to 31st January, 2014.

7. **Dr Dipali Devi,** Professor I, Life Sciences

Fellowship of the Indian Academy of science & Nature (IASN), 2013

8. **Dr. Nandana Bhardwaj**, DBT-RA, Life Sciences

ICMR, DBT and CSIR travel grant award for attending Tissue Engineering and Regenerative Medicine International Society Meeting (TERMIS-AP) Annual Conference from 23rd-26th October, 2013, China.

9. **Dr. G. Choudhury**, Associate Professor I, CCNS

(a) Elected Editorial Board Member of

(i) The periodical *"Far East Journal of Theoretical Statistics"* (*Pushpa Publishing House, Allahabad*): Dr. G. Choudhury.

(ii) The journal "Applied Mathematical Modelling" (Elsevier Journal)

(iii) "Journal of Assam Academy of Mathematics" of Assam Academy of Mathematics publication, Guwahati

Invited Lectures/Talks of IASST Staff

1. Prof. H. Bailung delivered an invited talk entitled "Dust acoustic waves in strongly coupled dusty plasma" in the *National Conference on Nonlinear and Complex Systems*, held at Jadavpur University, Kolkata during January 7-9, 2014.

2. Prof. H. Bailung delivered Topical Lecture entitled "Plasma : The Fourth State of Matter" in *DST INSPIRE CAMP for School Students, MC College Borpeta* on December 19, 2013.

3. Prof. Joyanti Chutia delivered an invited talk entitled "*Golden silk as plasma processed biomaterial"* in the *International Conference on Plasma Science and Application*" held at Nanyang Technological University, Singapore during December 4-6, 2013.

4. Neelotpal Sen Sarma, Sensors using biomaterials, invited talk delivered in the Third Euro-India International Conference on Nanomedicine and Tissue Engineering (ICNT 2013) held at Mahatma Gandhi University, Kottayam, Kerala, from **9-11 August 2013.**

5. Dr. Jibon Kotoky delivered a keynote lecture at College teachers' reorientation programme at Pub-Kamrup College, Baihata Chariali organized by UGC, Govt. of India, New Delhi on 15th May, 2013.

6. Dr. Jibon Kotoky attended the "Participated and delivered oral presentation in International conference on natural product utilization, Bulgaria during 3-6 November, 2013.

7. Dr. Jibon Kotoky delivered invited lecture (mentor) lecture at Inspire Internship camp at M.C College, Barpeta, Assam on 19th December, 2013.

8. Dr. Jibon Kotoky attended and chaired a Technical Session on 20th ISCB International Conference on Chemistry and medicinal plants in Traditional Medicine for Healthcare organized by Indian Society for Chemist and Biologist, Delhi University, New Delhi during 1-4 March, 2014.

9. Dr. Rajlakshmi Devi delivered an invited talk at Regional Science Center at Khanapara, Guwahati on 11th May, 2013 on the occasion of National Technology day.

10. Prof. B.C. Tripathy delivered an invited lecture titled "*On Sequences of Fuzzy Numbers*" in the national conference on "Non-linear Dynamics, Analysis and Optimization" organized by Department of Mathematics, Jadavpur University, held during January 9-10, 2014.

11. Dr. G. Choudhury delivered a lecture titled "*Development of Mathematical Probability and its History*" in Inspire Internship Science Camp (Innovation in Science Results for Inspired Research) (INSPIRE) Sponsored by Department of Science and Technology , Govt. of India organised by M.C. College, Barpeta, Assam held during December 17-21, 2013.

12. Dr. M.B. Sahriah delivered a lecture entitled "*Density Functional Calculations in Metals*" in the International workshop on Materials Modeling and Simulation, Shri Sankaracharyya group of Institutions, Bhilai, Chattisgarh held during June 24-27, 2013.

13. Dr. M.B. Sahriah delivered a lecture entitled "*Introduction to Materials Modeling and Simulation*" in the Departmental seminar in Department of Physics, Gauhati University, Guwahati on 6th Sept., 2013.

14. Dr. M.B. Sahriah delivered a lecture entitled "*Understanding the shape memory behaviour of Fe-based Heusler Alloy*" in the International Conference on Structural and Physical Properties of Solids, ISM Dhanbad held during Nov. 18-20, 2013.

15. Dr. G. Choudhury delivered a series of lectures delivered for the Pre-Ph.D students of Department of Mathematics , Gauhati University in topic "Basic Statistics".

M.Sc. / B.Tech Projects / Training Courses

1. Pre-Ph.D Course work on plasma physics has been arranged for six months duration for IASST Research Scholars registered under Gauhati University in 2013.
2. Sandwich course on plasma physics (experiment) for M. Sc (Physics) students of Gauhati University. 15 students participated in the course. Also, a practical examination has been conducted for those students appeared in the M.Sc (Physics) Final Semester examination 2013 under Gauhati University.
3. Mr. Munin Agarwala, Research Scholar, Center for Studied in Biotechnology, Dibrugarh University has undergone training on "*Plasma synthesis of nanoparticles for biomedical applications*" during April – June, 2013 under the supervision of Dr. A. R. Pal.
4. Ms. Trishna Moni Das and Ms. Susmita Rabha, BS students of IST, Gauhati University have carried out end semester project work on "*Fabrication of Solar Cell using Core/Shell Nanoparticles*" during April – May, 2013 under the supervision of Dr. A. R. Pal.

Seminar / Lecture Organized at IASST during 2013-14

Date	Name of the Speaker	Affiliation	Topic
27/5/2013	**Prof. R.N. Bhaumik**	Emeritus Professor, Department of Mathematics, Tripura University	Prediction of Coronary Artery Disease (CAD) using rough Set Theory
21/11/2013	**Prof. H P Sarma**	Professor Department of Environmental Sciences Gauhati University Guwahati-781014	Growth and development of department of environmental sciences in the Gauhati University
22/11/2013	**Dr. Albert Chiang**	Well-come Trust-DBT India Alliance Fellow at National Centre for Biological Sciences, Bangalore and Honorary Research Fellow (Well- come Trust-DBT India Alliance) at University College London	Mechanisms of synapse maintenance- insights from brain neural circuits of insect and vertebrate model systems.
28/11/2013	**Dr. Hariom Yadav**	Ramalingaswami Fellow, National Agri-Food Biotechnology institute, Mohali	Probiotic Biotherapy for Obesity/Diabetes
09/12/2013	**Prof Annemarie OHLER**	Museum, Histoire d'Naturalle, Paris, France	Identify: compare, recongnize and describe amphibian species
17/12/2013	**Dr. Rintu Barman and Dr. Utpal Tahbildar**	Medical consultant of IASST	First aid on medical emergency
06/01/2014	**Dr. Khairul Islam Ansari**	Harvey Cushing Neuro-oncology Laboratory, Department of Neurosurgery, BWH Harvard Medical School, Harvard University, Boston, MA	Epigenetic Mechanisms of Glioblastoma (GBM) Pathogenesis
24/01/2014	**Dr. Rahul Mahanta**	**Associate Professor, Department of Physics, Cotton College, Guwahati**	Multiscale interaction and intense rainfall events over Northeast India
19/02/2014	**Dr. Pankaj Chetia**	Research Associate, Bio-Informatics Center, Assam University, Silchar	Sequence Analysis using Bioinformatics tools DNA Sequence Analysis in Bio-informatics Center
24/03/2014	**Prof. D S Patil**	Scientific Officer and Prof. & Head Homi Bhaba National Institute Laser and Plasma Technology Division, BARC, Trombay Mumbai-400085	Low pressure plasma assisted chemical vapour deposition

Prof Annemarie OHLER- Museum, Histoire d'Naturalle, Paris, France on '*Identify: compare, recongnize and describe amphibian species*'

Dr. Albert Chiang- on Mechanisms of synapse maintenance- insights from brain neural circuits of insect and vertebrate model systems

Major Events

IASST Foundation Day Celebration

The Institute fraternity celebrated the 35th foundation day with a day long programme in the institute premises on November 04, 2013. The programme started with flag hoisting and It was followed by an open meeting in the conference hall attended by distinguished scientists and academians of institutions/universities of uwahati city. The Director of the institute welcomed the distinguished guests, Prof K.S. Krishnan of Tata Institute of Fundamental Research (TIFR), Bangalore, Dr. R.C Boruah of the North East Institute of Science & Technology (CSIR NEIST), Jorhat and the gatherings. On this Foundation Day, Prof. K.S. Krishnan, Dr. R.C Boruah, Dr. Jyoyanti Goswami, wife of late Dr. Pratul Goswami, former Director of IASST, Prof. Joyanti Chutia, former Director and DST Emeritus professor and Sri Uddhab Bharali, a renowned innovator and entrepreneur of Assam were felicitated with citations for their distinguished career and contribution to science and technology. Dr. (Mrs.) Lipi Banerjee Mahanta, Associate professor, read out the citations. Prof. R.S. Krishnan delivered the Foundation Day lecture and enthralled the audience with a very illuminating science topic "Chemical communication: a bouquet of smells". In his lecture, he also highlighted the DBT's initiative to open a window of opportunity in chemical ecology research for the young researchers of the north east India at NCBS, TIFR. Dr. R.C Boruah in his speech highlighted the areas in which, there was scope for cooperation between the NEIST and IASST.

Prof. Sabitry Choudhury Bordoloi, convener of the celebrations committee anchored the entire proceedings and offered vote of thanks to the participants. The beautiful evening of the Day was marked by a programme to showcase the institute's talents in cultural fronts and also Prize distribution. In what turned out to be a very enjoyable evening, research scholars and the young children of the IASST family captivated the audience by their performances ranging from songs, recitations, short skit to bihu dance. Research scholars, Mr. Geetartha and Ms. Jafreen, anchored the culture show and finally the noted singer Ms. Trishna Devi enhanced the beauty and joy of the evening through mix of some of her very best modern numbers. The colorful evening of the foundation day come to an end as Dr. M.R. Khan offered vote of thanks to one and all.

Prof. R.S. Krishnan delivering the Foundation Day lecture

National Science Day Celebration by IASST and Cotton College State University, Assam jointly:

National Science Day 2014 was celebrated at Cotton College State University (CCSU) by organizing Science Fair 2014 which spread over two days on 28th February and 1st March, 2014. The event was organized jointly by the Cotton College State University (CCSU) and the Institute of Advanced Study in Science and Technology (IASST). It turned out to be the maiden mega event of National Science Day in the city despite of the dates coinciding with the final board examinations of schools of Guwahati. It was an event of overwhelming participations of 432 participants from across 40 organizations and institutions on the seven science events.

Several distinguished guests who graced the occasion by delivering lectures in different frontline scientific topics were: Prof. Krishnamoorthy Kannan - renowned stem cell researcher, Prof. Arun Chattopadhyay- nanobiothechnologist, IIT Guwahati, Dr. Anil Kumar Goswami - former Principal, Cotton College, Dr. Chandan Mahanta - Department of Civil engineering, IIT Guwahati, Ms. Archita B. Bhattacharyya -Programme Officer, World Wild Life Fund for Nature – India, Assam and Arunachal Pradesh, Prof. Parimal Bhattacharjee - former HoD, Department of Zoology, Gauhati University, Mr. Uddhab Bharali, a brilliant innovator in his own right with over 100 innovations to his credit, Mr. Sameer Joshi - Team Indus, Google Lunar X Prize, Mr. Mrinal K. Choudhury - Assam Energy Development Agency (AEDA) and Dr. Kulendu Pathak - former Vice Chancellor, Dibrugarh University.

The Science Fair 2014 at Cotton University was concluded with an illuminating talk entitled "*GOD PARTICLE and the INFANT UNIVERSE at CERN*" by the renowned physicist Prof Bikash Sinha, Homi Bhabha Distinguished Professor of the Department of Atomic Energy. His lecture was followed by distribution of awards to the winners of different event.

Prof. Krishnamoorthy Kannan delivering lecture

Students from different colleges/universities displaying Science model on the occasion of National Science Day Celebration

Celebration of vigilance week at IASST:

IASST have been Celebrating the vigilance awareness week and during 2013, the week began on 28th of October. The celebration got kicked off with the pledge taking ceremony led by the Director at 11a.m. Sri P.P.Varma, IAS and former chief secretary also joined in the pledge taking ceremony. It was then followed up by a meeting attended by the entire staff and the invited guests in the auditorium. Prof. N.C.Talukdar, director welcomed Shri Verma and the gathering. Prof. Sabitry Choudhury Bordoloi, Vigilance Officer of IASST introduced the invited speaker Sri P.P. Varma. Shri Varma delivered a thought provoking speech highlighting the significance of the vigilance week. He also took part in a lively interaction during which he answered various queries related to vigilance in administration, raised by the IASST fraternity. Former Director, IASST Prof. Joyanti Chutia also made valuable suggestions with respect to transparency in administration. Dr. Diganta Goswami, Registrar of the institute offered the vote of thanks. The vigilance week celebration continued till 2nd November, 2013. Local newspaper covered the vigilance week celebration of IASST.

Oath taking at by IASST fraternity on the occasion of Vigilance Awareness Week

Celebration of Hindi Diwas:

September 14 of every year is celebrated as “Hindi Divas” in the institute. The chief guest in the celebration of “Hindi Divas 2013” was Sri Mohan Koirala, Hindi Officer, Brahmaputra Board (Ministry of Water Resources), Basistha, Guwahati. The meeting started with a chorus presented by the research fellows and employee of the institute. In his welcome address, Prof. B.C. Tripathy spoke about the importance and reason behind the consideration of Hindi as an official language for all central government works. In his address to the gathering, Sri Koirala elaborated about the different stages of development of the Hindi language. Also, he focused about the struggle made by the people for making Hindi as the official language along with English by the Government of India for all the official purposes and get it passed by the constitution of our country. Prof. N.C. Talukdar, Director in his address spoke about the importance of language both mother tongue and official language and encouraged the audience to make a habit to communicate in Hindi. The meeting ended with vote of thanks offered by Dr. D. Goswami, Registrar.

Sri Mohan Koirala delivering lecture

National Seminar on Cell Phone/tower Radiation Hazards and Solutions

In recent time, there has been concern expressed by all concerned on the possible hazards from mobile phone/tower radiation in view of the enormous increase in mobile phone usage and installation of mobile phone towers everywhere. Although limited scientific studies carried out, conclusive evidences are yet to emerge. IAAST organized a day-long national seminar on Cell phone/tower radiation hazards and solutions on 18th February, 2014 with the prime objective of bringing together the interested persons to discuss and express their views on cell phone/tower radiation hazards related to human health, biota and ecology of India. There were one hundred thirty participants from various colleges, institutions and universities in the seminar.

Few scientists from the reputed scientific institutions and universities were invited who were involved in scientific research on the topic were involved. Prof. R. C. Deka, Former Director, AIIMS, New Delhi delivered the inaugural lecture. He highlighted health issues and health concern associated with electro-magnetic frequency (EMF) and radiofrequency (RF) exposures. The keynote address was delivered by Prof. Girish Kumar, IIT, Bombay who threw light on several health hazards due to overuse of cell phone and continuous exposure to cell phone tower radiation. In the invited talks by Prof. J. Behari and Dr. R. Paulraj, from JNU, New Delhi delighted the seminar with wonderful insights on the issue which is the theme of this seminar. In his concluding speech, Prof. D. J. Saikia, Vice Chancellor, Cotton College State University thanked the organizers for arranging such seminar on a burning topic and urged the young peoples to come forward and take initiative in carrying out research on effect of cell phone/tower radiation hazards on human and environment and also to create awareness among the common people.

Prof. R. C. Deka, Former Director, AIIMS, New Delhi during his inaugural IASST auditorium.

Participants of the seminar seen with Prof. R.C. Deka, AIMS, New Delhi (3rd from left) and Prof. Girish Kumar, IITB (5th from left) in front of IASST building.

Workshop on Sensor and its application

A Workshop on Sensor and its application was organized in the Polymer Section of IASST on 15th November 2013. The workshop was supported by DeitY, GoI. The objective of the workshop was to give update students and researchers about the latest development in the field of sensors. Key note address was delivered by Dr. Amarnath Sen, Chief Scientist & Head, Sensor & Actuator, CSIR-Central Glass & Ceramic Research Institute. Prof. Arun K. Nandi, Head, Polymer Science Unit Indian Association for the Cultivation of Science Kolkata, Prof. Gopal Das, Department of Chemistry IIT Guwahati, Dr Kamal Dasgupta, Chief Scientist and Head of Optical Fibre and Photonics Division and Acting Director CSIR-CGCR and Dr. Somenath Roy, Sensor & Actuator Division of the same institute also delivered lectures in the workshop.

Delegates and participants of the workshop on sensors and its applications.

Seri-Biotechnology research workshop and brainstorming

A day long workshop was held at IASST on Seri-biotechnology on 03/02/2014. The meeting was started with welcome address of Dr. N C Talukdar, Director, IASST. In the workshop a number of scientists involved in seri-biotechnology research participated. Eminent Scientists from Japan Prof. Hiromu Akai and Prof. Motoyuki Sumida along with Mr Parva Tanaka, Mrs.Yoise Nagata and Mrs.Keiko Hiyama have graced the occasion as invited speakers and guests. The workshop was anchored by Prof. J. Kotoky, Sectional Head, BCSS, Life Sciences Division, IASST.

Prof. Hiromu Akai is a distinguished scientist and Editor In Chief, International J. Wild Silk moths and Silk, President, International Society of Wild Silk Moth, President, Japanese Society of Wild Silk moths and Visiting Professor, Tokyo University of Agriculture, Japan. In his lecture, he dealt on structure of cocoons of mulberry and non-mulberry silk and lucidly illustrated the topic with various visual and microscopic images.

Prof. Motoyuki Sumida, Adjunct Professor, Hannan University, Japan talked on the methodology developed for study of fibroinase enzymes. Dr S.N. Choudhury, Retd. Scientist, NEIST, Jorhat, Assam illustrated the various types of food plants (Muga) with different chemical composition. Dr. P. Jayaprakash, Scientist and Head, Muga Silkworm Seed Organization, CSB, Guwahati appraised the present scenario of muga silk production in Assam. Dr. Bhuban Chutia, Assistant Professor, Nowgong College, Nagaon highlighted the wild silk moths diversity in Nagaland through a set of high quality images. Dr. Nandana Bharadwaj, Women Scientist, Seri-biotech Lab., IASST informed how silk materials could be engineered to make compatible biomaterial. for Biomedical application. Mr. Suradip Das from IIT Guwahati talked on data base of silk. Dr. Bijit Talukdar, Research Associate, Seribiotech Lab., IASST presented a brief report of research on silkworm and silk done at IASST. Mrs. Dolly Gogoi, Research Scholar, IASST presented a talk on application of plasma for enhancement of bio-compatibility of silk as suture material. Dr. A.K. Sahu, Retd. Scientist of CSB explained the necessity of conservation (*in- situ* and *ex-situ*) of silk worm for sustainable growth and preservation of the non-mulberry silk worm.

At the end of the technical session, Prof. N. C. Talukdar, Director, IASST summarized the presentations. He opined that there is an urgent need for collaborative research on Seri biotechnology and IASST will take initiation for connecting other institute for such a collaborative work. There must be at least three groups to address three focused programme on sericulture research:

1. Biology and conservation
2. Societal program to benefit the industries from technology generated so far.
3. Quality control during production and down stream processing.

Dr. Jayprakash added his views that muga industry need to be well organized and stressed upon necessity of indoor rearing, induction of diapause and development of viral disease resistant race. Dr S.N.Choudhury commented that the host plants should be identified with the help of farmers and multiplied. Pursuance should be there after launching the program to arrive at desired result. The Japanese group expressed desire to extend their help towards developing a programme on fibroinase and also in publication of research. The meeting was ended with the vote of thanks offered by Dr. Dipali Devi, Associate Prof., Life sciences.

Brainstorming workshop on fibre research and development organized in February,2014

Scientist from the Australian Future Fibres Research and Innovation Centre (AFFRIC), IFM, Deakin University, Geelong, Australia made presentation on the exciting development in fibre research and development. Dr. Rangam Rajkhowa and Mr. David Pardoe of Deakin University, Australia and Prof Xungai Wang delivered a brief lecture overviewing the research at AFRIC, Deakin University. He appraised about the capacity and research offerings of Deakin University. The Australian Future Fibres Research and Innovation Centre (AFFRIC) is a collaborative program between Deakin University, CSIRO Materials Science and Engineering and the Victorian Centre for Advanced Materials Manufacturing (VCAMM). It has been supported by significant grants from both the federal government and the state government of Victoria. AFFRIC conducts research focusing on all aspects of fibre manufacturing, including silk and carbon fibre development. AFFRIC has more than 100 researchers and PhD students who are engaged in research associated with fibre, textile, biomedical, composite, automotive and aerospace industry in the Precinct. They engage in research at a local level and internationally with collaborations in USA, Europe, Singapore, China and India. The group also expressed willingness to enter into a MOA with IASST for research collaboration.

Brainstorming Session on Issues Related to Climate Change

A brainstorming session was arranged on 19-02-2014 at IASST for a very intensive discussion on the burning issue of climate change and its consequences. Few prominent scientists from Japan also participated in this session. Prof. Taiichi Hayashi, Disaster Prevention Research Institute, Kyoto University, Japan discussed the problem of reduced rainfall in the Cherapunjii area at present and some of the causes why Mousiram records highest rainfall in the world. He also showed the database of the Indian meteorological department (IMD). He expressed that in the North-East of India, the IMD data has not been generated extensively. They have placed 15 instruments (Rain gauges), for fresh data collection in the North-East of India and six in Bangladesh. Dr. Yusuke Yamane, Tokoha Gakuen University, Japan in his presentation showed how convective storms originates and their incidences in the northern Indian region. Dr. Yusuke Yamane, Tokoha University and Dr. Azusa Fukushima, Kobe University also talked on the related issues.

Prof. Chandan Mahanta, IIT, Guwahati delivered a presentation on "Trend of Monsoon rainfall in the eastern part of the Brahmaputra valley". Prof. S.C. Bordoloi, IASST presented her work on amphibian in NE region and studies on wetland of North East of India. Prof. Bordoloi opined that amphibian an indicator species of global climate change and their exhaustive record can act as prediction parameter in climate change issues.

Visiting scientists from Japan with Indian scientists who participated in the brainstorming session on climate change

IASST Colloquium 2013

IASST colloquium was organized for the first time during 4th-5th October, 2013 in the institute's auditorium. The colloquium was aimed to provide a platform for research scholars to present their research activities and enrich their research theme through interaction with the experts. The colloquium activity was structured in two sessions. One session dealt with Physical Sciences and Centre of Computational and Numerical Sciences and another with life sciences. A distinguished invited scientist from a national institute presented a lead talk in a session, which was followed by presentations from the research scholars and alumni of IASST. A team of external scientific experts judged the presentations for colloquium award. Prof. Girish Kumar, IIT Bombay; Prof. Rintu Banerjee, IIT Kharagpur were the lead speakers and six experts namely, Prof. T.K. Deka, Gauhati university; Prof. N. N. Singh, Gauhati university; Prof. A. Dutta, Gauhati university; Prof. C. M. Sharma, Gauhati university; Prof. M. Qureshi, IITG and Prof. S.S. Ghosh, IITG judged the presentations. Altogether, there were 45 presentations by PhD students and 3 presentations by alumni of IASST. The award recipients were as follows.

Physical sciences and CCNS

1st. Dolly Gogoi
2nd. Priyanka Dutta
3rd. Neelam Gogoi

Life Sciences Division

1st. Ranjita Das
2nd. Priyanka Sharma
3rd. Sanjeeb Kalita

PhD student presenting research work

Establishment of Bio-Resource Conservation Hub at IASST

IASST has established a Bio-resource Conservation Hub in its campus covering a land of 7 acres. The hub is inaugurated by Dr. Hemo Prova Saikia, Chairperson, Assam Tourism Development Corporation (ATDC) and wife of former Chief Minister Late Hiteswar Saikia on the World Environment Day 5th June, 2014. A total of 250 seedlings representing high value of timber tree, valuable indigenous bamboo varieties, medicinal herbs of the North-East of India and endemic citrus plants. In selection of plant species, it was kept in mind that they acts as support for nesting of resident birds of the area besides ensuring a strong sense of ecstatics.

Dr. Hemo Prova Saikia inaugurating Bio-Resource Conservation Hub

Plantation by IASST's Staff at Bio-Resource Conservation Hub

Staff Welfare Measures

Medical Facility
The institute operates medical reimbursement system through which bills on expenses of both indoor and outdoor treatment in respect of all employees and their dependent family members are reimbursed as per CGHS rates. One allopathic doctor is engaged on part time basis who pays visit to the institute twice a week. He provides free consultation to the staff both in the institute and in his consulting room. Facilities like rest bed and pressure machine are readily available in the doctor's chamber. The institute has entered into deal with few renowned hospitals of Guwahati to provide medical facilities to employees and their dependent family members as per central government rules/CGHS rates.

Canteen Facility
The institute's canteen is run by a private party. In the canteen meals, snacks and beverages are prepared in hygienic condition and are served to employees, students and guests at subsidized rates.

Benevolent Fund
An IASST employees' Benevolent Fund was established by equal contribution from employees and the IASST core fund. All the regular staff members are member of the Fund. The fund envisages a benefit in the form of onetime payment to nominees of the members in case of death and permanent disability while in service.

Group Insurance
A Group Insurance Scheme for the employees of the institute is in operation with the Life Insurance Corporation of India. All the regular employees of the institute are members of the scheme. Subscription for the scheme is made by the institute to get appropriate insurance cover for each group of employees.

Reservation Policy
The Institute is following post based rosters for affecting the prescribed percentage of reservations to SC/ST/OBC in all its new recruitments as per Government of India Rules.

Official Language Policy
The institute's emphasis is on implementation of provisions of Official Language Act and the rules made and instructions issued thereunder. All the Letter heads of the Institute are in bilingual format. Annual Report of the Institute is published both in English and Hindi. The institute celebrated the Hindi Diwas with great zeal.