R&D NEWSLETTER

Indian Institute of Technology Roorkee

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TIDES BUSINESS INCUBATOR

Inauguration of the extension centre of TIDES at Greater Noida Extension Centre of IIT Roorkee

IIT ROORKEE has launched an extension centre of its TIDES Business Incubator on 20th July, 2018 in Greater Noida.Thus start-ups incubated by the institute at its Roorkee campus will benefit from the start-up ecosystem of NCR. TIDES is supported by the Govt of India under Start-Up India scheme. The Greater Noida Extension Centre will initially offer incubation to three start-ups with 15 incubatee team members. The Technology Innovation and Development of Entrepreneurship Support (TIDES) Incubator has been granted Rs. 12 crore funding through Department of Science and Technology (DST), Ministry of Electronics and IT (MeitY), National Science and Technology Entrepreneurship Development Board (NSTEDB) and other agencies. Dr. Anita Gupta, Associate Head, NSTEDB, DST, was the Chief Guest of the occasion. DST has approved one Incubator Accelerator under NIDHI Accelerator program at GNEC at a total cost of Rs. 75 lakhs at National level with focus on IoT and B2B, and has recommended cohort size of minimum 10 startups.

Recently Registered Research Projects

Dynamics Analysis and Shape Control of Inflatable Structures for Space Application

Sponsor: Department of Science & Technology (DST), Govt. of India and the Ministry of Science, Technology and Research (MSTR), Government of the Democratic Socialist Republic of Sri Lanka

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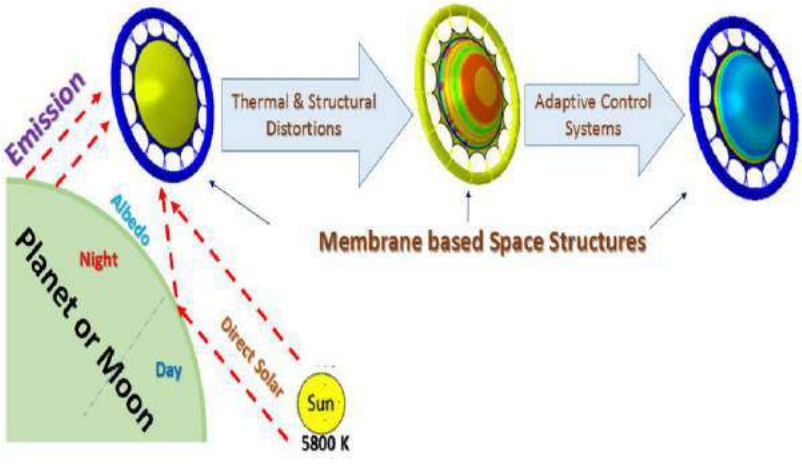
This project is under Indo-Sri Lanka joint research program between IIT Roorkee and University of Moratuwa. The research work deals with dynamic behavior and shape control action of highly flexible reflector with the application of smart materials. Space-based membrane materials showed non-linear behavior at launching and orbital conditions. These structures are often partially wrinkled and the formation of wrinkles drastically alters load paths and structural stiffness within the membrane. A better understanding of the effects of wrinkles on the structural performance and stability of these structures is essential and desirable. Analytical and numerical studies of the wrinkling analysis of membranes provide a natural way of approaching this field.



Reducing the surface roughness and controlling the shape of membrane reflector at orbital loading condition are one of the challenges for space application. The aim of this project is to develop a mathematical model for optimizing the surface error of space-based membrane structures and validate its effectiveness with the help of experiments.

Test Facilities for Sustainable and Durable Construction

Sponsor: National Building Construction Corporation Ltd.

Prof. Umesh Kumar Sharma
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The environmental impact of construction industry can be reduced through resource productivity by conserving materials and energy for their production and by improving the durability of building products.

Improving durability of building materials presents a long-range solution and a major breakthrough for improving the resource productivity of the construction industry. However, there is no dedicated laboratory for testing materials for durable and long life structures. Such laboratory should not only be able to conduct all relevant durability related tests but should also be capable of performing tests on already built structures for designing their life extension techniques. Towards this end, the proposed project involves establishing a Laboratory on "Sustainable & Durable Construction" under the IITR-NBCC R&D Centre at Greater Noida Extension Centre.

Development of molecular diagnostic method for early detection of Chikungunya using fluorescent virus-like nanoparticles

Sponsor: Department of Biotechnology, Govt. of India

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Chikungunya Virus (CHIKV) has recently emerged in the dengue virus endemic areas in India. Infections by these viruses share some common signs/symptoms, but diagnosis and persistent symptoms differ. Thus, accurate and timely diagnosis of CHIKV disease is essential for differentiating the infections and also to control the CHIKV disease. Presently, Chikungunya diagnosis is based on RT-PCR and serological based diagnostics kits Chikungunya disease is caused by a small, spherical, enveloped virus having positive-strand RNA as the genetic material. The glycoprotein E1 and E2 are the key antigens that are present on the surface of CHIKV particles. The main objective of this proposal is to develop a diagnostic method for early detection of virus particles in infected patients. Virus-like nanoparticles (VLPs) will have florescent tag engineered in VLPs. In the proposal, fluorescence based method for detection has been proposed as it is more sensitive and specific.

Fate and Management of Emerging Contaminants (FaME)

Sponsor: National Environment Research Council (NERC), UK

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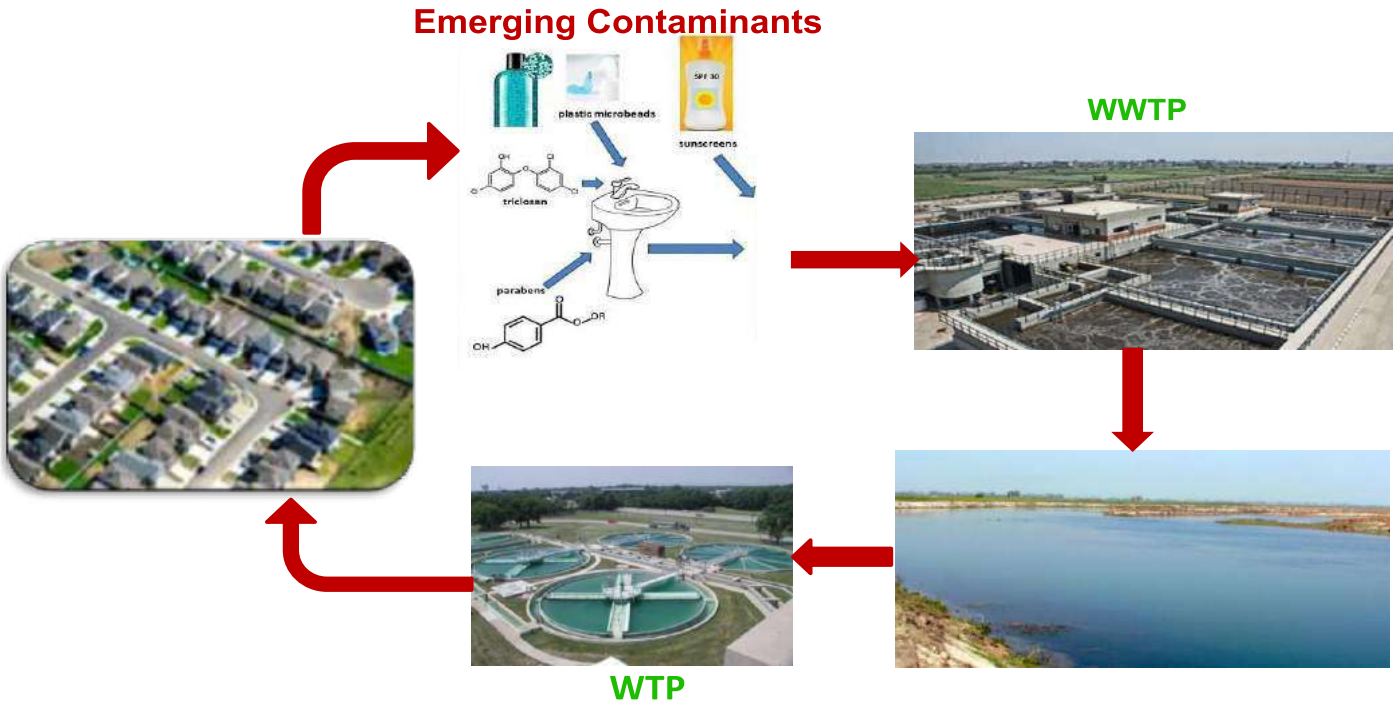
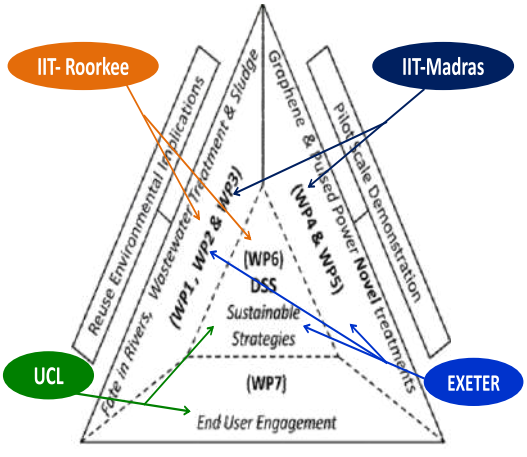
FaME project supports to the Clean Ganga Mission in India and water pollution control in the UK through the investigation of fate of emerging contaminants (ECs) and the development of novel solutions for their sustainable management. It is Indo-UK collaborative project comes under the National Environment Research Council (NERC), Newton Water Quality, UK. The collaborative institutions from UK and Indian side are: University of Exeter, University College of London (UCL), IIT Chennai and IIT Roorkee respectively. To achieve the main objective, the following key challenges are to be addressed. The monitoring of the fate and interaction of emerging contaminants in polluted Yamuna River water, river bed and aquatic life,

groundwater and existing sewage treatment plants is necessary. Another important factor is to monitor the fate of emerging contaminants in sludge line and composting at sewage treatment plants.



Co-development of cost effective solutions for the treatment of ECs in urban and rural communities using new approaches such as graphene based polymer composites, and innovations in advanced oxidation processes coupled with chemical free treatment with pulsed power and energy efficient membranes, development of an "open access" novel decision support system capable of automatically generating and identifying optimal sustainable water management strategies to meet end users' needs and contexts; and End user engagement and impact generation would help in attaining the objectives.



Role of integrin receptors in tumor mediated immune editing of macrophages

Sponsor: Department of Biotechnology, Govt. of India

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Our immune system plays a crucial role in protecting our body from the development of cancers but as the cancer progresses; it deceives our defense mechanisms by reprogramming our immune cells to a pro-

tumorigenic phenotype. Macrophages are the professional phagocytes that are very plastic in nature. The proposed work will discover new molecular interactions in a cancer environment that switches the tumor-associated macrophages from an inflammatory to anti-inflammatory cell type. Thus, the results from this study will help in the development of novel targeted therapeutics that could help in managing cancer patients by restoring the functions of macrophages

Analysis of rapid phase transition in liquid natural gas spills

Sponsor: Science and Engineering Research Board

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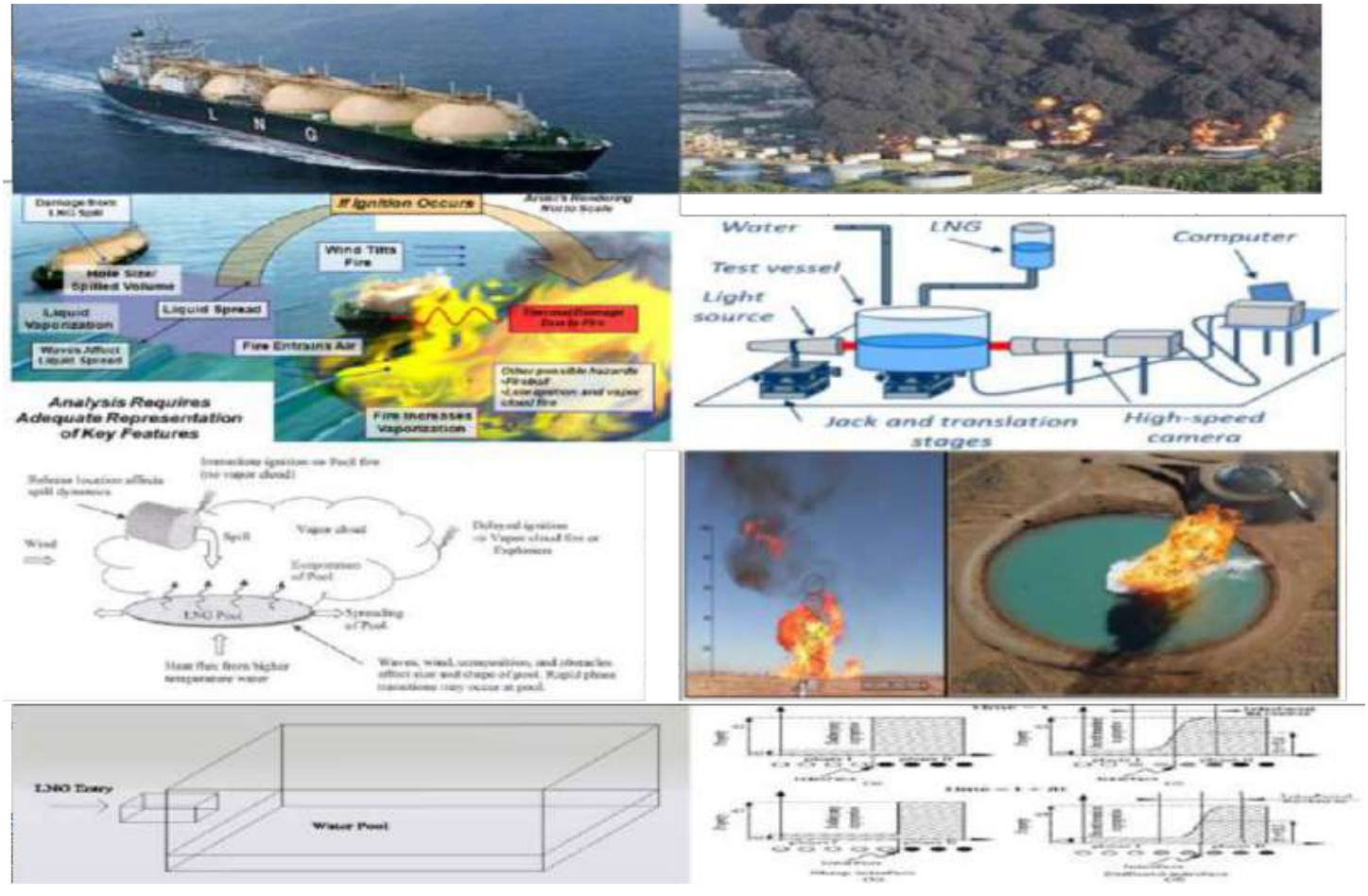
This project is aimed in knowledge-building for naval industry, promoting safety in LNG transportation, refueling and production. Objective of this project is to enable better risk quantification of large scale accidents caused by LNG spills onto water. The project will contain both experimental and theoretical/modeling tasks, both aimed at filling the knowledge gaps in the current understanding of LNG RPT. Performing systematic experiments to capture the statistical properties of the apparently stochastic phenomenon and developing new theoretical models covering the triggering phase of RPT are main activities in the project.



Impact of Weather Variability on Hill Agriculture: A Comparative Study of Himachal Pradesh and Uttarakhand

Sponsor: Indian Council for Social Science Research (ICSSR) New Delhi

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Hill agriculture is strongly influenced by weather variation. Due to weather variability in particular unpredictable rainfall, cold and heat stresses results in massive yield losses in agriculture. Uttarakhand and Himachal Pradesh are neighboring Himalayan states similar with respect to characteristics, such as topography, demography, socio-economic development pattern and especially the environment and farming practices. Uttarakhand is ahead of rest of India in terms of per capita income and surpassed that of Himachal Pradesh in 2009-10. However, these trends raises more questions especially with regard to the state of agriculture and the condition of those engaged in it in the two states. Uttarakhand saw more reduction in share of agriculture to state GDP vis-a-vis Himachal Pradesh. The reasons mostly attributed are climatic or weather related factors. The objective of this study is to assess the state of hill agriculture (in the hill districts) with special focus on production of foodgrains and horticulture. The study proposes incorporation of real time weather data in an economic model to analyze impact on productivity (in selected locale). From policy point of view, the study would also attempt to identify adaptation (short term and medium term) strategies towards enhancing resilience of farmers.

In vitro cell based characterization of some synthetic drugs for anticancer/ other activities

Sponsor: Michigan Diagnostics, Royal Oak, Michigan, USA

Prof. Partha Roy
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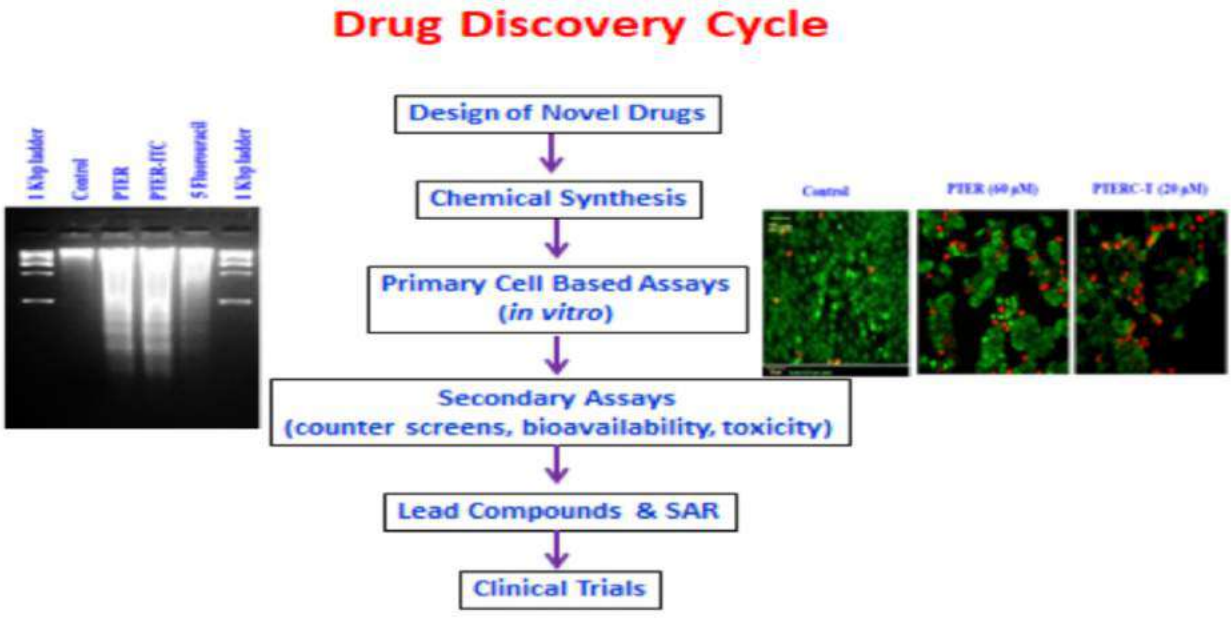
Cancer is a serious public health burdens globally both in developed and developing countries. It is basically an abnormal growth of cells in body with subsequent invading to other healthy cells and finally leading to death. These abnormal cells are produced due to several factors right from food to exposure to environmental chemicals and in some cases remains unexplained. According to American Cancer Society, cancer constitutes 2-3% of annual death globally. Several existing chemo-preventive agents are used to treat cancer, but most of them are associated with serious problems in terms of toxicity, drug-resistance and lack of tissue specificity. All these demands development of novel drugs devoid of said problems. Major emphasis in the project is the development of novel drugs inspired by the anti-cancer potential of some existing drugs but with structural modifications to reduce the associated side effects to enable the development of better drugs. Based on the information obtained from cell based assays the potent

molecules would be taken further for animal based pre-clinical study and further towards translation. The industry-academia partnership in this project will create a compatible platform for development of novel molecules and its translation for the cure and management of cancer.



Inhibition of clinically relevant Carbapenemases (ICARBA)

Sponsor: Indian Council of Medical Research and Research Council of Norway (Indo-Norway)

Prof. Ranjana Pathania
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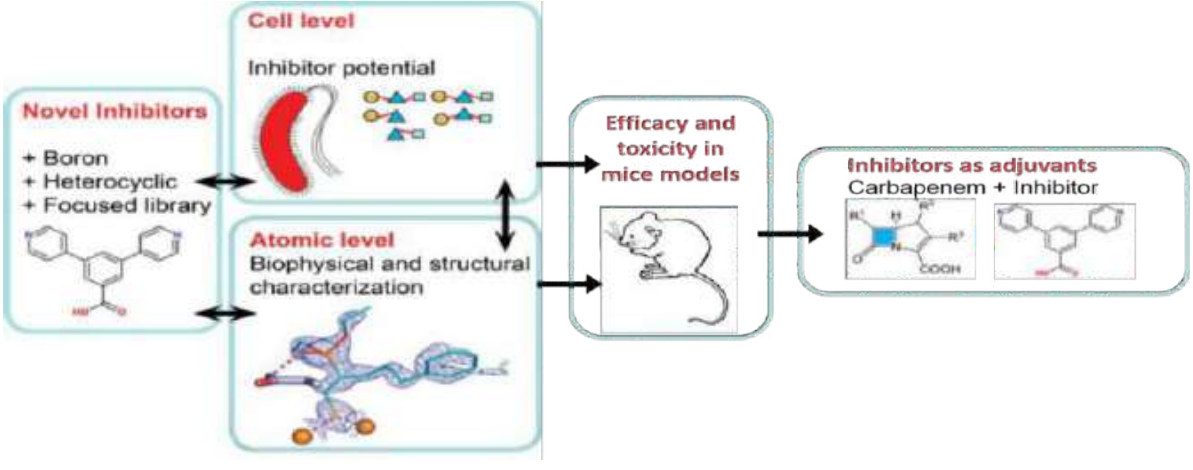
Carbapenemases are one of the most frequently encountered determinants to resist the antibacterial action of carbapenems, the last resort antibiotics. In this project, our lab is engaged in identification of inhibitors of OXA-48 and KPC-2, two of the most important carbapenemases worldwide.



Fragment based and small molecule libraries will be used in a phenotype based screening to identify lead compounds and their biophysical and structural properties (Structure Activity Relationship, SAR) will be

evaluated. Their preclinical potential will be assessed by studying in-vivo safety and efficacy in mice. The outcome of this endeavor in the form of leads is likely to go a long way in countering the problem of antibiotic resistance due to carbapenemases.

Reduction of carbon footprint and VOCs by migration from solvent to water based ink from for printing solution for flexible packaging (under Uchchatar Avishkar Yojana)

Sponsor: MHRD, Ministry of Environment and Forest and Afflatus Gravures Pvt Ltd, Noida (Industry partner)

Prof. Yuvraj Singh Negi
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This work is aimed to cater the needs of the vastly developing and much demanded to reduce the VOCs and carbon footprint from packaging industries by using water based rotogravure printing ink. The formulation of water-based gravure ink will be formulated by changing pigment/binder ratio for replacement of solvent base ink. Rheological influence of formulation will be analysed by characterization study and printing quality parameters. This study also describes an experimental investigation into the process parameter effects from electronic to laser cylinder product quality in rotogravure printing.

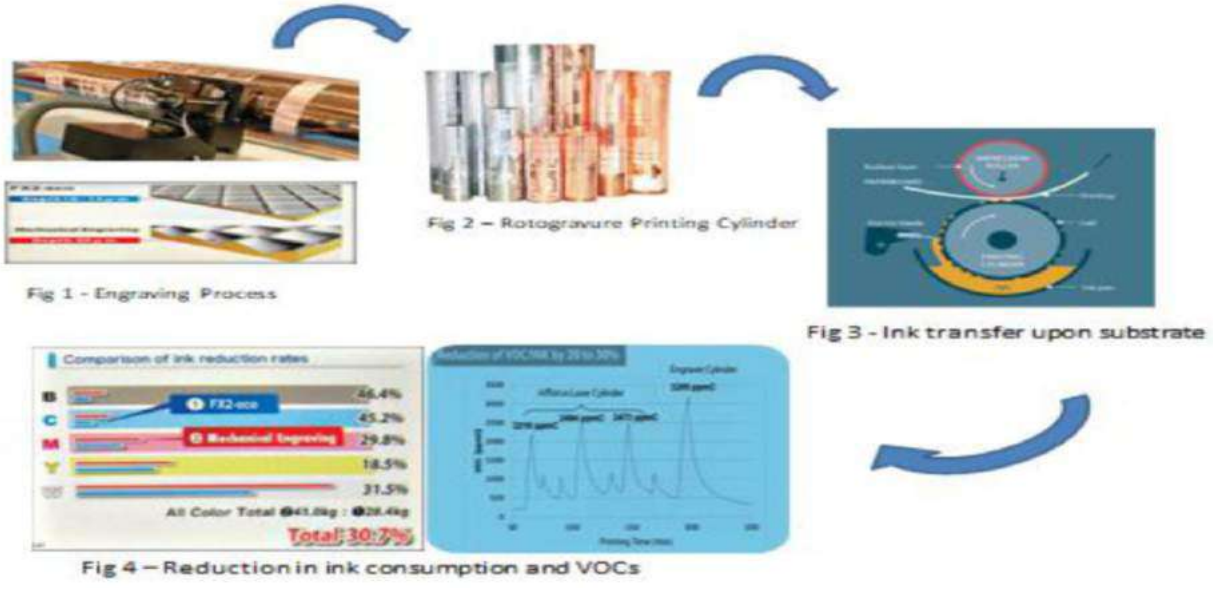

Fig 4 – Reduction in ink consumption and VOCs

Development of polymer/biopolymer viscosifier (like Xanthan gum) for temperature stability up to 250° C for use in drilling fluid

Sponsor: Oil and Natural Gas Corporation Limited (ONGC)

Prof. Yuvraj Singh Negi

Drilling fluids are used in oil recovery application which aids the drilling of boreholes into earth. It helps in certain ways such as generating hydrostatic pressure to prevent the entry of formation fluid into the well

bore, keeping the drill bit cool, suspending the drill cuttings and thus cleaning the well bore. The property of drilling fluids is significantly affected by its viscosity. High viscosity is required to improve the functioning of drilling fluid which can be maintained by the addition of viscosifiers. Till date, the utilization of viscosifiers is limited to a temperature up to 150°C. So our objective is to develop viscosifier with high thermal stability to be used in drilling fluid for oil recovery. A 70, 49, 500.00 Lakhs INR fund will be used over 1.5 years for research and development of xanthan gum based materials which can be used up to 250°C in drilling fluid.

The objectives of the project are to develop viscosifier like xanthan gum and high thermally stable polymers for drilling fluid and to enhance crude oil recovery from underground reservoirs by using viscosifier and thermally stable polymer which will provide hydrostatic pressure to prevent formation fluids during the wellbore process up to 250°C temperature. From strategic point of view, the project research goal is to develop thermally stable materials with collaboration between ONGC and IIT Roorkee in continuing effective research directions of enhanced oil recovery.

Development of sustainable and safe hybrid supercapacitor with high energy density (~100 $WhKg^{-1}$), power density (2 $kWKg^{-1}$) and long cycle life (>20,000 cycles) for high end applications such as space, defence and hybrid electric vehicles

Sponsor: Department of Science and Technology, Govt. of India

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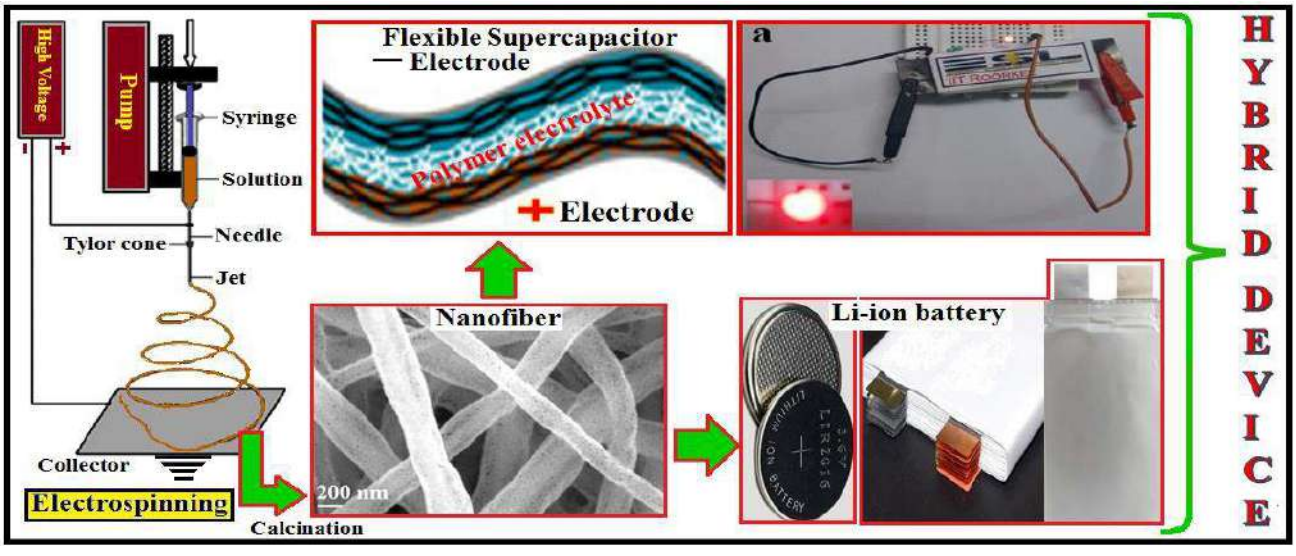
Hybrid energy storage system has been gaining much more attention now-a-days with the aim of utilizing this device in high end applications as it combines two or more energy storage technologies with complementary characteristics to provide optimal solution that is not achievable by any one technology (particularly either battery or supercapacitor).



Schematic diagram of prototype hybrid device

In this regard, optimum structural and morphological featured active material comprising of all beneficial properties (High surface area, homogeneous pore size and its distribution, smooth conduction path for electrolytic ions etc.) synthesized by easy, cost effective and reliable methods are of great interest. In view of this, in this project we propose the fabrication of ternary spinel oxides nanostructures of beneficial morphological features (high aspect ratio, porous network consisting of inter-connected nanoparticles of spinel-AMn2O4) which provides smooth percolation of electrolytic ions even to interior of active material and thereby increase the participation of materials to exhibit high performance with appropriate electrolyte. The gaps/fissures between two individual nanoparticles usually buffer the volume expansion during cycling and provide stable cycling. Further, proposed material with unique morphological features (high aspect ratio, porosity, high surface area, pore size distribution) along with optimized electrolyte (aqueous / non aqueous) is expected to be a prospective electrode material in prototype supercapacitor / hybrid supercapacitor to deliver high energy density (~100 WhKg-1), high power density (~ 2kWKg-1), good cyclability (>20,000 cycles) and good rate capability.

Hyper-redundant Robots

Sponsor: Department of Science and Technology, Government of India & Ministry of Science, ICT and Future Planning Republic of Korea

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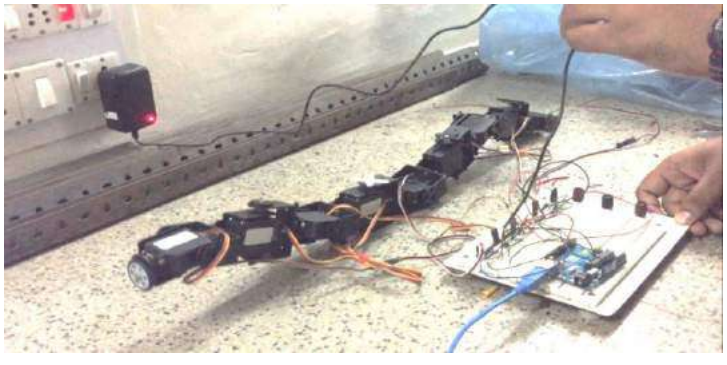
This project is being executed through a Joint Network Centre: ***Research in Human-Centered Robotics with special emphasis on Field and Bio-Medical Rehabilitation*** with participants from Indian and Korean institutes. IIT Delhi, IIT Roorkee, CSIR-NAL, CSIR – CMERI, Durgapur, CSIR-CEERI, Pilani are the participants from India and from Korean side Chungnam National University, Kyungpook National University, Konkuk University, Korea Aerospace University, Daegu Gyeongbuk Institute of Science and Technology are the collaborators in this project. IIT Roorkee and Kyungpook National Univ. (Korea) are the direct collaborators in this program.



The project is aimed to design a hyper-redundant snake robot in a biomimetic mechanism, and novel motion and task control schemes for the robot. The design is based on the various types of motions exhibited by snakes. The bond-graph modeling is utilized to analyze and simulate the proposed dynamics of the robot, as well as to validate the integrity of the biomimetic design concept. The control problems are defined in hierarchical terms for mechanical parts of the robot, control of position/force is addressed in terms of dynamics of a hyper redundant manipulator; for a discrete-event-system model of the robot consisting of wheels and links, biomimetic and hybrid control schemes are proposed based on supervisory and corrective control for

adjusting links/joints of the robot to acquire optimal performances. The intelligent behavior of the robot will also be developed to work in highly cluttered and confined environments subject to kinematic faults or uncertainties, such as moving into channels, pipes, rescuing operations in collapsed buildings, etc.

Study of design feasibility for high power GaN based Power Amplifier at Ku-Band in hybrid MIC Technology

Sponsor: Centre for Advanced Semiconductor Technology (ASemiT), Defence Research and Development Organization, Govt. of India

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The point to point radios for high data communication use Ku and higher frequency bands for transmission. This has created challenges and opportunities for RF circuit designers to cater the need of power amplifier (PA) at these high frequency bands. Recently, Gallium Nitride (GaN) technology has appeared as a high power solution at these frequencies. Unfortunately, the technology such as GaN over silicon carbide (SiC) presents several challenges related to circuit manufacturing and device integration. This includes appropriate heat spreading, good die attachment and precise wire bonding to solve issues related to thermal relief as well as low parasitic effects at high frequencies such as Ku-band. In addition, the GaN devices readily available at this frequency still uses 0.25 µm technology, which is more suitable for X-band. In such cases, the RF circuit designer should take challenge to obtain high power and high gain from the available off-the-shelf GaN devices at higher frequencies such as Ku-band. This research project aims to design a high power GaN based PA to operate at Ku-band. The target is to achieve best efficiency at high power with off-the-shelf GaN devices. The high power handling, thermal relief, RF packaging at Ku-band makes this research very challenging and open end. Therefore, several approaches will be explored in terms of inter-stage matching, power combining etc, as part of this project to get the best solution. This proposal will thoroughly study the feasibility of high power PA design with best efficiency at Ku-band frequencies using printed circuit board level hybrid technology and off-the-shelf components.

Study of Design Challenges in GaN MMIC based Power Amplifier at Ku-Band

Sponsor: Solid State Physics Laboratory, Defence Research and Development Organization, Govt. of India.

Prof. Karun Rawat

Radar has been used in modern day defence for missile guidance, satellite based sensing, etc. With the research advancement, the centralized transmitter in these Radar systems has been replaced by distributed transmit-receive (T/R) module at each transmitting element. For modern day Radar design, on-chip T/R module fabricated with Monolithic Microwave Integrated circuit (MMIC) technology is far superior over printed circuit board level hybrid technology using off-the-shelf components. The MMIC chip can give flexibility of integrating customized components in PA design which enhance the performance in terms of efficiency, output power, etc., which is limited in case of printed circuit board level hybrid design due to limited availability of off-the shelf components. This is very useful for Ku-band design where

bonding and integration of off-the-shelf components itself adds parasitic to the design and limits the performance. The main objective of this project is to study various design schemes and challenges in the area of high power on-chip Power amplifier (PA) design at Ku-band using GaN based MMIC technology. This project targets to achieve optimum efficiency at high power at Ku band using MMIC PA technology. The proposed research is targeting the solutions for overcoming three major bottlenecks in the area of GaN MMIC PA design: size, efficiency and power. The chip fabrication will be done by one of the standard foundries such as UMS France, WiN Semiconductor corporation, Taiwan, Wolfspeed, USA, OMMIC France.

DESIGN INNOVATION CENTRE AT IIT ROORKEE

The Ministry of Human Resource Development (MHRD), Government of India has recently approved the proposal of Indian Institute of Technology Roorkee to establish a Design Innovation Center (DIC), named NAVONMESH , "नवोन्मेष", with a budget outlay of ten crore rupees. This approval is under the National Initiative of the Ministry for setting up of Design Innovation Centers, Open Design Schools and National Design Innovation Network.**Prof. Apurbba Kumar Sharma (Coordinator)** and Prof. Inderdeep Singh from Mechanical and Industrial Engineering, Prof. RajatAgrawal from Management Studies, Prof. Gaurav Raheja from Architecture and Planning Department and Prof. Sanjeev Manhas from Department of Electronics and Communication Engineering are principally involved in the creation of DIC at IIT Roorkee.The proposed DIC will operate in the Hub & Spoke Model, in which IIT Roorkee will be the Hub Institute; three other premier institutions of the region – National Institute of Technology Uttarakhand, Indian Institute of Management Kashipur and College of Technology, G B Pant University of Agriculture & Technology,Pantnagar shall participate as the Spokes.

The center will thrive for developing design and innovation as a culture while primarily addressing the relevant problems of the North-West Himalayan region, in particular, and other national priority areas in general.The proposed activities of the DIC will be carried out under three major categories which include – (i) Supporting innovative product-based projects of faculty members and students of the Institute, (ii) Academic activities and (iii) Outreach activities. It has been proposed to introduce two graduate-level new academic programs on (a) Master of Industrial Design (M Des) and (b) Master of Innovation Management (MIM) apart from organisingworkshops and modular courses on Design and Innovation. The center has also proposed innovative outreach programs like P2P (Prayogshala to Prayogkshetra), U2U (Udbhavan to Utpadan) and COMAL (Common MAn to Laboratory).

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