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R&D Newsletter

INDIAN INSTITUTE OF TECHNOLOGY KANPUR

Putting a STOP: Structural visualization of GPCR signaling termination PAGE 3

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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.

Mr. M.R. Saraf and Mr. D.J. Kulkarni from the Automotive Research Association of India (ARAI), Pune delivered a talk on September 10, 2014. The ARAI has been playing a crucial role in assuring safe, less polluting and more fuel efficient vehicles and provides technical expertise in R&D, testing, certification, homologation and framing of vehicular regulations. ARAI also assists the Government of India in formulation of automotive industry standards and acts as the secretariat for WP 29 activities. Areas of possible collaboration were discussed.

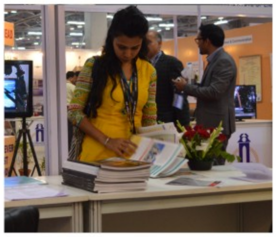
Mr. Sunil Mandem, Mr. Shenbagakannan A. and Mr. Ravsaheb Shinde from SKF delivered a talk on September 22, 2014. Areas of possible collaboration were discussed. SKF has been a leading global technology provider since 1907 with the fundamental strength in the ability to continuously develop new technologies in the areas of bearings and units, seals, mechatronics, services and lubrication systems - and then use them to create products that offer competitive advantages to customers.

R&D News

IIT Kanpur participated in the recent India-US Technology Summit and Knowledge Expo during November 18-19 and 20-21, 2014 respectively, organized by the Confederation of Indian Industry in partnership with the Department of Science & Technology (DST), Government of India (GOI). A large number of stakeholders from Industry, Government and Research organizations participated in this event.





One of the main objectives of this exposition was to showcase technology intensive products, services, projects and government initiatives towards promoting Research, Science and Technology. The exhibition was spread over an approximate area of 5,800 square meters and featured numerous exhibits with an underlying ethos of innovation, design and hi-technology, featuring all key drivers of knowledge economy. IIT Kanpur put a stall in the summit which highlighted the research capabilities and recent achievements of all the departments of IIT Kanpur. A list of all proprietary technologies and details of inventors were also shared with prospective interested industry representatives.

Understanding the Molecular Basis of Myoclonic Epilepsy in Lafora Disease using Mice Models

PI: Prof. S. Ganesh, Dept. of Biological Sciences & Bioengineering

Sponsor: Science & Engineering Research Board, DST

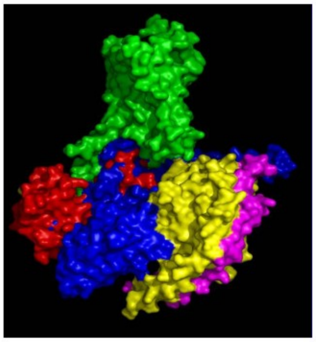
Lafora progressive myoclonus epilepsy or Lafora disease (LD) is one of the five forms of inherited progressive myoclonus epilepsies in human and is caused by mutations in the gene coding for laforin phosphatase or malin ubiquitin ligase. Besides epilepsy, LD is characterized by an abnormally high level of glycogen and its aggregation as Lafora bodies in many tissues including the neurons. Studies on the Lafora disease mice models - created by targeted deletion of the gene coding for laforin or malin - have demonstrated that in addition to the epilepsy and glycogen accumulation, the animals also show impairment in autophagy – a cellular process whereby damaged organelles and protein aggregates are cleared using a vesicle-mediated proteolytic pathway. However the physiological basis of epilepsy in LD, and whether the epileptic phenotype is a cause or consequence of glycogen aggregates and/or the autophagic defects have not yet been established. This study aims to address this very important question by using the mice models of LD (laforin- or malin-deficient mice).

Structure, Function and Novel Signaling Pathways of the "Non-canonical" G Protein-Coupled Receptors

PI: Prof. Arun K. Shukla, Dept. of Biological Sciences & Bioengineering

Sponsor: Wellcome Trust DBT India Alliance

The cells in our body are surrounded by a membrane, which acts as a barrier and protects the interior of the cells from harmful factors (e.g. pathogenic organisms). Embedded in this membrane, there are certain protein molecules called G Protein-Coupled Receptors (GPCRs). These receptors receive the signal on the outside of the cells and transmit it to the inside in a highly regulated fashion. These receptors are involved in pathological symptoms of a number of deadly human diseases such as heart failure, hypertension, diabetes, obesity and cancer. The major goal of this project is to visualize the three-dimensional structure of selected GPCRs at atomic resolution by X-ray crystallography. Such structural visualization should facilitate novel drug design as a potential treatment for several human diseases.



This figure represents the superimposition of a GPCR-G protein complex and a GPCR-arrestin protein complex. The GPCR component is shown in green and the arrestin component is in red. The subunits of the heterotrimeric G proteins are shown in blue (Gα), yellow (Gβ) and magenta (Gγ). This superimposition reflects the overlapping nature of G protein and arrestin binding sites in the GPCRs and therefore, explains the arrestin mediated G protein signaling termination event of GPCRs.

Deployment and Management of Brithaspati-3 Services over NKN for Indian Academia

PI: Prof. Y. N. Singh, Dept. of Electrical Engineering

Sponsor: Department of Electronics And Information Technology

We have been using and developing Brihaspati Learning Management System for more than a decade at IIT Kanpur. In the NMEICT (National Mission on Education through Information and Communication Technology) of MHRD, it was envisaged to convert it to a service, where any institute need not make an installation. Instead, it can use a national service. NMEICT had funded the development of such a service which is running over ERNET connectivity provided to IIT Kanpur. Meanwhile NKN was started by DeitY (Department of Electronics and Information Technology). NKN has provided network connectivity to large number of institutes and universities. In order to increase the utility of NKN, DeitY invited us to provide Brihaspati-3 and all other services developed under ERP mission project of NMEICT on the virtual servers provisioned in Data Center of NKN. In this project, we are supposed to deploy and manage the services for the academic institutes in India. We are now in process of getting the VM (virtual machines) on which all the Brihaspati3 services will be migrated very soon.

Adaptive Clustering for Decentralized Resilient Energy Management (ADREM)

PI: Prof. S. N. Singh, Dept. of Electrical Engineering

Collaborators: Prof. Frances Brazier, TU Delft, Netherlands
Prof. Han La Poutre, CWI, Netherlands
Prof. A R Abhayankar, IIT Delhi

Sponsor: Department of Science & Technology, NWO Netherlands

This project will explore the potential of a distributed approach to self-optimization and self-healing in the Smart Grid environment. New distributed market mechanisms for multi-criteria egotiation on the basis of which adaptive groups/clusters of energy resource providers and consumers can collectively balance supply and demand in the global market by local coordination will be proposed. Both local and global stability are the goal.

To achieve cost-effective and technical sound supply and demand balance, an effective forecasting tool is required for predicting the output of distributed resources, market price and demand response. In this proposal producers and consumers are represented by agents. Agents negotiate service level agreements for cluster participation.

The framework to be developed includes:
(1) agent models for resource consumers and resource providers,
(2) clustering algorithms as the basis for coordination: criteria and objectives
(3) market mechanisms and negotiation strategies for cluster formation/reconfiguration,
(4) effective forecasting tool with which different markets can be explored.

The total cost of the project is 71.32 lakhs.

A Solution based Approach to the Fabrication of Novel Chalcogenide Glass Microlens Arrays for the 6-12 μm IR Optics Applications

PI: Prof. Ashutosh Sharma, Dept. of Chemical Engineering
Co-PI: Dr. Prabhat Dwivedi, Dept. of Chemical Engineering

Sponsor: DRDO

Mid Infrared (MIR) technology is now major part of current research in sensing (chemical/biological) and military applications. However, to use this particular spectral range, cost effective and easy to fabricate optical materials and structures that are transparent in the MIR are needed to focus and detect the light. With the recent development of less expensive un-cooled detector technology, expensive optics is among the remaining significant cost drivers. As a potential solution to this problem, chalcogenide glass has been studied in recent years. In the current project, we will explore solution phase deposition and patterning in chalcogenide glasses which will open doors as a promising route towards the realization of novel techniques to fabricate microlens arrays in chalcogenide glasses for 6-12 μm IR optics applications. We will also develop a set up to test optical performance of the developed microlens arrays with the help of IRDE, Dehradun (DRDO Lab).

Synthesis and Characterization of Iron Chalcogenide FES_2 (Pyrite) and FE_2 $S1S_4$ Thin- Films for Photovoltaic Application

PI: Prof. Sarang Ingole, Dept. of Materials Sc. & Engineering
Co-PI: Prof. Ashish Garg, Dept. of Materials Sc. & Engineering

Sponsor: Department of Science & Technology

Present investigation will focus on solution based synthesis of iron-pyrite (FeS_2), and iron thio-silicate (Fe_2SiS_4), and investigate their structural, compositional, and electronic properties for assessing their potential for thin-film photovoltaic application. Both the compounds have suitable band-gap of 0.95 and 1.54 eV, respectively, high photo-absorption ($\alpha > 10^{-5}cm^{-1}$ for $h\nu > 1.4$ eV), as well as abundant availability of constituent elements, viz. iron, sulfur, and silicon which are also benign towards the environment compared to cadmium, selenium etc. that are being used in some of the relatively established thin-film PV materials.

The facilities established in the PI's laboratory for this project would be Glove-box, a SILAR and Spin Coating instrument.

Synthesis of Polymer Nano Composites for Energy Storage Applications

PI: Prof. Raju Kumar Gupta, Dept. of Chemical Engineering

Sponsor: Department of Atomic Energy

Polymeric films have received great attention due to ease of processing, flexibility and low cost for capacitor based energy storage devices applications. However, drawback lies in their low dielectric constant. Incorporating high dielectric constant fillers like ceramics within polymers will lead to capacitor devices having high energy storage capacity. Current approaches based on physical blending suffer from the adverse excessive agglomeration of fillers due to the incompatibility of these fillers with the polymer matrix. This project aims to synthesize non-aggregated polymeric/ceramic hybrid materials and develop capacitor based devices utilizing such composite materials. Upon success of the thin-film prototype design; electrical properties, performance and reliability of the device will be studied.

Investigation of Interdiffusion and Diffusional Interactions in the Ternary Ti-Al-Mo Alloys.

PI: Prof. Kaustubh Kulkarni, Dept. of Materials Sc. & Engineering

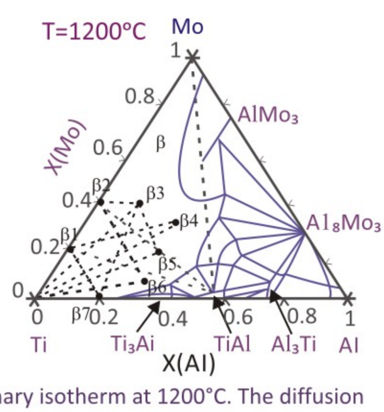
Co-PI: Prof. Anandh Subramaniam, Dept. of Materials Sc. & Engineering

Sponsor: Science & Engineering Research Board

The phenomenon of solid-state diffusion is of significant importance in Materials Engineering as it guides most of the processes including precipitation, dissolution, homogenization, welding, sintering and solid state alloying. Knowledge of fundamental diffusion behavior is of utmost importance in controlling and predicting the evolution of microstructure during these processes. Although unary and binary diffusion has widely been studied, diffusion behavior of multicomponent (ternary and higher order) systems still remains vastly unexplored. Interactions among diffusing species play crucial role in guiding the multicomponent diffusion processes; to the extent that they can even make a component diffuse against its own concentration gradients. Such multicomponent effects are not possible to predict with extrapolation of binary diffusion data to higher order systems in absence of ternary diffusion data. Hence, the objective of this study is to investigate interdiffusion in ternary alloys with specific emphasis on diffusional interactions and their relations with the basic thermodynamic factors.

Titanium alloys have widespread applications in various fields including aerospace, automobile and medical implants. However the use of Ti-alloys on mass-scale is still restricted due to the high costs associated with them. However, with the emergence of low-cost production techniques for pure Ti in powder form, solid-state alloying through the route of blended elemental powder metallurgy is gaining popularity. This makes the availability of multicomponent diffusion data in Ti-alloys even more desirable.

The ternary interdiffusion coefficients in Ti-Al-Mo system will be evaluated experimentally with diffusion couple experiments. The alloy compositions used for assembling diffusion couples will be selected based on the thermodynamic activity data so as to get prominent diffusional interactions within the couples. The multicomponent diffusion data will be used to model the homogenization kinetics in order to bring out the effects of the diffusional interactions in the Ti-Al-Mo alloys.



Ti-Al-Mo ternary isotherm at 1200°C. The diffusion couples to be assembled in β phase field are indicated by dark dotted lines and the multiphase couples are indicated by gray dotted lines.

An Investigation on Carbon Nanotube-Glass Composites for Bone Tissue Engineering

PI: Prof. Niraj Sinha, Dept. of Mechanical Engineering

Sponsor: Department of Science and Technology

The area of bone tissue engineering integrates principles of biology and engineering with the ultimate goal of creating artificial scaffold materials to proliferate, differentiate and organize into normal, healthy bone as the scaffold degrades. In past, several scaffold materials have been used as substrate to grow osteoblasts (the bone forming cells) *in vitro*. Most of the artificial bone scaffolds used in bone graft currently possess relatively low strength and are often susceptible to immune rejection. With advancements in synthesis techniques, glasses have emerged as potential materials for bone tissue engineering. At the same time, the incorporation of carbon nanotubes (CNTs) in glasses can improve the mechanical properties of the bone scaffolds and may be beneficial for osteoblast cell attachment and proliferation. This work focuses on composites of CNTs and borate-based glasses for bone tissue engineering applications. The overall goal is to improve our understanding of how the composition, surface roughness, sample dimensions and experimental conditions impact the performance of the glass-CNT system.

Innovative Thermal Energy Storage Systems – INOTES

PI: Prof. Arvind Kumar, Dept. of Mechanical Engineering

PI from Germany: Prof. Ing. Axel Gottschalk,
University of Applied Sciences Bremerhaven

Co-PI from Turkey: Prof. Cemil Alkan, Gaziosmanpaşa University

Sponsor: EU-INDO New INDIGO Partnership Program (DST)

If thermal energy is available e.g. solar heat and/or industrial waste heat, but no demand at the same time, that heat cannot be used. Efficient heat storage systems overcome that weakness, because heat supply/source and heat demand/sink become disconnected in time. Available heat will charge a storage while heat demand at a later point in time will be satisfied by the heat stored. Such thermal energy storage systems can play an important role in reducing the primary energy consumption and related GHG emissions. This collaborative project aims on research, development and innovation on phase change materials (PCM) for energy storage. Using PCMs thermal energy is stored as a combination of sensible and latent heat. Latent heat absorbed or released during the phase change between solid and liquid provides a capability to store a large amount of heat.

Salt hydrate PCM based energy storage is a promising technology because of its cheap cost and availability. In spite of its several advantages and potential, these inorganic PCMs are yet to be commercialized in a significant way, primarily because of the lack of scientific understanding about the thermal performance and efficiency of these materials which is strongly governed by the phase change phenomenon. The main objective of this project is to address these issues using a combined experimental and theoretical approach. To achieve this goal, a consortium with an interdisciplinary team of researchers is formed. This team will focus on materials research, thermal performance research and application research (robust and sustainable applications) for these PCMs. Renewable heat as well as recovery of waste heat is the targeted heat source for advanced and innovative thermal energy storage (TES) systems based on innovative phase change materials (salt hydrate PCMs).

Seamless Affordable Assistive Technology for Health (SAATH)

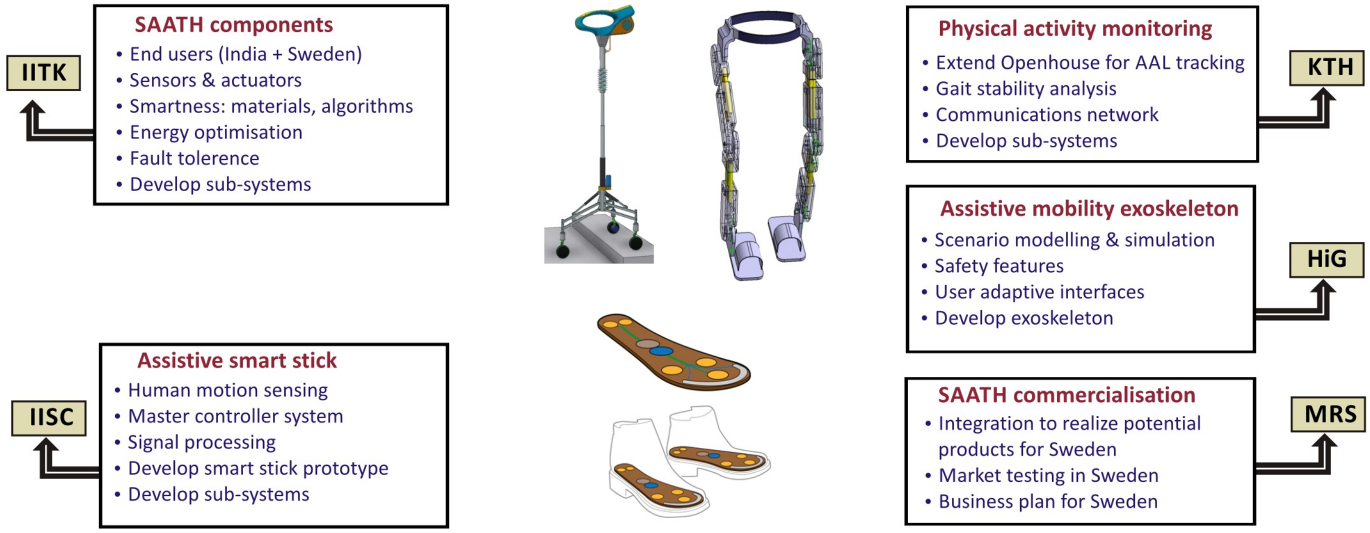
PI: Prof. Bishakh Bhattacharya, Dept. of Mechanical Engineering

Collaborators: Prof. Peter Handel, Royal Institute of Technology, Sweden
Prof. K.V.S. Hari, Indian Institute of Science, Bangalore
Prof. Gurvindar Virk, University of Gävle, Sweden

Sponsor: Department of Biotechnology and VINNOVA

Normal ageing leads to physical and cognitive degeneration often causing loss of independence and the need for care support. The global growth in the ageing population is causing concern since it is clear that the human resources available for elderly care will be unable to cope with the growing demand. The numbers in India and the percentages in Sweden are alarming and it is clear that they will impose a huge burden on the healthcare resources needed. Thus, there is urgent need for developing appropriate solutions to help elderly persons to continue to enjoy independent and active lives and to monitor and assess the status of the elderly persons to target assistive support and care to ensure this.

The SAATH projects aims to develop physical activity monitoring and diagnostic tools for assessing the mobility and motor skills of elderly persons and, if this falls below a critical threshold, design and test a variety of assistive solutions for helping elderly persons maintain/improve levels of physical activity for full, active and independent lives. This involves developing/fitting inertial motion tracking/gait analysis technologies for long term monitoring at home, develop a range of assistive solutions (from smart walking sticks to restraint type lower body exoskeletons), investigating the technical challenges in ensuring stability of the assisted elderly persons, testing the prototypes realised, and prepare commercialisation plans for implementation. The project is funded under Strategic Indo-Swedish Cooperative programme on Health and Disease Prevention. Four academic institutes (IIT Kanpur, IISc Bangalore, KTH Sweden and Gavle Univ.) are involved in this collaborative project along with industrial partner from India/Sweden. A schematic details is provided in the following figure.



Feedback/Suggestions

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