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R&D Newsletter

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Industry Connect Talk Series

In the Industry Connect Talk Series, organized by the Industrial Collaboration Advisory Group (ICAG), speakers from the industry are invited to present their company's research areas of interest to explore possibilities of collaboration with researchers at IIT Kanpur.

Dr. Chedarampet S. Karthikeyan, from Global Dow Ventures & Business Development, presented on 5th October, 2015, an overview of the Dow Chemical Company as well as about different business areas of Dow including packaging, water purification, electronic materials, agricultural chemicals, coatings (industrial, protective, decorative and architectural), performance plastics, adhesives, polyurethanes, elastomers, plastic additives, solar, food and pharma, home and personal care. The talk also described as to what do they do in Dow ventures & business development and the process to bring new technologies.

A team from Emerson Network Power comprising Mr. Sunil Khanna, President, Mr. Vikas Luthra, General Manager, Quality, and Mr. Kamlesh Keharia, Head R&D, AC Power Business, delivered a talk on 9th November, 2015. The covered topics included energy efficient designs of data centre, power plant solutions for telecom, latest trends in energy efficient precision cooling solutions and wireless solutions for process plants.

MOU signed with DCIPL and Emerson Network Power

On 4th November, 2015, MOUs were signed between IIT Kanpur with Dow Chemical International Pvt. Ltd. (DCIPL) and with Emerson Network Power in the Rashtrapati Bhawan in the presence of the President, Shri Pranab Mukherjee. The MOUs were signed by Prof. Indranil Manna, Director, IIT Kanpur and Mr. Sudhir Shenoy, CEO Dow Chemical and Mr. Sunil Khanna, President, Emerson Network Power.

TCS Innovation Day

The TCS Innovation Day @ IITKanpur was held on 15th October, 2015. A large delegation of TCS Senior Scientists, led by their CTO, Mr. Ananth Krishnan, IITKanpur Director Professor Indranil Manna, DORD Professor Amalendu Chandra, many faculty members and students participated in the daylong event. The visiting team showed broad interests in several areas including Materials Engineering, Chemical Engineering, Mechanical Engineering, Biological Sciences and Engineering, Electrical Engineering, Computer Science and Engineering, Physics, Chemistry, Mathematics & Statistics. The objective of this event was to explore the possibility of carrying out collaborative research with IIT Kanpur in the areas of mutual interests and conducting 'Research Cafe' where research scholars of IITK can interact with TCS scientists. The event was concluded with an Institute Lecture by Mr. Ananth on 'Digital Forces combine to create Innovation at the Intersections'.

MOU signed with TCS

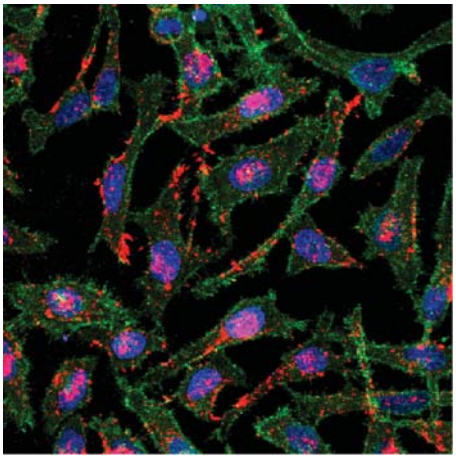
An MOU was signed between IIT Kanpur and TCS on 15th October, 2015. This agreement was signed by Prof. Amalendu Chandra, Dean, Research and Development, IIT Kanpur, and Mr. K. Anantha Krishnan, CTO TCS in the presence of Prof. Indranil Manna, Director, IIT Kanpur.

Modulation of Adeno-Associated Virus (AAV) Replication by Host Cell Transcriptional Repressors: Pharmacologic and RNA Interference to Improve AAV Vector Delivery during Gene Therapy

PI: Prof. Jayandharan G. Rao, Biological Sciences & Bioengineering

Sponsor: Department of Biotechnology

In recent years, gene therapy for human diseases such as hemophilia and hereditary blindness using adeno-associated virus (AAV) vectors has shown great promise. Nonetheless, relatively large dose of vectors are used in clinical trials to achieve a therapeutic outcome. This large dose also triggers an immune response that clears the virus from the host, resulting in only a transient improvement in the patient's disease phenotype. Thus for this mode of therapy to be long lasting, it is important that the host immune response is resolved or minimized. We have shown previously that host-cellular proteins linked to unfolded-protein response pathway play a major role in initiating immune response against AAV vectors. The current project attempts to extend these findings by further study of microRNA regulators involved in this pathway. This information will be useful in developing designer AAV vectors that will incorporate specific microRNA elements so as to overcome barriers imposed by host immunity.



AAV labeled with a cyanine dye are seen as red particles in HeLa cells. The cell nuclei is stained with Hoechst (blue) and the cadherin molecule is stained in green for contrast.

This project is supported by a Senior Innovative Young Biotechnologist (IYBA) award to Dr Jayandharan Rao

Photodiode Arrays for Near Infrared Detection and Tracking

PI: Prof. Utpal Das, Electrical Engineering

Sponsor: DRDO

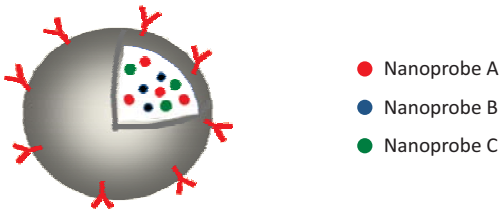
Large-scale, multi-element pin photodiode arrays (unlike CCDs) have applications in the fields of medical imaging and laser tracking systems, including three-dimensional imaging. Unlike avalanche Photodiodes, uniformity in breakdown voltage simplifies readout integrated circuit designs where a single bias may be used for all array elements. The proposed InGaAs/GaAs strained QW detector array Responsivity ~ 0.9A/W on GaAs substarte is larger than that of 0.65A/W in commercial InGaAs/InP arrays at 1060nm wavelength. Hence this detector is the most suitable for focal plane arrays working at 1060nm at a cheaper cost.

Target-Specific Nanomaterials as Contrast Agents for High Precision Multimodal Bioimaging Applications

PI: Prof. Sri Sivakumar, Chemical Engineering
Co-PI: Prof. Ashutosh Sharma, Chemical Engineering

Sponsor: Department of Science & Technology
(Under DST-Nano Mission Program)

The essential requirements for an imaging technique are high target specificity, 3-D tomography, real-time imaging, non-invasiveness, and high spatial resolution in which accurate and real-time imaging of biological targets is highly essential to understand the fundamental biological processes as well as to successfully diagnose various diseases. However, a single imaging technique cannot provide all the above and each techniques has its own merits and demerits. These issues can overcome by multimodal imaging methods which can compensate for the deficiencies of single imaging modalities. However, a separate contrast agent should be administered for every imaging method which can cause toxicity to the patients. To overcome these issues, it is urgent to develop a target specific contrast agent with multimodalities (e.g. magnetism and fluorescence). To this end, this proposal focuses on designing of a novel class of monodisperse, target specific multimodal nanoparticles-loaded (e.g. metal, magnetic, semiconductor, and lanthanide-doped nanoparticles) carbon nanocapsules for variety of bioimaging applications such as magnetic resonance imaging (MRI), positron emission tomography (PET), and optical imaging. Additionally, these nanoparticles-loaded carbon capsules can have molecular functionality on their surfaces, such as catalytic centres, fluorescent markers, and DNA or organic ligands for biorecognition.



Schematic diagram of nanoparticles-loaded carbon capsules

Controlling Electronic Switching in Organo-Metallic Molecular Patterns at Solid-Liquid-Interface using Scanning Electrochemical Tunneling Microscopy

PI: Prof. Thiruvancheril G Gopakumar, Chemistry

Sponsor: Department of Science and Technology

Highly ordered molecular patterns of molecules with metal centers find excellent application in the field of molecular electronics. Incorporating metal in the organic self-assembled layers provides a great opportunity to tune their electronic as well as magnetic properties. In this project we are controlling the electronic switching (switching electronic states) of redox active organo-metallic molecules on crystalline surfaces. Scanning tunneling Microscope (STM) will be applied to selectively addressing the metal center of molecules adsorbed on crystalline surfaces; either in electrochemical environment or at ambient conditions. Overall the project aims at development of external control of oxidation states (electronic properties) of molecules, which is expected to act as molecular switches. Research facility proposed to be created under this project is Scanning Tunneling Microscope (STM).





Establishing a Critical Zone Observatory (CZO) in the Ganga Basin: Focus on Water Balance, Water Quality, and Hydro-Meteorological Information System

PI: Prof. Debajyoti Paul, Earth Sciences
Co-PI: Prof. Rajiv Sinha, Earth Sciences
Prof. Sachchida Nand Tripathi, Civil Engineering
Prof. Shivam Tripathi, Civil Engineering
Prof. Indra Sekhar Sen, Earth Sciences

Sponsor: Ministry of Earth Sciences

The critical zone is defined as "the external terrestrial layer extending from the outer limits of vegetation down to and including the zone of groundwater". We propose to set up a Critical Zone Observatory (CZO) in a watershed of the Pandu River basin (catchment area ~2270 km^2) in the Gangetic plains. An array of field instruments will be set up to monitor hydro-meteorological parameters, partitioning of different components of water balance, determine soil characteristics and chemistry, and geochemical fluxes. Data generated will quantify various climatic, hydrological and geochemical parameters related to the critical zone, and contribute towards understanding of physiochemical (and biological) processes responsible for sustenance of the critical zone.

Advancing the Efficiency and Production Potential of Excitonic Solar Cells: Phase II

PI: Prof. Ashish Garg, Materials Science & Engineering & SCDT

Sponsor: Department of Science & Technology
(Under DST-RCUK Solar Initiative)

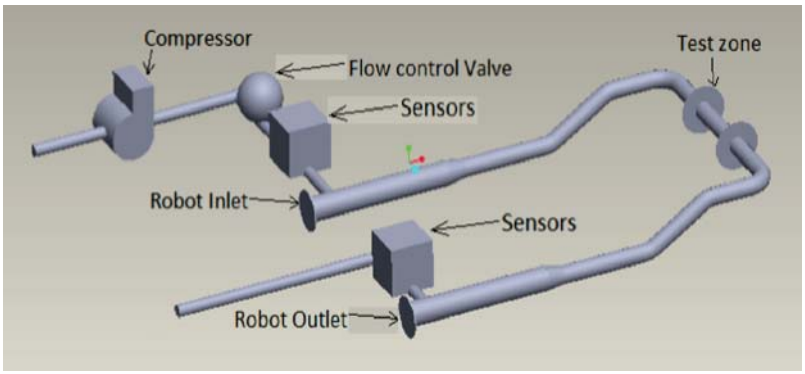
This multi-institution India-UK project is built on the results achieved in the first phase of this project where we demonstrated extended life time of excitonic solar cell devices by using interface engineering methods. In the second phase, the challenge is to demonstrate the power conversion efficiencies of 10% and 6% on large area substrates of size 10x10 cm fabricated on glass as well as flexible substrates respectively.

Development of Compressed Air-Based Test Bed for Pipe-Line Health Monitoring Robot

PI: Prof. Bishakh Bhattacharya, Mechanical Engineering
Co-PI: Prof. PK Panigrahi, Mechanical Engineering

Sponsor: Gas Authority of India (GAIL)

This project aims at developing a compressed air based test bed on which performance of various pipe health monitoring robots (PHMR) can be examined. PHMR had already been developed in the first phase of R&D work at IITK from the GAIL funded Project at Phase-I. The current project, more specifically, will be guided towards design and development of compressed air based test bed and demonstration of the performance of pipe health monitoring report.



Proposed test bed

Optimal Power Architecture for Next Generation Datacenters

PI: Prof. Santanu Kumar Mishra, Electrical Engineering

Sponsor: Science and Engineering Research Board

Datacenters are facilities that store and process electronic data. As per published data, the total electricity use by datacenters in 2010 was estimated to be 1.3% of all electricity use for the world. Experts predict, global datacenter carbon dioxide emissions are poised to equal that of the airline industry; almost quadrupling between 2010 and 2020. This makes it important for researchers to investigate better architectures to improve the efficiency and power density of future datacenters. The project will look at next generation power converter technology and its control to improve performance and efficiency of datacenters.

Recently Registered Projects

Three Problems in Algebraic Complexity Theory

PI: Prof. Nitin Saxena, Computer Science & Engineering

Sponsor: Department of Science and Technology

This project is funded under DST SwarnaJayanti Fellowship 2013-14

Computation has become indispensable in today's scientific and applied world. The theory and practice of computing had made giant strides in the last century -- from Turing's abstraction of computation in 1936 to the computing devices of today. Yet certain fundamental computation questions are still unresolved. The Project will aim to focus, very specifically, on three such questions that lie in the intersection of computation and mathematics. Here we try to model computation in algebraic terms, and hope to develop algebraic tools that are more specialized to computation. This not only leads to a good understanding of the complexity of problems, but also enriches the classical notions of algebra.

Problem 1: Depth-3 identity testing.

An algebraic computation on input variables x_1,...,x_n, taking values in a ring R, can be seen as a rooted directed acyclic graph (dag or circuit) C with the variables at the leaves, the output at the root, and the internal nodes computing addition or multiplication in R[x_1,...,x_n]. For this proposal we will focus on depth-3. I.e. C(x) = \sum_{i\in[k]} \prod_{j\in[d]} \ell_{i,j}, where \ell_{i,j} is a linear polynomial in F[x_1,...,x_n]. The question of depth-3 identity testing is to test whether C=0 in poly(ndk) time.

Problem 2: Algebraic independence over finite fields.

Polynomials f_1,...,f_m \in F_p[x_1,...,x_n] are called algebraically dependent if there exists a nonzero polynomial F(y_1,...,y_m) such that F(f_1,...,f_m) = 0 (F is called annihilating). If no such F exists then the polynomials are called algebraically independent. Given polynomials, in some way, we want to test their algebraic independence in time polynomial in the input size. When the field characteristic p is `large' there is a classical tool-- Jacobian --that comes to our rescue, and yields a poly-time randomized test. For general p, however, nothing close to poly-time is known.

Problem 3: Integer factoring via lattices.

Given an integer n in binary, we would like to factor it into its prime factors. The trivial algorithm requires \sqrt{n} steps, which is exponential in the input size. The problem of integer factoring has been around for several millennia and in the recent decades it has found intense applications in computing (eg. cryptography). We would like to investigate new approaches that involve lattice and AKS cyclotomic methods.

Feedback/Suggestions

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