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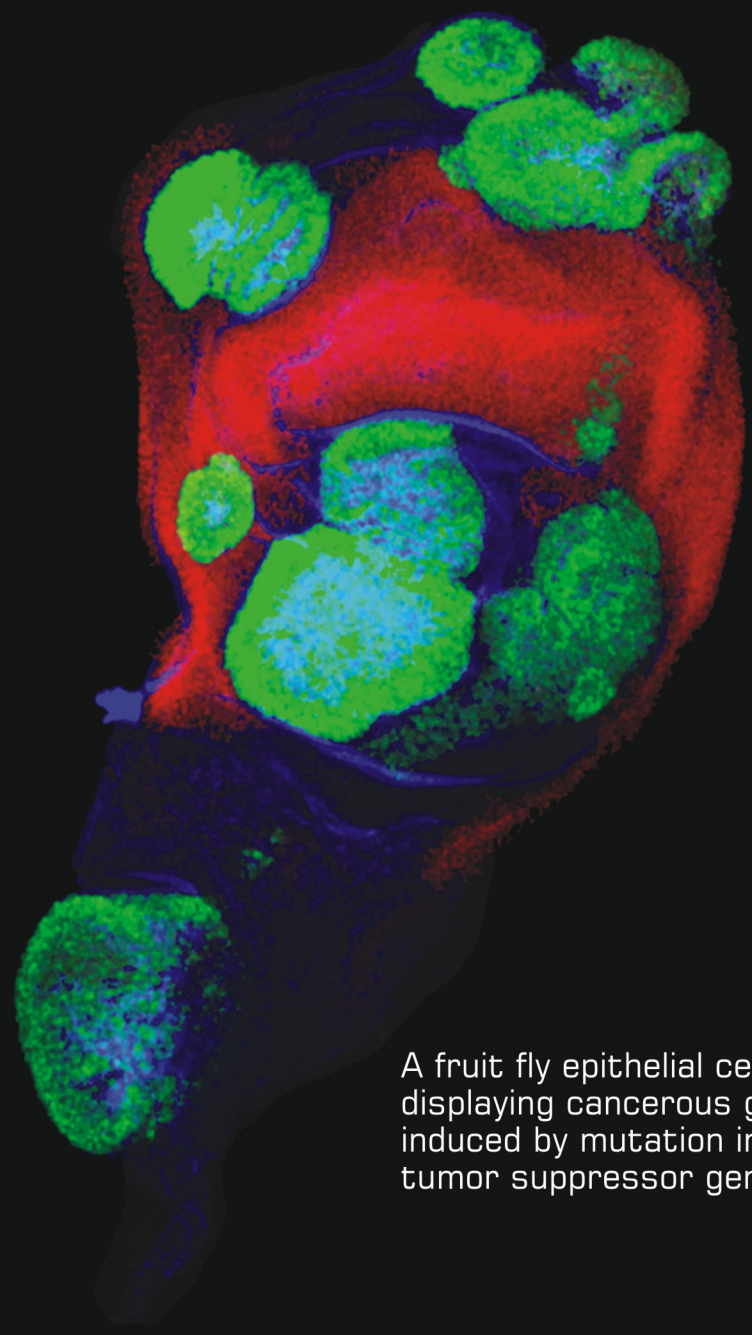
R&D Newsletter

INDIAN INSTITUTE OF TECHNOLOGY KANPUR



A fruit fly epithelial cell sheet displaying cancerous growths (green) induced by mutation in one of its tumor suppressor genes PAGE 2

soft copy of the newsletter is available at
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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. John Kim, Mr. Chatur Gadhia, Mr. Kaushik Dutta, Mr. Guruprasad N, and Mr. Amit Kapoor, from LG Soft India (LGSI) delivered talks on May 28, 2014.

LG Soft India is the innovation wing of LG Electronics in Bangalore, India. LG Soft India is the largest research & development centre of LG Electronics outside Korea. LG Soft India focuses on niche technology areas such as mobile application development, digital video broadcast, biometrics software, etc. Areas of possible collaboration were discussed.

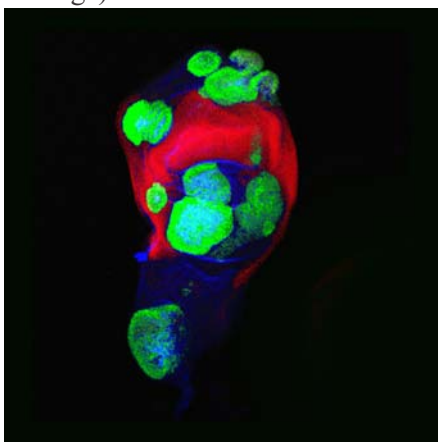
Recently Registered Projects

A translational exploration of the *Drosophila* cancer model for biomedical research

Dr. Anjali Bajpai, Prof. Pradip Sinha
Biological Sciences and Bioengineering, BSBE

Sponsor: Wellcome Trust-DBT India Alliance

Cancerous transformation of a cell is often accompanied by a loss of its original developmental program or what could be said as cellular memory (www.bpod.mrc.ac.uk/archive/2013/7/26). This project aims at unraveling mechanisms of loss of cellular memories during cancer progression and, at the same time, explore therapeutic opportunities by reversal of such processes. These investigations take advantage of the sophisticate genetic techniques of the fruit fly, *Drosophila*, wherein cancer can be induced by specific mutations (see image).



A Drosophila epithelial cell sheet displaying cancerous growth (green) induced by mutation in a tumor suppressor gene, lgl. Note that these cancerous cells thrive only in regions where a protein called Vg (red) is not expressed. Cellular memories conferred by Vg expression antagonizes cancer growth.

This is an Early Career Fellowship funded by Wellcome Trust-DBT India Alliance to Dr. Anjali Bajpai under supervision of Prof. Pradip Sinha. This project will also have collaborative inputs from Dr. Ashwani Thakur of BSBE and Prof. Marco Milan of Institute for Research in Biomedicine (IRB), Barcelona, Spain.

Numerical and Experimental Studies of Annular Trapped Vortex Combustor

PI: Prof. D.P. Mishra, Dept. of Aerospace Engineering

Sponsor: Science and Engineering Research Board

The main objective of this project is to design and develop an annular trapped vortex combustor and its performance characteristics.This advanced combustor concept is expected to be adopted by the next generation gas turbine engines as it is having the potential of better flame stability, higher combustion efficiency and low emission level over a wide range of operating conditions as compared to the existing swirl stabilized combustors. In this project, an annular trapped vortex combustor along with the test rig has to be designed and developed. The performance characteristics of the trapped vortex combustor in terms of combustion efficiency, pattern factor, lean blow-out limit and emission level will be investigated while using CNG as fuel. In this regard, a detailed investigation of the effects of momentum flux ratio on cavity flow structure, fuel-air mixing, and flame structure is to be carried out experimentally. Besides this, the limited cases will be simulated using CFD tools which may help us to understand the intricate flow and flame structures which may not be captured well by experimental work. It is also proposed to investigate the effect of mainstream premixing on exit temperature distribution and emission level.

Exploring the Neurogenic Potential of Bone Marrow Stromal Cells (BMSCs) following the Inhibition of BMP Signaling

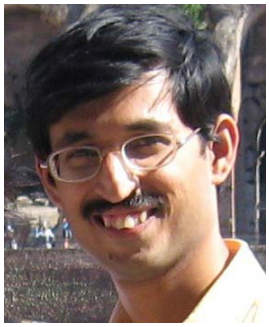
PI: Prof. Jonaki Sen, Dept. of Biological Sciences & Bioengineering

PI: Dr. Nibedita Lenka, National Centre for Cell Science (NCCS), Pune

Co-PI: Prof. Amitabha Bandyopadhyay, Dept. of Biological Sciences & Bioengineering

Sponsor: Department of Biotechnology

Bone marrow stromal cells (BMSCs) are a source of adult stem cells that have the potential of undergoing trans-differentiation into multiple cell types including neurons. Thus, they could be utilized for treatment of degenerative diseases of the nervous system where the lost neurons are replaced by new neurons derived from BMSCs. Prior to the initiation of this project we observed that genetic depletion of Bone Morphogenetic Proteins (BMP) signaling in mouse BMSCs results in their trans-differentiation into neuron-like cells. This observation served as the motivation to initiate this project through which we propose to extensively characterize these neuron-like cells derived from BMSCs after inhibition of BMP signaling. In this context we also propose to examine the interaction of Wnt signaling with BMP siganling in collaboration with Dr. Nibedita Lenka from NCCS, Pune. This study will open up many therapeutic avenues where BMSCs can be used as a readily available source to produce neurons of the desired kind on providing the appropriate molecular environment.



Extending Skyline Queries to Distributed and Uncertain Databases

PI: Prof. Arnab Bhattacharya, Dept. of Computer Sc. & Engineering

Sponsor: Science and Engineering Research Board

While choosing a flight, it is not always that lower cost is the only objective; in many cases, a user may wish to choose flights having lower durations and other such parameters. This problem of multiple objectives is solved by the skyline queries in databases. A skyline set of objects are those that are not worse than another object in all the preferences. For the flight example above, it is useless to return a flight to the user that has larger cost and higher duration than another flight. It is not a skyline and the user will never be interested in it. The project aims to extend the skyline queries to probabilistic and distributed databases. The aim will also be to handle aggregate attributes such as total cost and total duration in multi-hop flights.

3D Documentation of Heritage Structures and Development of Documentation Standards with TajMahal as the test bed

PI: Prof. Bharat Lohani, Dept. of Civil Engineering

Co-PI: Prof. Samit Ray Choudhury, Dept. of Civil Engineering

Collaborator: Shri Navratan Pathak, ASI, Agra Circle

Sponsor: MHRD

Heritage structures generally do not have documented details about their structure and layout. This leads to problems in their maintenance and also in their studies. Further, natural and anthropogenic agents cause damage of these structures thus jeopardizing their very existence. Digital documentation of these structures provides a way for archiving their data for future so as to use the same in their maintenance, reconstruction, dissemination for tourism and academic purposes.

The objective of this project is to develop technologies for digital documentation of heritage structures using laser scanning and associated technologies. The work will be carried out at TajMahal thus the project will lead to developing 3D model of TajMahal, which will also be used for an initial structural analysis of the structure.

Figure: Laser scanned point cloud model of TajMahal (collected during reconnaissance survey)

Porphyrin Dimers as Model of Di-heme Proteins: Inorganic and Bioinorganic Perspectives and Consequences of Heme-Heme Interactions

PI: Prof. Sankar Prasad Rath, Dept. of Chemistry

Sponsor: Science and Engineering Research Board

This project is aimed at biomimetic study of di/multi-heme proteins (some of them are shown below) in order to understand the structure-function relationships at the molecular level. The presence of more than one redox center provides the Nature with a further tool to modulate various properties via heme-heme interactions that can be cooperative or anti-cooperative but both having functional consequences. Active site analogues can explain various aspects of Nature's sophisticated design to develop such architectures. Model of the di/multi-heme centers will be synthesized in which two or more porphyrin macrocycles are covalently connected by spacers. Judicious choice of the spacer will allow precise control in the spatial arrangement for inter-macrocycle interactions and possible electronic communications. Focus will be on how the nature and extent of heme-heme interactions influence the structure, function and properties of the individual heme centers.

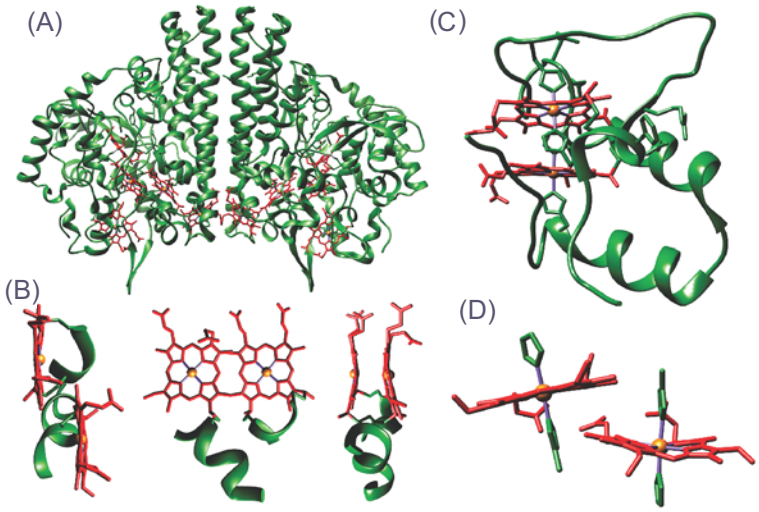


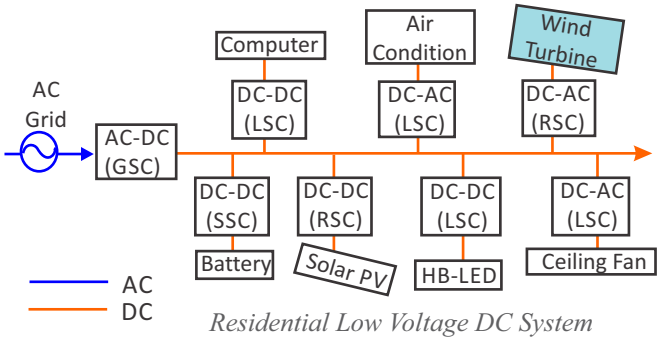
Figure: (A) Cytochrome c nitrite reductase (PDB code 1QDB) and (B) diheme motifs therein. (C) Di-heme cytochrome c_2 (PDB code 2CZS) and (D) without protein chains.

High Reliability DC-DC Converter for Integrating Battery with Low Voltage DC System

PI: Prof. Sandeep Anand, Dept. of Electrical Engineering

Sponsor: Science and Engineering Research Board

Significant population of India does not have access to electricity. Due to climatic conditions and decreasing cost of solar PV panels, this technology could be used to provide clean electricity to various remote locations. DC based system could be more effective as compared to conventional ac system due to dc nature of sources, loads and storage elements. Suitable dc-dc converters are required to integrate battery and solar PV with dc system. High efficiency of conversion is required, which could be realized by suitable circuit design. Soft-switching could also be used to improve the efficiency of conversion. However, by incorporating these techniques, converter becomes complex and reliability may degrade. Further due to high ambient temperature in most part of India, life of operation of these converters may reduce. Therefore, reliability and life time analysis of these converters is important. Key objectives of this project are to identify high reliability dc-dc converters for battery interface. This will require lifetime analysis of the existing battery interface circuits and suggesting suitable modifications to improve the reliability.



Residential Low Voltage DC System

A BCI Operated Hand Exoskeleton Based Neurorehabilitation System for Movement Restoration in Paralysis

PI: Prof. Ashish Dutta, Dept. of Mechanical Engineering
Co-PI: Prof. Anupam Saxena, Dept. of Mechanical Engineering
PI from UK: Prof. G. Prasad, University of Ulster, UK

Sponsor: Department of Science & Technology - UKIERI

It is known that stroke sufferers can gain much enhanced upper limb movement recovery with active physical practice in conjunction with motor imagery (MI) practice of activities of daily living. The project objectives are to develop a lightweight three-finger exoskeleton with embedded sensors, capable of replicating human motion for physical practice. It will be controlled by users' EMG and EEGsignals in assist-as-needed mode. A novel brain-computer interface (BCI) that facilitates EMG and EEG fusion will also be developed for controlling the exoskeleton and provide visual neuro-feedback to ensure focused physical and MI practices. Finally, pilot trials to evaluate the effectiveness of the exoskeleton along with BCI in movement restoration of stroke patients will be conducted.

BCI interface

Three finger exoskeleton

Integration of in-situ Electron Backscatter Diffraction and crystal plasticity simulations to decipher tension-compression asymmetry in Titanium and Ti6A14V

PI: Prof. N.P. Gurao, Dept. of Materials Sc. & Engineering
Co-PI: Prof. Sandeep Sangal, Dept. of Materials Sc. & Engineering

Sponsor: Science & Engineering Research Board

Structural components are likely to be subjected to loading reversal in service that can lead to failure. This is particularly important for hexagonal close packed materials wherein polar deformation mechanisms like extension and/or contraction twinning are operative along with basal, prismatic and pyramidal slip. Direct observation of the micro-mechanisms of deformation elucidating the effect of load reversal on twinning are yet to be explored. We plan to integrate in-situ straining and electron backscatter diffraction studies with crystal plasticity simulations to study the effect of load reversal on micro-mechanisms in aerospace grade titanium and Ti6Al4V alloy.

Free Standing Nano-particle Formation by Ball Milling at Cryogenic Temperature

PI: Prof. Krishanu Biswas, Dept. of Materials Sc. & Engineering
Co-PI: Prof. Dipak Mazumdar, Dept. of Materials Sc. & Engineering

Sponsor: Science and Engineering Research Board

The study of nanocrystalline material is an active area of research in materials engineering, physics, chemistry, biomedical engineering etc as nanoparticles are thought to hold some keys for solving many of the present and future technological problems. The size- and shape- dependent properties are closely related to important applications of nanoparticles like in chemical sensors, flexible video display etc. Free standing or isolated nanoparticles have been studied extensively in past decades in order to extract their intrinsic properties, which are useful for device applications as these are of foremost importance to the scientific and technological communities. However, such particles were prepared by chemical synthesis routes. The bulk preparation of such nano particles is not reported in the literature. It is expected that ball milling at low temperature can be used as the preparation process. Therefore, it is imperative to understand the synthesis of free standing nanoparticles of controlled particle size by ball milling. Fundamentally, the preparation of free standing nanoparticles is decided by the competition between cold welding and fracturing during ball milling. These two factors strongly depend on the milling temperature. The cryomilling is expected to provide us the answer.

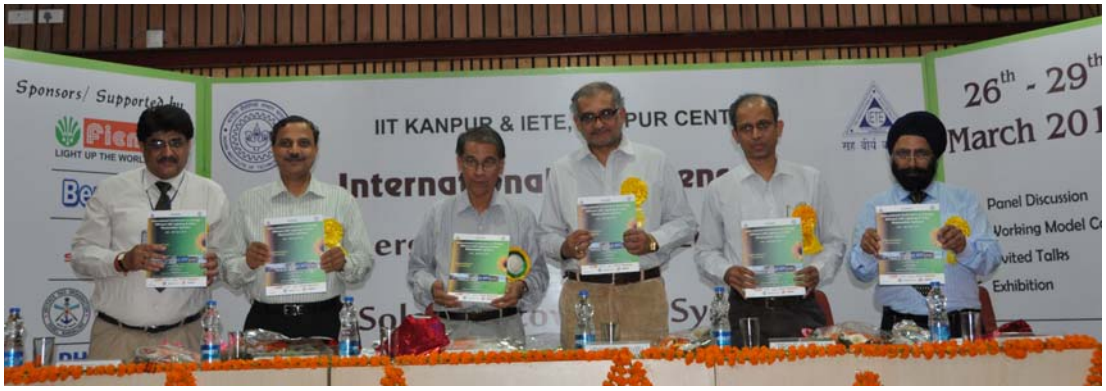
The problem basically deals with the synthesis and direct applications of free standing nanoparticles of different materials. Due to their size and stability problem, the nanoparticles aggregate easily because of their high surface energy and also quickly get oxidized. The present research work deals with scientific understanding of the free standing nanoparticles during cryomilling. In fact we aim to probe this theoretical concept in the present project. The present investigation will also study the measurement of strength of cold-weld joints of similar metals at different temperature (from room temperature to low temperature) to probe the above mentioned points. For this joints will be prepared by cold–welding of two plates under pressure in in-house cold welding set up and then strength of the welding joint will be measured.

Figure: The modified cryo-mill set up to be used in the present investigation

Inside the Tower

New RA Tower to accommodate more Research Staff and Students

International Conference on Energy Efficient LED Lighting & Solar Photovoltaic Systems



The International Conference on Energy Efficient LED Lighting & Solar Photovoltaic Systems was jointly organized by IIT Kanpur & IETE Kanpur Center from 27-29 March, 2014 under the convenorship of Dr. RS Anand, Department of Electrical Engineering and Co- convenership of Prof. Narendra Kohli, HBTI Kanpur. The focus of the conference was on using energy efficient LED lighting and to promote solar photovoltaic as renewable energy. The conference was inaugurated by Dr. T. Ramasami, Secretary, DST in the presence of Prof. Indranil Manna, Director, IIT Kanpur, Prof. SC Srivastava, Deputy Director and other dignitaries and delegates. Tutorials on LED and solar PV technologies, scientific/research paper presentation, exhibition of LED & solar products, working model contest and Laser show were conducted. A very fruitful panel discussion took place on the topic "Role of Indian cell manufacturers on the global stage". The Panelists were Prof. KL Chopra, Former Director, IIT Kharagpur, Mr. Ravi Khanna, CEO, Aditya Birla Solar, Mr. Raghu Tatachar, Tata Power Solar, Dr. Praveen Saxena, Head, NISE, Gurgaon and Mr. Sameer Mehta, Vice President Bergen, Gurgaon.

Feedback/Suggestions

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