Volume 5, Issue 4

November 2017

R&D Newsletter

Indian Institute of Technology Kanpur

Highlight of the Issue

Recent Major Projects

Newton Prize for an EPSRC Project

Celebration of National Entrepreneurship Day

IITK received MeltingPot2020 Innovation Award

First humanitarian drone, developed at IITK put into use for medicine delivery at Malawi

www.iitk.ac.in/dord

Newton Prize for the project *Advancing the Efficiency and Production Potential of Excitonic Solar Cells*

A multi-institute consortium of several universities from India and the UK, co-funded by Department of Science and Technology (DST) and Research Council of the UK (RCUK), for the project titled "Advancing the Efficiency and Production Potential of Excitonic Solar Cells (APEX)" has been awarded the Newton Prize worth £200,000 at an event on 1st November 2017 in New Delhi, presented by Minister for Universities, Science and Research Jo Johnson and Sir Venki Ramakrishnan, Chair of the Newton Prize Committee and President of the Royal Society.

The project was conducted under the flagship of India-UK consortium project APEX-II (Advancing the Efficiency of Excitonic Solar Cells). The project has focused on developing advanced materials and process technologies to create cleaner, more sustainable and affordable energy with aim to improve the quality of life in various parts of the world including villages in developing countries. In addition to several publications and patents, the project has led to strong partnerships between academic groups of various institutes of India and UK as well as Industries. The consortium was coordinated by Prof. Hari Upadhyaya of Brunel University and Dr. Suresh Chand of NPL Delhi (Phase-I) and Prof. Viresh Dutta of IIT Delhi (Phase-II). IIT Kanpur has been the partner of this consortium since its inception in 2010 with Professor Ashish Garg, Department of Materials Science and Engineering being the Principal Investigator. The other participating institutes from India are IIT Delhi, IISc Bangalore, CSIR-NPL New Delhi, CSIR-NCL/IISER Pune, JNCASR Bangalore, and CSIR-IICT Hyderabad while UK partnering institutions are Imperial College London, Cambridge University, University of Oxford, Swansea University, Edinburgh University and several industrial partners from both India and UK. The project has also resulted in the award of SUNRISE project which has been funded as part of the GCRF grow call by the UK Government and is scheduled on start in early 2018.

more details*: https://www.epsrc.ac.uk/newsevents/news/newtonprizeindia/.*

National Entrepreneurship Day

National Entrepreneurship Day is celebrated in India on 9th November to augment the business ecosystem and to encourage the prospective entrepreneurs of the country. As part of the National Entrepreneurship Day celebration, SIDBI Innovation and Incubation Centre (SIIC) organised an event jointly with TIE UP, Kanpur Angels and DBR Ventures at SIIC Conference room. Prof. S. Ganesh, Dean Research and Development and Prof. Sameer Khandekar, Associate Dean Innovation and Incubation welcomed the participants. Various facilities available for incubation, the soft skills as well as the lab space such as the tinkering lab, the bio-incubator and the Motwani Accelerator was highlighted during their talk. Mrs. Vandana Srivastava, a life coach, motivational speaker, Counselor, Cosmic healer & Vibration therapist conducted a workshop on 'Learn how to attract wealth'. This was followed by investment pitch by 5 startup companies. Different startup companies, potential entrepreneurs, students of IIT Kanpur and local colleges participated in the event.

First humanitarian drone, developed at IIT Kanpur in association with EndureAir put into use for medicine delivery at Malawi

The Government of Malawi and UNICEF has launched an air corridor for potential humanitarian use of unmanned aerial vehicles (UAVs), commonly known as drones. This is the first of its kind in Africa and unique in the world for the application of drone with a focus on humanitarian and developmental purpose.

The joint application of IIT Kanpur with EndureAir (sponsor and partner of IITK team for this activity) is approved by the Malwai CAA for first humanitarian drone testing activity involving medicine delivery at Malawi as part of UNICEF drone corridor. This is a great opportunity for IIT Kanpur and Endure Air to collaborate and compete on a global platform.

The solution based on Autonomous Helicopter has been developed by the students of Aerospace Engineering Department: Mr. Nidhish Raj (PhD), Mr. Sagar Setu (PhD), Mr. Ankur Duhoon (Research Engineer, IITK alumni) and Mr. Joydeep Bhowmik (PhD) under the guidance of Prof. Abhishek and Prof. Mangal Kothari, Department of Aerospace Engineering. The current Rotary Wing Unmanned Air Vehicle (RUAV) developed at IIT Kanpur is capable of lifting 3 kg of useful payload and fly for over 2 hours. The best range speed of the RUAV is 75 km/hr and the top speed can easily reach 120 km/hr. The UAV uses regular petrol as its fuel, which enables it to achieve better performance than battery powered drones. The autopilot which is "brains" of the RUAV for fully autonomous operations has been fully developed by the students. The trial in Malawi would allow to test the capabilities of the existing platform. The feedback received would allow us to enhance the design further. This solution would facilitate delivery of critical supplies to remote areas which are not easily accessible by other means. IIT Kanpur team would be heading to Malawi for trials and demonstration in February next year.

IIT Kanpur received MeltingPot2020 Award

IIT Kanpur has been selected to receive the **MeltingPot2020 Innovation Award** under the category, Exemplary Incubation Ecosystem – Public University. The award, institutionalized by CL Educate, is to felicitate Institutions who have set a benchmark by pioneering progressive thought and recognize their contribution towards revolutionizing the educational environment in India. The award was presented during the MeltingPot2020 Innovation Summit 2017 on 14th November 2017, at Hyderabad.

Industry Connect Talk Series

Introduction to Tata Open Innovation (OI), Success Stories

Dr. Suneel TS
General Manager
Open Innovation Group Technology & Innovation Office Tata Services Limited
Date: September 12, 2017

Global and India-centric R & D Challenges in Upstream of Oil & Gas Industry

Dr. Sandeep D. Kulkarni
Principal Technical Professional
Halliburton Energy Services at Houston, USA
Date: September 5, 2017

Institute lecture (October - November 2017)

Fascinations of semiconductor nanomaterials: Their extraordinary luminescent properties

Professor D. D. Sarma, Indian Institute of Science, Bengaluru

Prof. D.D. Sharma is a faculty member at Solid State and Structural Chemistry Unit and currently holds the J. N. Tata Chair of IISc. His research interest spans the science of strongly correlated electron systems, primarily based on transition metal compounds, and semiconductor nanocrystals using a wide range of experimental as well as theoretical tools.

http://www.iitk.ac.in/dord/data/institutelecture/2017/L7.pdf

The Ribosome – restless molecular machine at the center of all life

Professor Joachim Frank, Columbia University, USA

Prof. Joachim Frank is a Professor in the Department of Biochemistry and Molecular Biophysics, and in the Department of Biological Sciences of Columbia University, New York, USA. He has been honored with numerous prizes, the latest being the Nobel Prize for Chemistry in 2017 "for developing cryo-electron microscopy for the high-resolution structure determination of biomolecules in solution".

http://www.iitk.ac.in/dord/data/institutelecture/2017/L5.pdf

Can India get to 100% Electric Vehicles by 2030? What does it mean for the auto and oil industry?

Professor Ashok Jhunjhunwala, Principal Advisor to the Minister of Power and MNRE

Ashok Jhunjhunwala, Professor at IIT Madras, is currently on deputation as Advisor to the Minister of Power and MNRE. He was a faculty member at Washington State University before joining IIT Madras. His group TENET has designed a large number of technologies in many sectors. He conceived and built the first Research Park (IIT Madras Research Park) in India. Prof. Jhunjhunwala received the Padma Shri in 2002, and the title of "Dronacharya" for his contributions to the cause of entrepreneurship.

http://www.iitk.ac.in/dord/data/institutelecture/2017/L6.pdf

Optical Coatings for High-Reflection and Anti-Reflection Applications

PI: Prof. R. Vijaya, Dept. of Physics and Centre for Lasers and Photonics (CELP)

Sponsor: MHRD & DRDO

Optical coatings have several applications ranging from anti-reflection coatings on camera lenses for low-light photography and on solar cells for increasing their efficiency, all the way to high-reflection coatings for laser cavity mirrors and eye-safe goggles that protect the eyes from harmful laser radiation. The basic technology is not very different but specifications and tolerances (in layer thickness, refractive index, number of layers and surface uniformity) required for different applications differ a lot.

This project aims to bridge the long-standing gap of Indian research in this area by building prototypes of extremely high-quality optics (specifically for the three applications of high-reflection, anti-reflection and eye-protection from lasers).

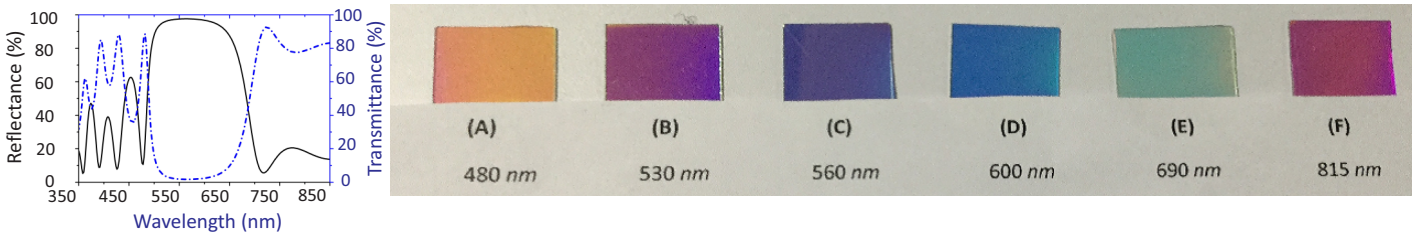

Figure: In the left panel, the complementary nature of reflection and transmission (measured at normal incidence) is shown for high-reflection optics designed for 500-650nm range. The right panel contains the photograph in ambient light of 6 high-reflection filters with the centre wavelength of reflection band indicated below each filter. The range spans from 450 nm to 850 nm.

Development of in-situ Contact-less Thermometer and Viscometer through Spatiotemporal Control at Nanoscale Dimension to Unravel the Dynamics of Complex Systems: Vibrating Molecules, Colloidal Clusters and Multiple Phases

PI: Prof. Debabrata Goswami, Dept. of Chemistry

Sponsor: Science & Engineering Research Board (SERB)

Femtosecond laser pulses can measure dynamical aspects of complex systems at molecular level by perturbing and probing their dynamics even under confined environments. Correlating molecular nature of solute-solvent dynamics to their interactions is important as almost all dynamical and static properties are strongly correlated. Any modulation of the micro-environment of the solute can alter its dynamics during measurement, which can be a possible approach to control complex systems in solutions. Similarly, photon flux confinement and ultrafast pulse shaping can be used as effective approach for spatiotemporal control of complex systems interacting with light. Irrespective of whether it is solvent/environment induced or optical flux induced spatial confinement, the dynamical nature of the complex system under control can be unraveled through simple physical principles that are often surprisingly simpler than one presumes.

The project has proposed to use one such aspect of spatiotemporal control as the in-situ contactless thermometer and viscometer to unravel the dynamics of complex systems.

Micro-Mechanisms of Plastic Deformation and Development of Processing Maps for Novel Single and Multiphase High Entropy Alloys

PI: Prof. Krishanu Biswas, Dept. of Materials Sciences & Engineering
Co-PI: Prof. Nilesh P. Gurao, Dept. of Materials Sciences & Engineering
Sponsor: Science & Engineering Research Board (SERB)

The present proposal deals with the understanding of deformation behaviour of novel single and multiphase high entropy alloys (HEAs) and development of processing map for any practical use of these materials. HEAs, being multi-component multi-principal alloys are new 'avatar' in the metallurgy and materials engineering. They can be either single or multiphase. These are multi-component solid solutions having FCC or BCC or even HCP crystal structure. These materials show interesting mechanical properties (high strength, sufficient ductility, extremely high fracture toughness etc) and are potential candidates for many industrial applications. However, the mechanical behaviour of single phase and multiphase HEAs are least understood.

The project aims at understanding the micro-mechanisms of plastic deformation by detailed study on dislocation motion, twinning and plastic flow behaviour at small to large strain rates. *Figure 1* indicates that the dislocation motion in a multi-component system having differently sized atoms in the vicinity is expected to be distinctly different from the conventional alloys. The presence of multiple and unequal energy barriers will lead to pinning and jerky motion of the dislocation through the 'distorted' lattice. Utilizing techniques like in situ tensile test inside a SEM to high pressure torsion (HPT), the attempts will be made to understand plastic deformation of these novel materials at different temperatures and strains as well as strain rates.

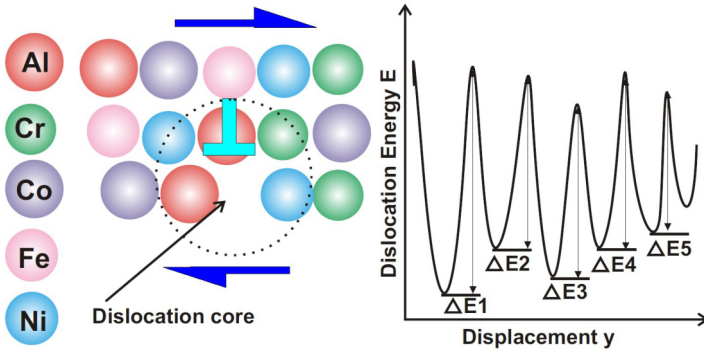

Figure 1: Dislocation motion in a multi-component system

Finally, processing map (*Figure 2*) of some of the HEAs, typical industrial guidelines for deformation processing of these alloys, will be generated for effective utilization of knowledge accrued during plastic deformation at different strain rates. Thus, the present study intends to shed light on the scientific understanding of the deformation of these novel materials. The processing maps can directly be used for industrial level processing of these materials showing huge potential.

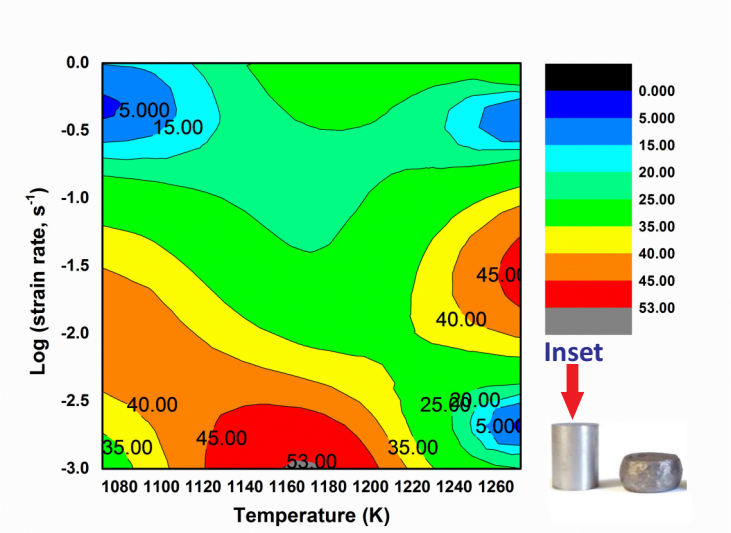

Figure 2: Processing Map of a typical HEA. The inset shows photograph of undeformed and deformed samples

Development of NASICON Framework Cathode for All-Solid-State Na-ion Battery


PI: Prof. Shobit Omar, Dept. of Materials Sciences & Engineering
Co-PI: Prof. Sarang Ingole, Dept. of Materials Sciences & Engineering
Sponsor: Science & Engineering Research Board (SERB)

All-solid-state sodium-ion batteries (SIBs) are promising candidates for large-scale energy storage applications. However, due to high ohmic and polarization resistances offered by solid-state electrolyte and electrodes, low rate capability and poor cyclic battery performance are achieved especially at higher current rates.

This project aims to address these issues by :

- Developing higher sodium-ion conductive electrodes,
- Utilizing optimal amorphous carbon loading in the electrode and
- Using a solid-state electrolyte with higher sodium conductivity.

For this work, materials for electrolyte and electrodes will be based on NASICON structure which possesses a rigid 3D framework. All-solid-state SIBs will be fabricated by screen printing electrodes on a dense disk-shaped electrolyte. For the electrode, $Na_3V_2(PO_4)_3$ based materials will be tested with $Na_{3.1}Zr_{1.95}Mg_{0.05}(PO_4)(SiO_4)_2$ as an electrolyte. The novel NASICON based electrolyte has been reported to exhibit one order of magnitude higher Na-ion conductivity than the conventional $Na_3Zr_2(PO_4)(SiO_4)_2$ at room temperature. The performance testing of battery cell will be done by measuring charge-discharge characteristics in a galvanostatic mode at different current rates. In addition, at C/10 and 10C current rates, specific capacity and columbic efficiency will be measured as a function of the cycle (at least 25 cycles). The overall goal of the work is to achieve an energy density of at least 250 Wh/kg in half-cell and 125 Wh/kg in symmetric solid-state full-cell configuration at C/10 discharging rate.

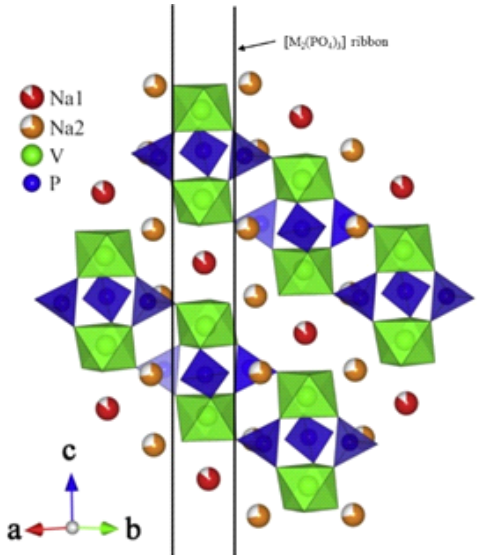

Figure: Crystal Structure of NASICON Compound

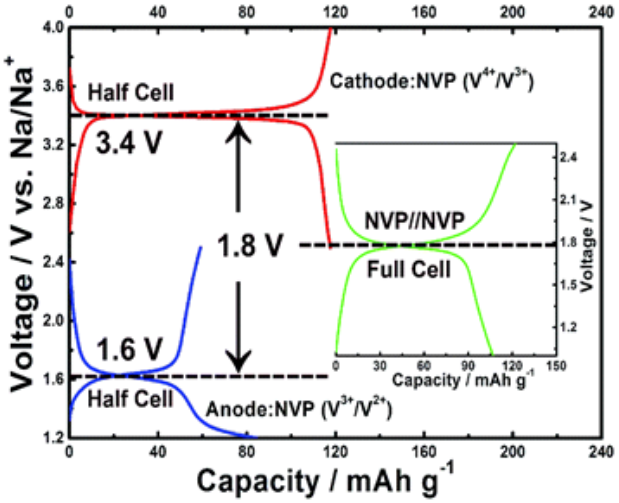

Figure: Galvanostatic Charge/Discharge Characteristics of Symmetric Cells[1]

1. Y. Zhang et al., Journal of Materials Chemistry A, 2016, 4 7155-7159.

Recent Project

ICME National Hub @ IIT Kanpur -A Joint IITK-TCS Initiative

PI: Prof. Amarendra Kumar Singh, Dept. of Material Sciences & Engineering

Sponsor: Tata Consultancy Services (TCS)

Integrated Computational Materials Engineering (ICME) is an emerging and transformative discipline with huge potential. Tata Consultancy Services (TCS), which has expertise in both materials and software development, has been in the forefront of ICME research since its inception and has decided to develop a state-of-the-art IT platform, TCS-PREMΛP – A Platform for the Realization of Engineered Materials and Products, to enable ICME based materials engineering and product development. ICME involves multiple disciplines in science and engineering and requires a focused approach in education and research. IIT Kanpur, with its inherent strength in modeling and simulation, multi-scale experiments, and computer science and proven track record in multi-disciplinary research, is ideally suited to take the lead in this emerging area. Keeping this in view, IIT Kanpur and Tata Consultancy Services agreed to establish a National Hub on ICME at IIT Kanpur during the MoU signing ceremony in November 2015. The National Hub @ IIT Kanpur was inaugurated by Mr. Ananth Krishnan on 2nd March 2017. The salient features of the National Hub for Integrated Computational Materials Engineering at IIT Kanpur are presented below:

Vision and Objectives

Creation of a multidisciplinary educational & research ecosystem for ICME in the country (a) to carry out cutting edge research on ICME based materials and technology development (b) to train world class manpower in the area of ICME (d) to develop open-source based tools/technologies for ICME and (e) to conduct Annual National Workshop involving all stakeholders.

Distinguishing Features:

The National Hub will act as a nodal point for national academia/laboratories and will collaborate with national/international academic institutions and will establish active collaboration with key industries (steel, aluminum, automotive, aerospace, glass, etc.) and government sectors (Defense, Space, Atomic Energy, Railways, etc.). The National Hub will offer ICME based PG/UG projects and will target to produce 20 PhDs & 40 M. Techs. in the next 5 years

Potential Collaborators:

National academia and laboratories: IITs/IISERs, IISc Bangalore, JNCASR, NML, NAL, DRDO and other national labs; International Academia: Mississippi State University, Georgia Tech, Purdue University, University of Oklahoma, etc.

Current focus areas/Industries:

High strength steel, aluminum, glass, composites, engineering polymers, additive manufacturing, heavy industries, automotive, aerospace

Industry-Academia Collaboration

Online form for seeking technology/ research solutions

http://www.iitk.ac.in/dord/query-form

Search expertize by Technology Domain
and/or by PhD/ M.Tech. Thesis Title

http://www.iitk.ac.in/dord/search-faculty-expertise/

Short term Industry Oriented Courses

https://www.iitk.ac.in/dord/industry-oriented-courses

Address for Correspondence

Dean, Research & Development
Indian Institute of Technology Kanpur
Kanpur 208016
dord@iitk.ac.in
Phone: +91-512-259 7578

Feedback/Suggestions

dord@iitk.ac.in
chitrab@iitk.ac.in