INDIAN NATIONAL ACADEMY OF ENGINEERING

E-Newsletter

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INAE VISION 2020-2025

INAE VISION

To be the premier Engineering Academy of the World providing timely inputs to the national and international policy makers, and to extend appropriate assistance in developing engineered solutions for the challenging problems facing contemporary societies and the humanity as a whole.

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INAE Mission

To serve professionals in building and institutionalizing engineering and technological excellence in education, research and industry in India and support advancement of engineering profession globally

Technology Roadmap

We are living in exciting times. We will have to contend with the profound transformation of our society and our industry, because of two revolutions in the making – namely, the digital revolution and the impending transition to fossil fuel free energy globally.

The digital revolution is rapidly transforming the very nature of industrial enterprise today. Many disruptive transformations are maturing rapidly because of the advent of cloud computing and internet of things (IoT) and due to major advances and breakthroughs being made on several fronts such as artificial intelligence (AI) including machine learning (ML) and big data analytics, robotics, autonomy, drones, 3D printing, advance sensors and 5G technologies.

Another revolution in the making is the exciting possibility of fossil fuel-free generation of electricity in the coming decade. The availability of electricity based on renewable sources such as sun, wind and biomass, will cause a major disruption as well as an opportunity for creating a cleaner world, since use of fossil fuels (coal, oil or natural gas) currently, creates deleterious environmental consequences which need urgent attention.

While both these revolutions will cause major disruptions in how we live and work, the transition to the new world in the making is contingent upon the availability of new sources of critical raw materials.

Both digital hardware and generation of electricity from renewables (including the technological challenges associated with energy storage) require a host of new metals and materials for which the new value chains (also the appropriate global supply chains) will have to be established. Innovative processes for extraction of minerals and metals as well as recycling, which are more energy efficient and environment-friendly will have to be developed to produce these critical elements.

To facilitate this global transition, we need to create human resources with high level of domain expertise in different facets of engineering as well as the much needed engineering skill sets needed to deal with the problems of scalability, uncertainty, reliability, complexity, system engineering, ability to deal with variability and yet manufacture products and create solutions of uniform and reproducible quality, capability to design, develop and optimize engineering systems for a given set of inputs and for a desirable set of assured outputs of consistent quality.

Our engineering education has to be appropriately re-engineered so as to equip our future leaders with not only the domain expertise but also the skillsets to innovate continuously and consistently in the face

of constant change and dynamic transformations. The human ingenuity and the preparing the well-trained minds, will be critical ingredients in responding to the challenges ahead.

It in this context, INAE has come up with the following areas for our focused attention in the next five years. We believe that these efforts will assist us in facilitating the smooth transition to the new world in the making.

1. **Accelerated Discovery, Development and Deployment of Novel Materials, particularly for strategic sectors like Defense, Atomic Energy and Space.**

We have an urgent need of materials (metals, alloys as well as composites) development for the following sectors – auto sector (both electric vehicles as well as IC engines based vehicles), aerospace, ultra-supercritical power plants, nuclear power plants, renewable energy sector (novel PV materials, rare earth magnets, battery materials for both large scale energy storage as well as for electric vehicles and other electronic appliances, thermoelectric materials for converting low temperature heat into electricity), novel sensors for healthcare industry, materials for the defense applications and space applications, to name a few.

These materials will have to be engineered for India-specific applications. That means one must consider during the process of design & development itself, the kind of natural resources we have and the kind of supply chains we will be able to establish to source the starting raw materials, considering the complex geo-political scenario and vulnerabilities associated with dependence on raw materials from abroad.

The other important consideration is the speed of development. In order to remain globally competitive in this domain, we must leverage the state of the art digital platforms (equipped with advance modeling, simulation, data analytics and knowledge engineering tools) for accelerating the development cycle from conception to deployment in actual applications as well as the entire life cycle (cradle to cradle or cradle to grave in some cases), that is, even for the structural health monitoring of the structures where these materials will be deployed.

Another important consideration is the environmental impact of these materials, that is, we must undertake a life cycle analysis, both with respect to the environmental footprint as well as the energy efficiency (actual consumption as compared to the thermodynamic energy needed to accomplish the particular task), for every developmental effort.

It is now well established that integrated computational materials engineering (ICME) approach can help accelerate the materials development cycle.

INAE will work towards coming up with a national strategy to establish and institutionalize the ICME based approach for all material development efforts. The digital platform, thus created, must be equipped with knowledge engineering capabilities so that it can not only act as a knowledge repository of all past efforts made thus far but also continues to update the knowledge going forward.

2. **Strategies for Energy Transition to Fossil Fuels free Renewable Energy Sources**

It is inevitable that India, like several other nations of the world, will move away from fossil fuels as a source of energy. While we have made some headway in developing renewable energy sources like solar and wind, the necessary infrastructure to support the energy transition does not exist at the present time. INAE plans to create an interdisciplinary expert group to study the whole energy transition comprehensively and holistically, keeping in mind the challenges inherent in such a massive transformation.

INAE will focus on the following important sectors which will be disrupted in the immediate future and/or the areas of concern which we require a strategy for, urgently to facilitate the transition

- Large scale energy storage solutions - Solutions other than Lithium Ion Batteries which do not seem to be appropriate for a country like India for a variety of reasons including the fact that we do not have the basic raw materials - Liquid Metal Flow batteries (for example, Vanadium Flow Batteries) is another attractive option which must be explored.
- Electricity Grid Infrastructure - current grid will not be able to cater to intermittent and distributed electricity inputs; the concept of smart grids which is adequately robust to cater to both supply side challenges (renewable energy sources) as well as demand management (dynamic pricing to take care of its peak loads).
- Transportation (electric mobility, both for people as well as for goods).
- Mining, Mineral Processing and Extractive Metallurgy Industry (which currently depends totally on fossil fuels not only as a source of heat but also as a reductant to convert metal oxides to metals).
- Recycling of waste by-products including municipal waste, tailings and smelter slags including steel slag, red mud and spent pot lining, electronic waste and hospital waste.
- Supply chains for raw materials needed for the transition - sourcing strategies from other geographies, urban mining, deep sea mining and space mining.
- Finding alternative technology options for the manufacture of steel and cement to reduce the environmental foot-print - currently these two materials which will continue to remain the backbone of the Indian economy for the foreseeable future and the consumption is likely to increase by an order of magnitude in the coming decade.
- Waste-water treatment and recycling.
- Water purification technologies including desalination

3. Excellence in Engineering Education

Several groups including other academies globally, are working on the new curricula for engineering education so that our young emerging leaders are adequately equipped with necessary engineering skill sets to face the challenges in the coming decades.

Various deliberations within India as well as abroad have emphasised the need of providing hands-on design experience, problem solving skills and exposure to the systems engineering concepts, tools and technologies to the engineering students. The curricula also need to be updated with the advancements in digital technologies.

All engineers must be familiar with the sustainability paradigm and must be able to do life cycle analysis for every engineering product. They must be equipped with knowledge and the experience with various digital platforms and modelling tools such as computational materials engineering (all the way from atomistic scale to macroscopic scale), computational fluid dynamics, structural analysis tools, life cycle analysis modelling tools, engineering scale up, robust design methodologies to take care of uncertainty and complexity, machine learning and data analytics tools and algorithms, multi-objective and multi-variate optimization tools and technologies.

It is important that the professional ethics is part of the engineering course curricula. A multi-disciplinary systems perspective to all engineers will certainly broaden their horizons – much needed to face the emerging world scenario. Good communication skills and ability to work in teams, are also prerequisites for engineers to succeed in the real life.

All engineers must possess basic IT skillsets and it is a given since digital technologies are transforming every aspect of our lives.

A multidisciplinary INAE Expert Group will critically examine the current status of engineering education, identify gap areas and strive to fill those gaps with appropriate action plans

4. World Class Infrastructure

INAE will come up with an action plan in consultation with all stake- holders to upgrade our national infrastructure within next few years. This will include

- Requirements, technology options and the investments needed to create a few smart cities in the country - including mobility, healthcare facilities, e-governance, access to affordable housing, utilities (electricity and water), waste collection, processing and recycle, education, communication, maintenance of infrastructural facilities, disaster management infrastructure including extreme events (for example, excessive rain and floods) etc.
- Requirements, technology options and the investments needed to create a rural infrastructure so that they can enjoy access to certain basic amenities where they are located - digital connectivity for example can provide them with access to healthcare, online education, information dissemination, financial inclusion, logistics warehousing and agriculture and farm productivity with engineering focus etc.

5. Cyber-physical Systems

Globally innovations are taking place at the interface of digital technologies and domain expertise. For example, manufacturing is being transformed as a consequence of the following - robotics and automation, Internet of Things (IoT), cloud computing, 3D printing, AI, machine learning and data analytics (Digital Twins), structural health monitoring of built structures and engineered products, drones, autonomy, data analytics based predictive asset maintenance systems, blockchain technology to facilitate complete traceability of the products, digital platforms for integrated design, development, deployment and monitoring of materials and products and knowledge engineering platforms for capturing, retaining and context sensitive retrieval of knowledge to solve challenging problems.

Similarly leveraging the advanced digital technologies, the infrastructure available in a given locality or a city can be upgraded for easy accessibility – for example, healthcare facilities, e-governance, utilities (electricity and water)

It is now possible to make most of healthcare facilities available to the citizens at their place ofresidence (particularly important for senior citizens living alone) through the intervention of digital connectivity, sensors and IoT solutions. Provision of healthcare and affordable Medicare facilities through technological interventions is a key focus area.

INAE will select certain areas for focussed attention during the next five years and develop strategies to create infrastructure to facilitate digital transformation for achieving a set of desirable objectives for example, higher productivity, higher efficiency, better quality of life and better quality of products, reduced cost of services, higher safety of workers, etc.

Back to Main Page

ACADEMY ACTIVITIES

Academy News

INAE Announcements

- **Nominations invited for Innovative Student Projects Award 2021.** Last date of receipt of nominations is **July 31, 2021.** For details click on the link given below.

https://www.inae.in/innovative-student-projects-award/

Documentary film on INAE

At the behest of DST, the Vigyan Prasar had coordinated a series of films made on various institutes of DST including INAE. In this connection, Vigyan Prasar, DST informed INAE regarding release of film on INAE on Wednesday, 26th May 2021 to be watched on India's 24x7 national science channel on the internet, called India Science (www.indiascience.in) . The English and Hindi versions of the film can be viewed by clicking on the links given below:

https://www.indiascience.in/videos/dst-inae-e

https://www.indiascience.in/videos/dst-inae-h

INAE-NAEK Workshop on 'What's next in Aerospace Engineering and Materials' held virtually on June 14, 2021 – June 15, 2021

A series of collaborative activities had been organized jointly between the Indian National Academy of Engineering and National Academy of Engineering of Korea (NAEK), South Korea since 2017. The first Workshop between INAE and NAEK was held on 'High Temperature Materials' on March 16-17, 2017 at IISc Bangalore, India. The second Workshop on 'High Temperature Materials' was held on May 14-15, 2018 at Changwon, Korea. The third INAE-NAEK Workshop on "High Temperature Materials and System Engineering for Aerospace, Power Generation and Defence Industry" was held on 15-17th July 2019 at Hyderabad. To continue with the tradition, the fourth Workshop on "What's next in Aerospace Engineering and Materials" was held virtually on June 14-15, 2021 to commemorate celebration of India's 75th Year of Independence (Azadi ka Amrit Mahotsav). A copy of the programme can be viewed by clicking here

The Workshop started with the Welcome Address by Prof Kwon, Oh-Kyoung, President, NAEK followed by the Opening Address was delivered by Prof Indranil Manna, President, INAE and the workshop focussed broadly on the following three domains:

(i) Session I : Aerospace Engineering systems and Aerodynamics
(ii) Session II : Innovation for Materials in Aerospace industry
(iii) Session III: Additive Manufacturing for Aerospace industry

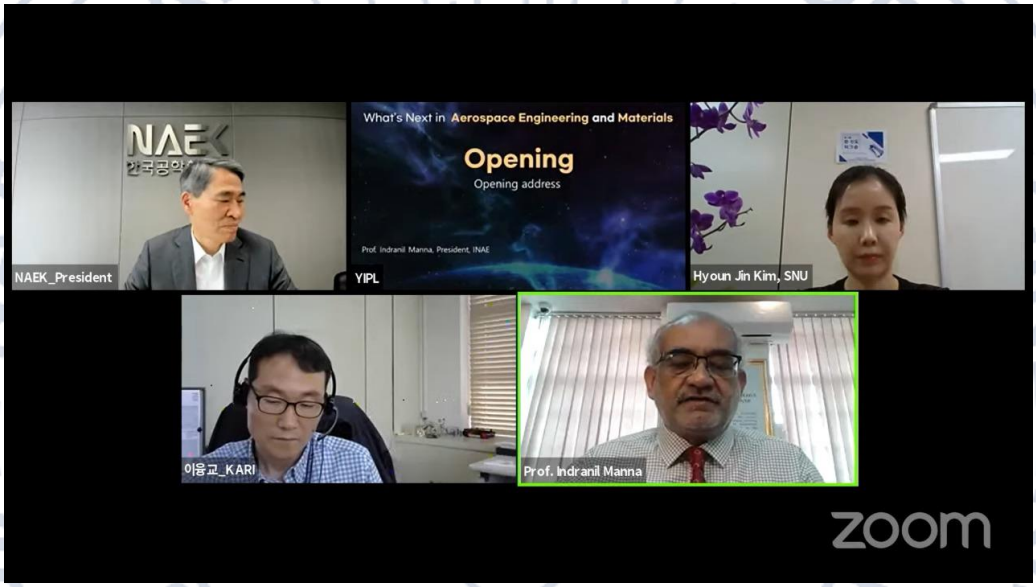
The details of the session are given below.

I. Date: 14 June 2021, Session I

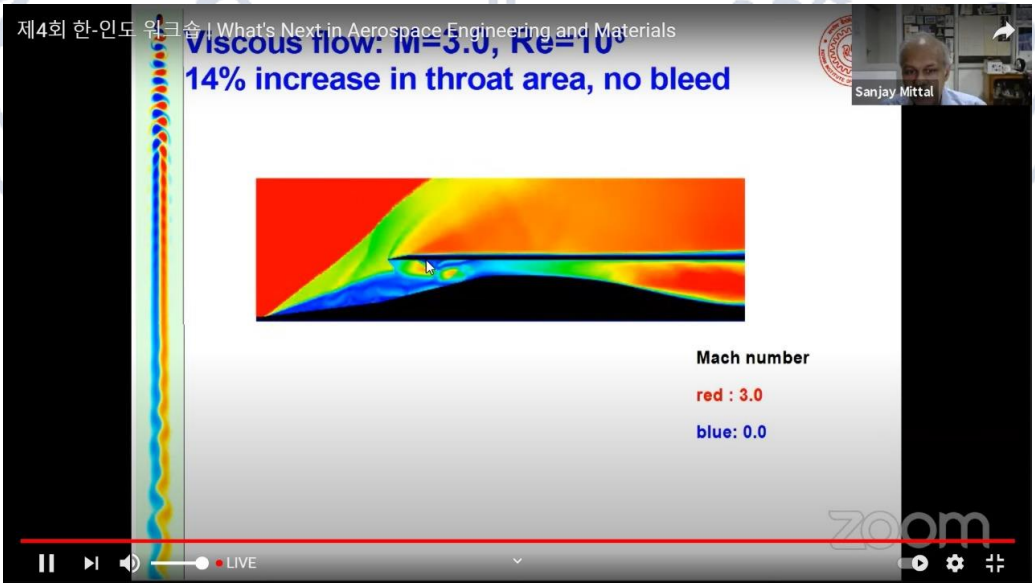
The first session was chaired by Prof Hyoun Jin Kim, Department of Mechanical and Aerospace Engineering, Seoul National University.

The details of the talks delivered are given below:

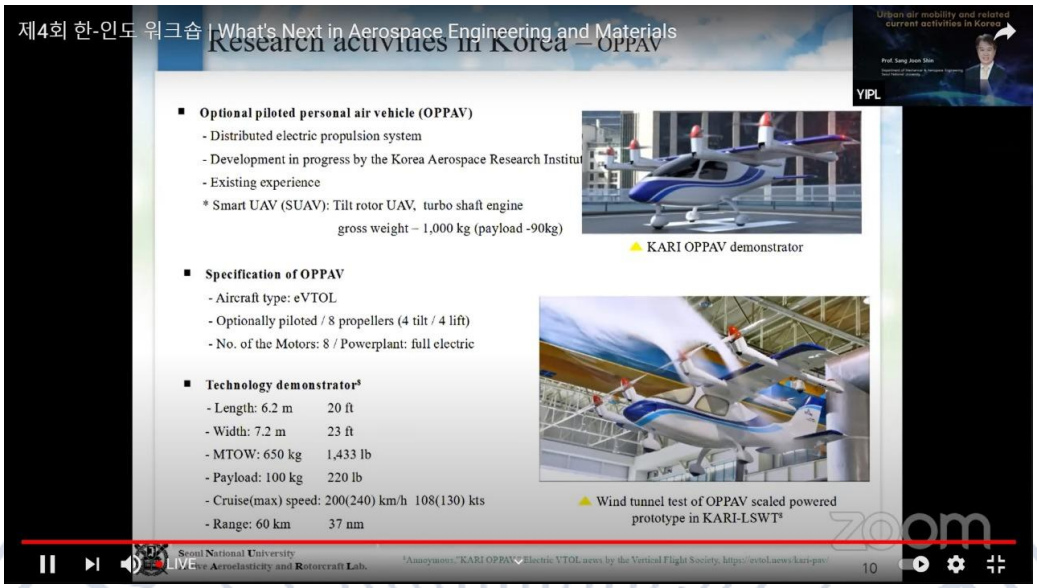
S NO	Details of the Speaker	Topic
1.	Prof Yung-Gyo Lee, Director, Aeronautics Technology Research Division, Korea Aerospace Research Institution (KARI)	Korean Solar Powered Stratospheric UAV Development
2.	Prof Sanjay Mittal, Department of Aerospace Engineering, Indian Institute of Technology Kanpur	Air Intakes of High Speed Aircrafts and Reusable Launch Vehicles
3.	Prof Sang Joon Shin, Department of Mechanical & Aerospace Engineering, Seoul National University	Urban air mobility and related current activities in Korea



Opening Address by Prof Indranil Manna, President, INAE



Presentation by Prof Sanjay Mittal



Presentation by Prof Sang Joon Shin

2. Date: 14 June 2021, Session II

The second session was chaired by Prof Young-Chang Joo, President, Advanced Institute of Convergence Technology / Professor, Department of Materials Science and Engineering, Seoul National University. The details of the talks delivered are as under:

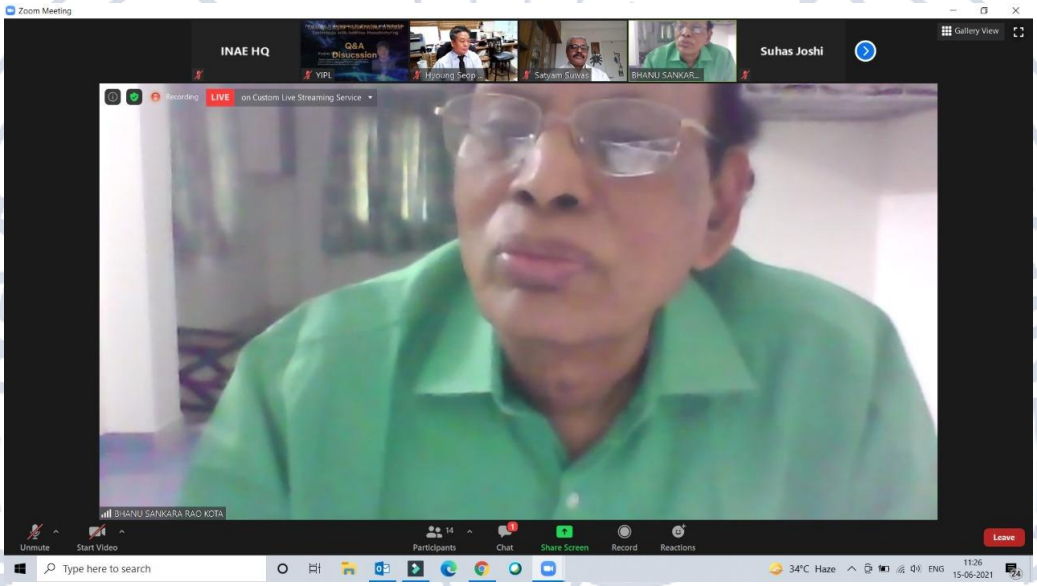
S No	Details of the Speaker	Topic
1.	Prof Dipankar Banerjee, Department of Materials Engineering, Indian Institute of Science, Bangalore	Aerospace Materials in India: Past, Present and Future
2.	Dr Yong-Nam Kwon, Principal Researcher, Korea Institute of Materials Science (KIMS)	The current status of Korean aerospace materials industry - Do we really have to run domestic supply chain
3.	Mr S Somanath, Director, Vikram Sarabhai Space Centre, Thiruvananthapuram	Materials development for Indian Space Program

II. Date :15 June 2021, Session III

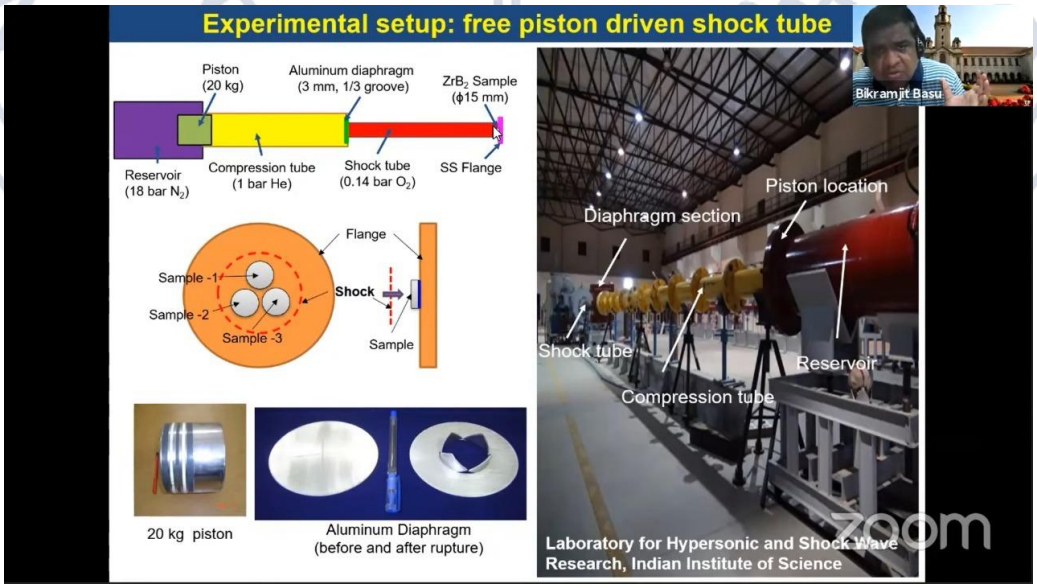
The third session was chaired by Prof K Bhanu Sankara Rao, FNAE, School of Engineering Sciences and Technology, University of Hyderabad. The details of the talks presented are given below:

S No	Details of the Speaker	Topic
1.	Prof Bikramjit Basu, Honorary Professor, University of Manchester, UK; and Professor, Materials Research Centre, Indian Institute of Science, Bangalore	Ultrahigh Temperature Ceramics for Aero structural Applications
2.	Dr Jongkee Ahn, Principal Research Engineer/Team leader, Advanced Material Design Team, Hanwha Aerospace R&D center	Present status and future prospects of additive manufacturing for gas turbine in Korea
3.	Prof Suhas S Joshi, Department of Mechanical Engineering, Indian Institute of Technology Bombay, Mumbai	Generating Multi-scale Functional Surfaces using Laser Micromachining

4.	Prof Hyoung Seop Kim, Professor, Department of Materials Science Engineering, Pohang University of Science and Technology (POSTECH)	Metal Additive Manufacturing for Heterogeneous Architectured Materials
5.	Prof Satyam Suwas, Department of Materials Engineering, Indian Institute of Science, Bangalore	Additive manufacturing of materials for high temperature applications
6.	Dr Keejoo Lee, Senior Researcher, Head of Small Launcher Team, Future Launcher R&D Program Office, Korea Aerospace Research Institute	Embracing Digital Transformation of Rocket Technology with Additive Manufacturing

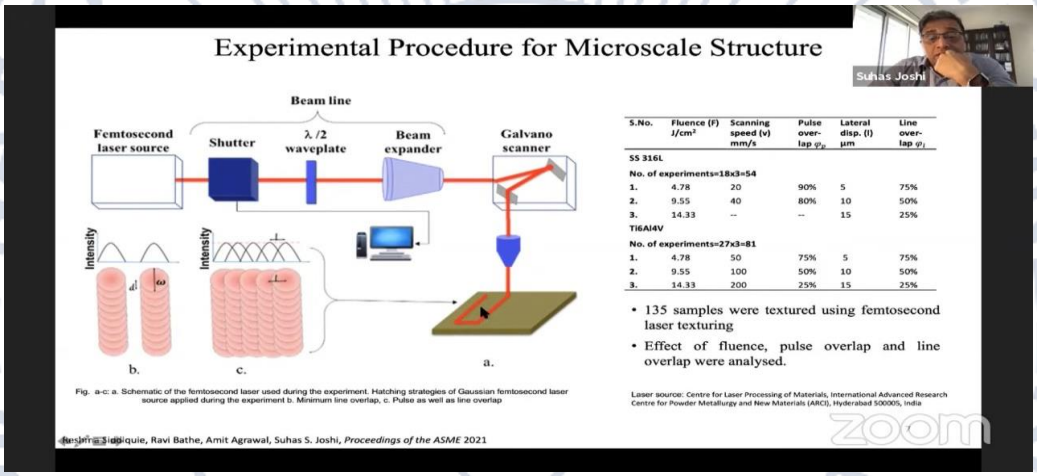


Chairing of Session by Prof K Bhanu Sankara Rao

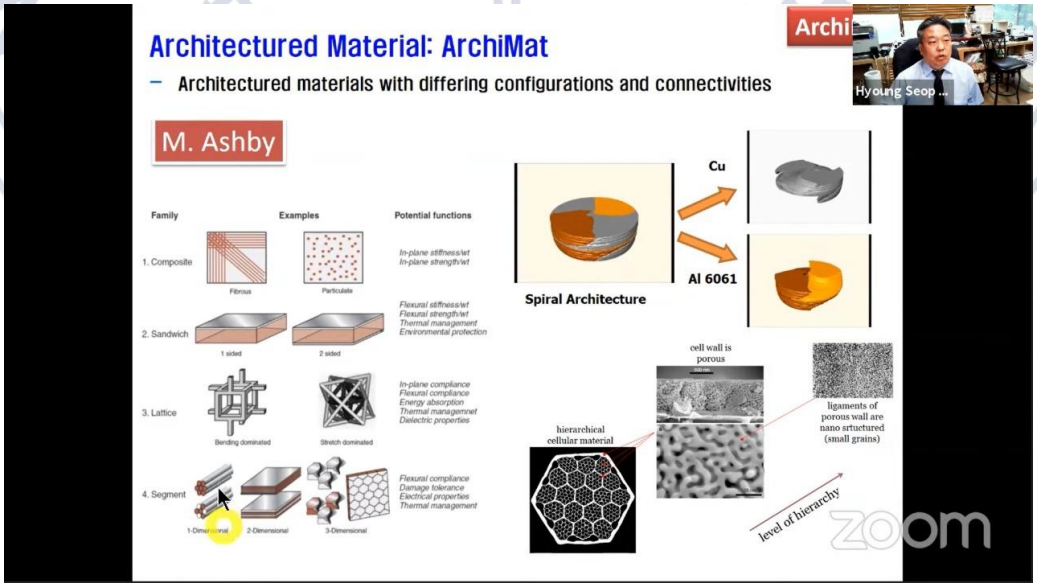


Presentation by Prof Bikramjit Basu

Presentation by Dr Jongkee Ahn



Presentation by Prof Suhas Joshi



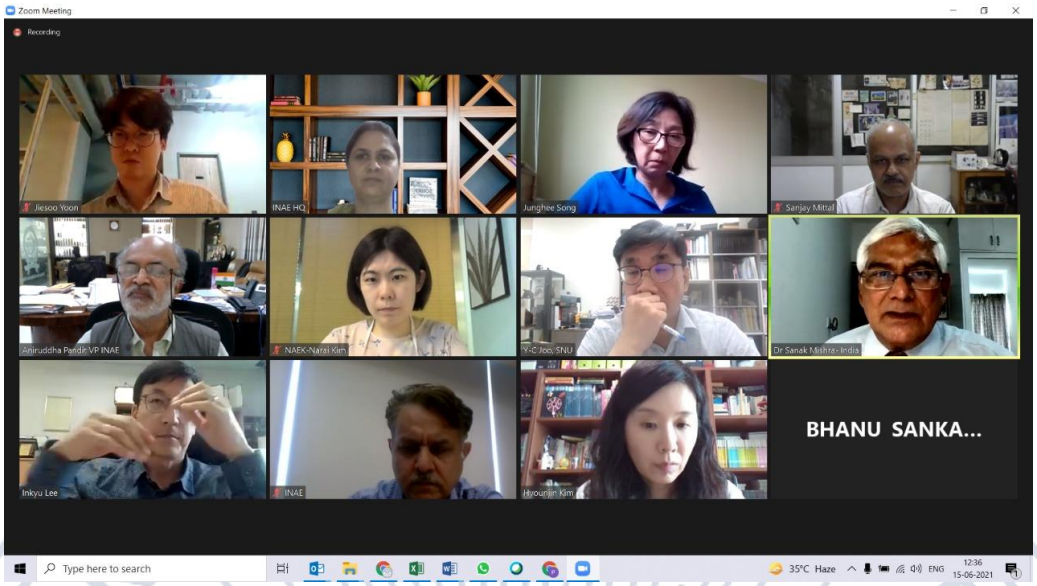
Presentation by Prof Hyoung Seop Kim

Presentation by Prof Satyam Suwas

Presentation by Dr Keejoo Lee

Each session was followed by the Q&A Session. The Workshop concluded with the Wrap up Session which was chaired by Dr Sanak Mishra, Immediate Past-President, INAE and attended by the following members from INAE and NAEK.

NAEK Participants	INAE Participants
1. **Dr Song, Jung Hee**, Vice President, NAEK 2. **Prof Inkyu Lee** Chair of International Affairs, NAEK 3. **Prof Young-Chang Joo**, Member, NAEK 4. **Prof Hyounjin Kim**, Member, NAEK 5. **Ms Narai Kim**, Senior researcher, NAEK 6. **Mr Jiesoo Yoon**, Researcher, NAEK	1. **Prof AB Pandit,** Vice-President, INAE 2. **Prof K Bhanu Sankara Rao,** Chief Editor of Publications, INAE 3. **Prof Sanjay Mittal,** Fellow, INAE 4. **Lt Col Shobhit Rai (Retd),** Deputy Executive Director, INAE 5. **Ms Pratigya Laur,** Research Officer, INAE



Concluding Session

➢ **National Frontiers of Engineering (NatFOE 2021)**

The National Frontiers of Engineering (NatFOE) Symposium is a flagship event of INAE being held since 2006. The 15th NatFOE 2021 is being organized online from July 9-10, 2021 at Indian Institute of Technology, Hyderabad online. Prof BS Murty, Director, IIT Hyderabad and Prof Sivaji Chakravarti, Vice-President, INAE are the coordinators of the event. Prof Chandrasekhar Sharma, IIT Hyderabad is the Convener of the event. The four themes of the Symposium are (i) ***Artificial Intelligence and Machine Learning; (ii) Advances in Materials and Manufacturing Technology; (iii) Infrastructure & Unconventional Energy; and (iv) Rural Technology & Entrepreneurship.*** Two Coordinators have been identified for each of the Themes. The first announcement can be viewed at https://www.iith.ac.in/natfoe2021/

An "Innovation in Manufacturing Practices (IMP)" event is also being organized online on sidelines of NatFOE 2021. IMP is a manufacturing design competition to provide the bright minds a platform to display and exuberate their talent in design and manufacturing. In this event, the participants (students) are expected to design, fabricate and demonstrate a hardware prototype using an innovative manufacturing process not limited to any engineering discipline. A pamphlet on the IMP 2021 can be viewed by clicking here

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➢ **INAE Youth Conclave 2021**

INAE Youth Conclave 2021 has been planned to be organized online by National Institute of Industrial Engineering (NITIE); IIT Bombay and ICT Mumbai on Engineers' Day September 15, 2021. The tentative date is decided to be on Engineer's Day i.e. September 15, 2021. The presentations would be based on five topics of national importance **namely:** Waste to wealth; Digitization and revolution in logistics & Engineering intervention to fight against COVID-19 and healthcare management; Innovative technologies and product developed during COVID; Teaching and learning in pandemic and Azadi Ka Amrit Mahotsav. Preparations are ongoing for planning of the event.

Local Chapter Activities

INAE Mumbai Chapter

INAE Mumbai Chapter organized a Webinar on "Production and Utilization of Green Hydrogen" on June 9, 2021 which was attended by Fellows, Young Associates and other invitees. The Moderator was Dr R B Grover, FNAE**,** Co-Convenor, INAE Mumbai Chapter and Emeritus Professor, Homi Bhabha National Institute, Mumbai. The Lectures were delivered by the following six eminent Panelists:

1. Shri Kalyan Bhanja, Heavy Water Division, BARC on "Production by electrolysis"
2. Prof Prakash C Ghosh, Department of Energy Science and Engineering, IIT Bombay on "Fuel cell PEFC".
3. Dr Shriniwas Rao, Chemical Technology Division, BARC on "Production by I-S process".
4. Dr V Sudarsan, Chemistry Division, BARC on "Hydrogen Storage".
5. Prof Ganapati D Yadav, FNAE, Emeritus Professor of Eminence Institute of Chemical Technology, Mumbai on "Production by Cu-Cl process".
6. Dr Suman Roy Chowdhury, NMRL, DRDO on "Fuel cell PAFC"

In his introductory remarks, Dr. R B Grover stated that climate crisis calls for expeditious deployment of low-carbon energy sources. All countries around the globe are concentrating on decarbonizing the electricity sector. Replacing petrol- and diesel-driven light motor vehicles and two-wheelers have also been prioritized by governments around the globe. This is not enough. Fossil fuels are also used in making iron and steel, cement, different chemicals, shipping, aviation, and trucking.

To achieve the goal of limiting temperature-rise to 1.5 Celsius, energy professionals have to think in terms of decarbonizing the energy sector and not just the electricity sector. For decarbonizing the electricity sector, the IPCC process has recognized hydro, nuclear, solar, and wind as low-carbon technologies. Solar and wind are intermittent sources. As their penetration in the grid increases, the challenge of balancing the grid is becoming bigger and bigger.

Importance of hydrogen lies in the fact that it can be used to replace fossil fuels in industry and also be a part of the solution to balance the grid. Like electricity, hydrogen has to be produced, and considering the challenge posed by the climate crisis, it has to be produced by clean processes. Some sectors such as chemicals already use hydrogen. That is produced mostly from steam reforming of methane and that is not a clean process.

Let's now talk about the transport sector. For light vehicles, for city transport, it will be prudent to use electric vehicles as there are energy losses from the electrolyzer to the wheel. However, for long-haul heavy trucking, one may have to use hydrogen. In this case, there is an alternate view that a truck driver has to take rest every four hours. By providing charging infrastructure along highways, one can use electricity even for trucking.

In view of the fact that using hydrogen in internal combustion engines to power transport vehicles will cost about five times more primary energy, experiments using hydrogen via fuel cells are underway in many countries. Efficiency of fuel cells can be almost double that of internal combustion engines.

In India, MNRE is supporting a broad based Research Development and Demonstration (R&D) programme on Hydrogen. Efforts by MNRE have resulted in development and demonstration of internal combustion engines, two wheelers, three wheelers, and mini buses that run on hydrogen fuel. Two hydrogen refuelling stations have been established (one each at Indian Oil R&D Centre, Faridabad and National Institute of Solar Energy, Gurugram). However, for shipping, hydrogen is perhaps the only solution.

Summarizing, Dr. Grover said,

- We have to decarbonize the energy sector and not just the electricity sector.
- The importance of hydrogen lies in the de-carbonization of the energy sector as it can de-carbonize industry, heavy transport, shipping, and aviation.
- To achieve this, we have to produce hydrogen in bulk.

He requested all the panelists to speak about technologies for the production of green hydrogen under development in their labs, cost of production, requirements of capital expenditure, use of intermittent sources of electricity, influence of intermittency on the cost of production, fuel cell development, hydrogen storage, and transport, and any other issue they think is relevant.

Mr. Kalyan Bhanja (Heavy Water Division, BARC) made a presentation of electrolytic production of hydrogen. Electro-splitting of water for hydrogen production has unique advantage as the electrolyser is compact and modular in construction with few process steps compared to other chemical routes. There are three electrolytic Hydrogen production processes, namely alkaline water electrolysis (AWE), ion exchange membrane based pure water electrolysis, and steam electrolysis.
As of now, only BARC has got indigenous technology for hydrogen production through AWE upto 10 Nm3/h. The cell module has compact filter press type construction with nickel bipolar electrode plates separated by membrane, producing high purity hydrogen as well as oxygen, simultaneously. The unique porous nickel electrode gives very high current density and the membrane gives high purity gases. The cell performance matches with international established manufacturers in terms of energy efficiency. At present, R&D is going on for scale up and BARC was looking forward to participation of industry to accelerate this development.

BARC is also working on Proton Exchange Membrane (PEM) based pure water electrolyser development and has demonstrated laboratory scale system for its performance in electrolyser as well as fuel cell mode. Unique feature of the system is, development of Membrane Electrode Assembly (MEA) using indigenous SPEEK-PEG-SiO2 membrane, instead of imported Nafion. BARC has also demonstrated steam electrolysis for hydrogen production using YSZ-LSM based system, which has been developed in-house. Special feature of BARC technology is that it is of tubular type, which is having advantage in multiplication or scale-up, compare to planner design.

Prof P C Ghosh (Department of Energy Science and Engineering, IIT, Bombay) presented a case for polymer electrolyte fuel cells (PEFCs), which are at the early stage of their commercialisation, and have the potential for different applications. However, PEFC technology faces several challenges and uncertainties during the pre-commercialisation phase. Platinum, used as the catalyst in PEFCs, is considered one of the critical obstacles towards commercialisation as it contributes significantly to the overall cost. Prof Ghosh made the case that around 90-95% of the Pt used in the PEFC is available at the end of its lifetime. Hence, a fuel cell-based transport system with platinum catalyst is something like "a locker on the wheel" since it can offer high salvage value leading to a profitable case. Therefore, the high investment in platinum could be beneficial instead of acting as the hurdle if the salvage value of platinum is considered. Hence, the high cost of platinum might promote the commercialisation of the fuel cells if an appropriate business model is in place. Therefore, the cost of platinum should not be considered as a hurdle towards commercialisation.

On the other hand, the sustainable supply of platinum to cater to fuel cell production only for the fuel cell-based electric vehicle is considered a long-term hurdle. The initial value for the reserves is based on a report in the South African Journal of Science by R. G. Cawthorn that estimates 48,000 Mg of platinum exists worldwide. According to the estimated the worldwide car production is reached 97 million per year. Considering a loading of ~20 gm per car (100 kW), an amount of 2,000 Mg of Pt is

required per year to produce only PEFC based electric vehicles. Hence, there are no options left other than recycling the platinum for offering a sustainable solution. If platinum is recycled, only 200 Mg of platinum is required per year only for cars. Hence, platinum must be recycled to make the PEFC system sustainable.

Dr. V. Sudarsan, (Head, FMS, Chemistry Division, BARC) made a presentation on Metal hydrides as candidates for Hydrogen Storage Technology. He spoke about extensive work being carried out in BARC for developing efficient technologies for storing hydrogen. It is now well established that among the different storage options available, solid-state hydrogen storage along with the fuel cell technology is the best option for transport applications as it can fulfil the criteria such as safety, efficiency and cost. In this regard a variety of materials which include main group elements, transition metals/alloys, porous carbon, carbon nanotubes etc., were investigated in detail in the recent past. Based on these studies, two systems namely nano-engineered magnesium and transition metal based ternary alloy Ti2CrV are found to be promising for this application. Both the systems have advantages and disadvantages. Nano-engineered Mg based systems show high hydrogen storage capacity of around 7 wt.%, however, desorption of hydrogen starts around 160°C and above. In the case of Ti2CrV the storage capacity is around 4 wt.%, while hydrogen desorbs at around 70°C. Currently both systems are being investigated in parallel for evaluating the long-time cyclic stabilities for large scale applications. Detailed cost calculations using the IAEA developed Hydrogen Economic Evaluation Program (HEEP) also confirms that solid-state hydrogen storage technology based on above type of materials/alloys will be cost effective compared to the conventional cylinder based storage methods.

The presentation by **Dr Shriniwas Rao** (Chemical technology Division, BARC) covered the development works carried out in hydrogen production from various thermochemical cycles which are used in conjunction with a green heat source. Iodine-Sulphur thermochemical process which is expected to have higher efficiency, was dealt in detail by him. The challenges encountered in the developmental work, future plans and the international status was also discussed.

Prof GD Yadav (Emeritus professor of Eminence, ICT, Mumbai) delivered a talk on "Production of Green Hydrogen and The Net Zero Goal: Potential of ICT-OEC Process" which is summarized as follows. Green hydrogen can be used as a feedstock, a fuel, or an energy carrier and storage, and has numerous applications across different industries, and in transport, power, and building sectors. It is the key to decarbonize industrial processes reducing carbon emissions, which is both important and challenging to achieve. Adaption of Green Hydrogen Technologies, for instance, ICT-OEC Technology will add to the might of India's commitment to the Paris Agreement on Climate Change to make the Net (Carbon) Zero Emissions to contain temperature rise to less than 1.5 ^{o}C. Hydrogen economy can be elegantly intertwined to make many chemicals from waste carbon sources including biomass and C1 off-gases.

What we need in the future are integrated plants for hydrogen production from water splitting and its use in controlling environmental pollution and climate change, as well as production of many chemicals by the carbon dioxide refineries. We need a novel, realistic rethinking of the energy policy—from transitioning from coal to petroleum to gas and eventually to electrification of transport, to carbon pricing and a focus on new technologies.

There is a need to develop different hydrogen production technologies and to evaluate their impact on energy and environment to meet the net zero goal. Biomass should be used for production of valuable chemicals and materials, and NOT as a source of fuel. Govt of India should adopt hydrogen economy to meet the demands of the Paris Agreement ICT-OEC Hydrogen Technology, where the cost of production of hydrogen is less than a dollar per kg without valorization of oxygen, is one of the most

viable technologies and should be part of Hydrogen Mission. This comparison was made on the basis of 19 other available technologies in the world.

Dr. Suman Roy Chowdhury (NMRL, DRDO) opined that considering the limitations of other sources to fill up the void that will be created due to withdrawal of the fossil fuels, it will be essentially the solar energy and its derivatives that need to be exploited to a much higher level in near future. However, since solar energy is diluted and intermittent (about 4-5 hours of good radiation per day), it calls for energy storage technologies, to the tune of ~4000 GWh, in a distributed manner to provide uninterrupted power when solar is not available. Technologies for the hydrogen grid components viz green hydrogen generation, transportation, exploitation and stabilization need to be seen in a holistic manner and suitable technology configurations need to be identified with performance markers, for e.g. hydrogen generation technologies like water electrolysis (at <1.5V), direct solar photolysis of water (efficiency >10%), H2-halogen electrolysis (at near thermodynamic potential) etc. needs to be evaluated for suitability. Similarly, H2 transportation technologies (like high pressure solid state compressors like electrochemical and hydride compressors), H2 energy exploitation (thru Pt free-low cost, high efficiency fuel cells - for e.g. hydrogen-halogen fuel cells and other flow battery technologies) need to be checked as a part of the total system and not in isolation. There is a dire need to have a comprehensive policy document on green hydrogen grid for managing fast growing solar energy in India. The document must bring out all possible technologies for the green hydrogen grid and compare the efficiency of the full power train vis-à-vis competitive technologies and identify the performance goals for the same, while evaluating the feasibility of implementation wrt cost, technology readiness, suitability, statutory regulations etc.

Dr Chowdhury opined that an accredited body like INAE may take the lead, and through a committee of experts publish a technology goal document to allow policy makers, researchers and industries to prioritize development and implementation of such a grid. NMRL with her rich experience of developing and industrializing fuel cell/hydrogen energy based power solution for defence use may support such a cause by sharing the rich development experience related to technology evaluation, development and deployment through a multi-party system.

INAE Bangalore Chapter

- INAE Bangalore Chapter organized Frontiers of Engineering webinar on June 24, 2021 on "An Overview of Smart Manufacturing and its Implications for Innovation and Growth" by Prof. Amaresh Chakrabarti, Center for Product Design and Manufacturing, IISc., Bangalore.

- **Seminar-cum-Webinar on "Ethics in Higher Education" on 25th June 2021**
  INAE Bangalore Chapter organized a Seminar-cum-Webinar on "Ethics in Higher Education" on 25th June 2021. The event was conducted by INAE Bangalore Chapter jointly with The Society for Professional Ethics & Management (SPEM) with the support from The National Assessment and Accreditation Council (NAAC), Visvesvaraya Technological University (VTU) and JAIN (Deemed to be University). The Programme and the Brochure of the event are enclosed at can be viewed by clicking here and clicking here

- **SAMVAAD** – an IIT Dharwad-INAE Bangalore Chapter Lecture Series was held on June 30, 2021 featuring talk by – by Padma Bhushan Awardee, Chancellor of IIST and former President, INAE - Dr BN Suresh, on "Mastering Rocket Science: Experiences and Excitements". The Poster of the said Lecture Series can be viewed by clicking here

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Proposed Document on "Landmark Achievements in Science and Technology in Independent India"

The Government of India has launched a 75-week celebration of India's 75th Year of Independence (*Aazadi ka Amrut Mahotsava*) with a grand celebration on 15th August 2022. In this connection, it has been decided that DST will publish a compendium of most significant scientific and technological achievement of India since independence. For this purpose, the Sectoral Group of Secretaries (SGoS) has been constituted. The Secretary DBT, Chairperson of the Sectoral Group of Secretaries (SGoS) has requested all Science and Engineering Academies of the country including INAE to join hands and produce an encyclopaedia containing all those feats in Science & Technology that make us proud and will inspire future generations since independence. In this regard, the Presidents of INSA, IASc, NASI and INAE had met on April 3, 2021 and committed to help create a volume and a website that would provide a comprehensive view of India's growth and contributions in S&T since independence. Further, it was decided to solicit suggestions (initially only name or item) to propose a list of 75 or 100 landmark innovations (individual or collective) in S&T in India achieved primarily after our independence that eminently merit a mention in the proposed volume so as to select deserving items. Suggestions were invited from Fellows/Conveners.

Subsequently, a meeting was held to consider suggestions received earlier and also to discuss and formalize the methodology to propose a list of 75 or 100 landmark innovations (individual or collective) in S&T in India achieved primarily after our independence that eminently merit a mention in the proposed volume so as to select deserving items. During the said meeting, it has been decided that each Convener of the Sectional Committee may request Fellows affiliated to his/her respective Engineering Section to seek 10 to 20 topics of such landmark technical achievements since independence. The inputs received are since being collated.

A list of suggested topics received for the proposed Compendium on "Landmark Achievements in Science and Technology in Independent India" were discussed in the Steering Committee during its meeting held on 10th June 2021 to shortlist and finalize 3 to 4 topics from each Engineering Section (a total of about 30-40 such engineering accomplishments) proposed to be submitted to DST for inclusion in the said Compendium.

During discussions, the Steering Committee has recommended that INAE may publish or contribute in two volumes as Compendium (Collection of Eminent Contributions by Individuals or Group) as given below:

Volume A: Jointly with Science, Medical, Agricultural and other National Academies.

Volume B: 75 (Azadi@75) most outstanding engineering feats or marvels in Independent India (one page each) – only by INAE; Not individual contribution or novelty, but major engineering or technological achievement that has made a huge difference, say, an engineering system or product.

Actions are ongoing and committees being constituted to undertake these activities.

Meetings of the Gender Parity Advisory Committee

INAE has been discussing the Gender Parity issue for the past several years but with no tangible solution. For this purpose, a Gender Parity Advisory Committee has been constituted under the Chairmanship of Dr. BN Suresh, Past-President, INAE to deliberate and suggest proactive measures to achieve acceptable level of gender parity in INAE. The composition of the Committee of INAE Fellows is as follows: Dr. BN Suresh, Former President, INAE is the Chairman of the Committee with Dr. Saswasti B Roy, Prof

Sushmita Mitra, Dr. VR Lalithambika, Prof. Ligy Philip, Ms Alpa Seth, Prof K Chattopadhyay, and Prof Prem Krishna as Members. Dr BN Suresh had prepared a Base Paper on the issue of Gender Parity in INAE which is summarized as follows. Gender parity subject is being discussed in many forums in India for a long time including the reservation for women in Indian Parliament. INAE has been discussing this issue for the past several years but with no tangible solution. As on date, INAE has only 28 women Fellows out of 871 Fellows in India, which is a meagre 3% of the entire Fellowship. Similarly, the representation of women in Young Associates is also poor. Although we have been pursuing very proactive policy to induct women into Fellowship for the last few years, the results are not all encouraging. It is therefore felt essential that we deliberate in detail and generate suitable recommendations to improve the situation in all these forums of INAE. There is a need for innovative and out-of-box thinking to drive gender parity. No doubt the implementation aspects also possibly demand certain structural changes to improve the nomination and selection processes and create an enabling environment. The recommendations so made should also be actionable and implementable.

The Base Paper on the subject prepared by Dr. BN Suresh was deliberated in the first meeting of said Committee held on 6th May 2021 wherein a number of valuable suggestions/comments emerged. These have been culminated in the form of Draft Recommendations on Gender Parity of INAE. The Draft Recommendation were circulated to the members to seek inputs before further deliberations in the next meeting of the said Committee held on May 22, 2021, so as to consolidate into actionable and implementable recommendations on Gender Parity in INAE. Productive meetings were held, and clear-cut recommendations were crystallized. The final Recommendations were put up for further discussion and approved by Governing Council during its meeting on June 25, 2021 for implementation from this year itself.

Constitution of ISRO-INAE Consultative Committee

INAE currently has several Consultative Committees with DST, DRDO, CSIR and Office of PSA which meet periodically to facilitate interaction and identification of topics on thrust areas of engineering for conduct of technical activities and programmes. In this direction, the ISRO-INAE Consultative Committee has been recently constituted on April 27, 2021 to discuss issues of national importance.

The composition of the ISRO-INAE Consultative Committee is as under.

Co-Chair
Dr K Sivan, Chairman, ISRO/Secretary DOS
Prof Indranil Manna, President, INAE

Members from ISRO
Shri AS Kiran Kumar, Former Chairman, ISRO, Bangalore
Shri S Somanath, Director, VSSC, Thiruvananthapuram
Shri P Kunhikrishnan, Director, URSC, Bangalore
Dr VR Lalithambika, DHSP, ISRO HQ, Bangalore
Dr V Narayanan, LPSC, Thiruvananthapuram

Members from INAE
Dr BN Suresh, Past President, INAE & Chancellor, IIST, Bangalore
Prof Sanjay Mittal, IIT Kanpur
Prof RI Sujith, IIT Madras
Dr AR Upadhya, ADA, Bangalore
Mr Arun Ramchandani, L&T

The first meeting of the Committee is planned to be held on July 1, 2021.

Important Meetings held during June 2021

- INAE Digital Platform Committee Meeting held on June 7, 2021 over WebEx.
- Steering Committee Meeting held on June 10, 2021 over WebEx.
- Meetings of Expert Committee for Cyber Security Related Disasters held on June 14, 2021 and June 30, 2021 over WebEx.
- 30th Finance Committee Meeting held on June 16, 2021 over WebEx.
- Discussion Meeting of Academy Presidents held on June 17, 2021 over Webex
- Meeting on "Regional Transport Aircraft" held on June 18, 2021 over WebEx.
- 139th Governing Council Meeting held on June 25, 2021 over WebEx.
- Second Meeting of SC-III (Mechanical Engineering) held on June 29, 2021 over WebEx.
- Second Meeting of SC-V (Electrical Engineering) held on June 29, 2021 over WebEx.

Second Meeting of SC-X (Interdisciplinary and Special Engineering Fields and Leadership in Academia, R&D and Industry) held on June 30, 2021 over WebEx.

Back to Main Page

International/National Conferences/Seminars being Organized By IITs/other Institutions

8th International Conference on Smart Computing and Communications (ICSCC2021) on 1st to 3rd July 2021 at Kochi (in person)
https://conferencealerts.com/show-event?id=230506

6th Scopus-Indexed IEEE International Conference on Communication and Electronics Systems [ICCES 2021] on 8th to 10th July 2021 at Coimbatore, Tamil Nadu (online and in person)
https://conferencealerts.com/show-event?id=233564

2nd Springer International Conference on Data Intelligence and Cognitive Informatics [ICDICI 2021] Conference at 16th to 17th July 2021 at Tirunelveli, Tamilnadu (in person)
https://conferencealerts.com/show-event?id=230625

Note: Due to Lockdowns imposed by Government in view of Covid-19, schedule of these conferences may be rechecked.

Back to Main Page

News of Fellows

1	Dr Sanak Mishra, FNAE, Member of the Governing Board of the Steel Research & Technology Mission of India and Formerly Managing Director, Rourkela Steel Plant and Director, Steel Authority of India Ltd.(SAIL); Vice-President, ArcelorMittal and CEO India Projects; Secretary General, Indian Steel Association; President, Indian Institute of Metals and Immediate Past-President, INAE recently co-edited a Special Volume on "Design & Manufacturing" published by Springer-Nature as the May 2021 issue of the Transactions of the Indian Institute of Metals. The speciality of this issue, with twenty-one invited papers reviewed and selected on merit, is that it focusses primarily on engineering and innovation. Several of the authors are INAE Fellows, and several of the reviewers are INAE Fellows as well. The co-editor was Prof. Jyoti Mazumder, Fellow INAE, who unfortunately passed away in April after a protracted health condition beginning November 2020. A copy of the cover of the Special volume can be viewed by clicking here and Guest Editorial can be viewed by clicking here
2	Dr NK Tyagi, FNAE, Formerly director, ICAE-CSSRI, Karnal has authored a book “Tryst with Destiny- An Autobiography” published by Index International on his life-time experiences.
3	Prof SN Mukhopadhyay, FNAE, Adjunct Professor, Department of Biological Sciences, BITS, Pilani and Former Professor, DBEB, IIT Delhi; Former Professor & Head, BERC, IIT Delhi; Former Professor SOBT, GBU, Greater Noida, joined as an invited guest participant in Icon SWM-CE-2021 Workshop Technical Session I at Mechanical Engineering Department, Jadavpur University, Kolkata on 24th June 2021. Prof. S.N Mukhopadhyay has also been invited by Vidya Kutir Publications to contribute an article in its forthcoming book 'Advances of Atmospheric Research'. His submitted abstract on “Discovered God Particles In Advances of Atmospheric Research" has been accepted by the publisher.

Back to Main Page

INAE on Facebook And Twitter

INAE has created a Facebook and Twitter Account to post the news of recent INAE activities in the Social Media. The same can be viewed at the link below.

(a) Facebook link https://www.facebook.com/inaehq1

(b) Twitter handle link https://twitter.com/inaehq1

Back to Main Page

Obituaries

Dr Gade Padmanabham

(August 10, 1964 - June 4, 2021)

Dr Gade Padmanabham, FNAE, Director, International Advanced Research Centre for Powder Metallurgy and Newmaterials (ARCI), Hyderabad pursued BE in Mech Engg from Andhra University, Visakhapatnam and MTech in Industrial Metallurgy at National Institute of Technology-Warangal. He worked on Metal-Ceramic Joining and Weldability of Al-Li alloys at IIT-Delhi and Technical University, Dresden, as German Academic Exchange Service-DAAD Fellow, earning PhD from IIT-Delhi.

Dr Padmanabham started his career as Deputy Manager with Bharat Dynamics Ltd, Hyderabad in 1987 and worked on indigenization of materials for strategic products. He joined Department of Science and Technology (DST) as Scientist-C in 1990 and became Scientist-G in 2006. He dealt with implementation of National Superconductivity programme, intelligent processing of materials and superconductor based magnetic resonance imaging materials. As a Nodal Officer, he coordinated establishment of Indo-Soviet Advanced Research Centre for Powder Metallurgy. He steered international joint S&T programs in the areas of engineering materials, electronic materials, applied mechanics, etc., with Belarus, Germany, Israel, Japan, Sweden and Switzerland for R&D, including doctoral/ post-doctoral fellowships in Japan and Germany. His efforts ensured engagement of Indian scientists for working on ultra-high voltage transmission electron microscopy, photon factory and super photon ring in Japan. Other such initiatives lead to creation of Centre for Laser Processing of Materials with Israel and use of mega research facilities at National Laboratory for High Energy Physics, Spring-8 Accelerators and Construction of Indian beam line in Japan. He leveraged his contacts in Germany for the benefit of Indian researchers in using state of the art facilities at German Electron Synchrotron, Berlin Electron Storage Ring Society, Facility for Antiproton and Ion Research, besides launching DST-DAAD Personnel Exchange Program, DST-German Research Foundation cooperation and DST-Max Planck partnership in niche areas, interaction of young Indian scientists with Nobel Laureates in Lindau, etc., in Germany.

Dr Padmanabham, on the request of ARCI, went on deputation as Scientist-G in 2005 to ARCI, where he did pioneering work on laser processing of materials, Sol-Gel nanocomposite coatings, carbon materials, etc. His stellar contributions transformed the Laser Centre as a unique facility for addressing complex problems through robotic brazing, high precision welding, micromachining and additive manufacturing for application in automotive, aerospace, nuclear, power, defense and electronics sectors. The group lead by him developed transparent ceramics and also successfully transferred infra-red dome technology for strategic sector. He reoriented the sol-gel nanocomposite group focusing on solar selective coatings, anti-tarnish coatings, architectural coatings and corrosion resistant coatings. His foray into carbon materials perfected different techniques of producing carbon nanotubes, and successfully integrated with the laser group in achieving high field emission properties for strategic applications, a unique attempt proved successful at the field level. He conceptualized and implemented multi-institutional consortia projects, involving IITs, original equipment manufacturers of automotive components, Fraunhofer institutes of Germany and private entities in developing a unique technique that combined laser welding and cold metal transfer brazing for tailor welded blanks and multi-material lightweight components. His concerted efforts resulted in development of Silica based aerogel sheets

for insulation applications, Sol-Gel Nanocomposite Coatings for colored glass, Zinc Sulphide infra-red transparent ceramics for strategic applications and Nanotitania for self-cleaning applications, with superior quality and close tolerances as compared to other processes. He and his team perfected many processes and transferred the same to a few enterprises.

After taking over as Director of ARCI in 2016, Dr Padmanabham provided overall leadership for successful development of technologies in the fields of engineering materials and additive manufacturing and its transfer to industry. He steered extramural and research-based consultancy projects on nanomaterials and nano-composite coatings, engineered coatings, ceramic processing, laser based manufacturing, automotive energy materials, solar energy materials and carbon materials through the value chain of conceptualization to commercialization. The clear focus on cutting edge technology driven initiatives for commercialization, with simultaneous development of specialized human resources for industry, lead ARCI as a premier institution winning many laurels. He ensured technology transfer and product supply activities to civilian and strategic sectors through establishing streamlined processes, appropriate costing of projects, development of intellectual property indices for scientists for engaging technology receivers, enhanced outreach through appropriate marketing strategies, etc. He, in collaboration with National Research Council of Canada, Fraunhofer Institutes of Germany, set up technology demonstration centers for extending value added services.

Dr Padmanabham successfully implemented 30 Extramural research projects and research based consultancy projects, supported by various funding agencies and industry, at a cumulative cost of Rs 85 Crore. He facilitated transfer of 18 technologies benefiting many stakeholders thus generating revenue for ARCI. He successfully guided 8 doctoral theses and over 30 Masters theses. He published 110 journal papers, presented 155 papers in conferences, contributed 8 book chapters and edited a book. He was on the Editorial Board and Reviewer of 8 reputed journals. He was granted 14 patents within India, Australia, Europe and USA. For the outstanding achievements, he was bestowed many awards, the most significant being, Abdul Kalam Technology Innovation National Fellowship by INAE, Materials Research Society of India Medal, Distinguished Alumnus Award by NIT-Warangal, Lifetime Achievement Award by SAE India, SP Luthra Lecture Award by The Institution of Engineers (India) and AP Scientist Award by Govt of AP. He was elected as a Fellow of National Academy of Sciences India, Indian National Academy of Engineering, AP Akademi of Sciences and Telangana Academy of Sciences. He was Chairman/Member of many scientific committees and Governing Council/Research Council of academic/R&D institutions.

Dr Padmanabham is well remembered for integrating many Indian and overseas researchers in academia, R&D Labs and Industry in addressing some of the technology intensive problems across the globe. With positive and ever helping attitude, he strongly believed in widening R&D base. He delivered numerous talks at many institutions enthusing faculty for taking up research and also offered facilities in ARCI to the faculty and scholars from less endowed institutions in embarking upon R&D. With the sad and untimely demise of Dr Padmanabham, due to coronavirus, in a hospital in USA on 3.6.2021, scientific fraternity, in particular ARCI and DST, have lost one of the most capable materials scientists of high calibre, who represented India's emerging technological front. He left behind his mother, wife, a daughter and son-in-law and a son plus two grandchildren. We pray almighty to shower blessings on the departed soul and also grant moral strength to members of his family to bear this loss.

May God Bless his Soul to Rest in Peace

Written by Dr DR Prasada Raju

Mr J Jayaraman

(November 19, 1940 - May 29, 2021)

Mr J Jayaraman, FNAE Formerly Scientist G, Associate Director, Aeronautical Development Establishment (ADE), Bangalore born on November 19, 1940 passed away on May 29, 2021. He had made significant Research & Development contributions in the areas of Mechanical Engineering Systems and Airframe Design including development of metallic and composite airframes of UAVs. He made contributions in evolving and promoting integrated system design concepts for UAVs and contributed towards the development of the Pilotless Target Aircraft- Lakshya by Aeronautical Development Establishment as Project Director, leading to its successful completion and induction by Air Force. He received Dr VM Ghatge's Design Award of Aeronautical Society of India in 1991 and DRDO Scientist of the year award for 1994 for Flight Sciences. In addition, he was a joint recipient of DRDO cash awards for Design & Development of Reusable rocket pod in 1985 and in 1986. He was also a Fellow of Aeronautical Society of India and Institution of Engineers India

May God Bless his Soul to Rest in Peace

Dr. Sudhir B Koganti

(June 15, 1949 – June 7, 2021)

Dr Sudhir B Koganti, FNAE formerly Head, RR&DD, Indira Gandhi Centre for Atomic Research (IGCAR), Kalpakkam born on June 15, 1949 passed away on June 7, 2021. He had made significant research contributions in the areas of Separation Technology and Multiphase Flow. He made several innovative contributions towards the equipment development, multi-phase flow and modelling aspects of solvent extraction for spent fuel reprocessing of Uranium, Plutonium carbide fuel that has undergone burn up in Fast Breeder Reactor. The important equipment developed include a single pin shear unit, high capacity feed clarifier, rotary semi continuous dissolver, fast centrifugal contactors, novel high efficiency air pulsed ejector mixed settler (HEMS), electrolytic ejector mixer settler, a radial pulsed column, no maintenance fluidic pumps and constant volume feeders. His contributions paved the way to formulate the analysis code (SIMPEX) for high Plutonium content. He was also responsible for the development of a design and simulation code for analysing the displacement chromatography for the production of enriched B-10, a strategic material. His work was highly relevant to the strategic area of nuclear fuel reprocessing.

May God bless his soul to Rest in Peace

Back to Main Page

Engineering And Technology Updates

Civil Engineering

1. Acoustic solutions made from natural fibres can reduce buildings' carbon footprint

Good acoustics in the workspace improve work efficiency and productivity, which is one of the reasons why acoustic materials matter. Researchers at Aalto University, in collaboration with Finnish acoustics company Lumir, have now studied how these common elements around us could become more eco-friendly, with the help of cellulose fibres. Cucharero's research explores the effect of natural fibres' properties on sound absorption and how these fibres can be used in room acoustics. Synthetic fibres, such as fibreglass and rockwool, are uniform in quality. Cellulose fibres have a complex structure with natural irregularities, which can be an asset for absorbing sound indoors. The origin of fibres also seems to matter: his research has found that hardwood fibres absorb sound better than softwood fibres. Based on the research, this can be attributed to the smaller dimensions of the hardwood fibres. In addition to their excellent acoustic properties, cellulose fibres also have positive environmental impacts compared to traditional acoustic materials. The production of cellulose fibres is considerably more energy-efficient, and the fibres also absorb significant amounts of carbon dioxide from the atmosphere. Using the fibre in construction materials is an effective way to store carbon: buildings last for decades, unlike single-use packaging and paper where cellulose is typically used.

'Acoustics solutions based on cellulose fibres can be applied to a wide range of facilities. For example, acoustic sprays -- which can be used on any surface to create a porous, sound-absorbing layer -- can significantly improve the comfort of buildings under renovation without changing their visual appearance,' Cucharero says. Alongside his doctoral dissertation, Jose Cucharero works at Lumir Oy, which produces acoustic solutions in line with the principles of the circular economy. The results of the dissertation are used in the development of new cellulose-based acoustics solutions, and the study has been rapidly applied in product development. The commercial perspective is also complemented by tests that ensure the products' scalable manufacturing and fire resistance. Based on the results, an industrially scalable process has been developed for the production of acoustic panels based on cellulose fibres.

Source https://www.sciencedaily.com/releases/2021/06/210602130336.htm

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2. Researchers can turn a single photo into a video

Sometimes photos cannot truly capture a scene. How much more epic would that vacation photo of Niagara Falls be if the water were moving? Researchers at the University of Washington have developed a deep learning method that can do just that: If given a single photo of a waterfall, the system creates a video showing that water cascading down. All that's missing is the roar of the water and the feeling of the spray on your face. The team's method can animate any flowing material, including smoke and clouds. This technique produces a short video that loops seamlessly, giving the impression of endless movement. Developing a method that turns a single photo into a believable video has been a challenge for the field. The team's system consists of two parts: First, it predicts how things were moving when a photo was taken, and then uses that information to create the animation. To estimate motion, the team trained a neural network with thousands of videos of waterfalls, rivers, oceans and other material with fluid motion. The training process consisted of asking the network to guess the motion of a video when only given the first frame. After comparing its prediction with the actual video, the network learned to identify clues -- ripples in a stream, for example -- to help it predict what happened next. Then the team's system uses that information to determine if and how each pixel should move. The researchers tried to use a technique called "splatting" to animate the photo. This method moves each pixel according to its predicted motion. But this created a problem. "Think about a flowing waterfall," a researcher said. "If you just move the pixels down the waterfall, after a few frames of the video, you'll have no pixels at the top!" So the team created "symmetric splatting." Essentially, the method predicts both the future and the past for an image and then combines them into one animation. "Looking back at the waterfall example, if we move into the past, the pixels will move up the waterfall. So we will start to see a hole near the bottom," a lead researcher said. "We integrate information from both of these animations so there are never any glaringly large holes in our warped images." Finally, the researchers wanted their animation to loop seamlessly to create a look of continuous movement. The animation network follows a few tricks to keep things clean, including transitioning different parts of the frame at different times and deciding how quickly or slowly to blend each pixel depending on its surroundings. The team's method works best for objects with predictable fluid motion. Currently, the technology struggles to predict how reflections should move or how water distorts the appearance of objects beneath it. "When we see a waterfall, we know how the water should behave. The same is true for fire or smoke. These types of motions obey the same set of physical laws, and there are usually cues in the image that tell us how things should be moving," the lead researcher said. "We'd love to extend our work to operate on a wider range of objects, like animating a person's hair blowing in the wind. I'm hoping that eventually the pictures that we share with our friends and family won't be static images. Instead, they'll all be dynamic animations like the ones our method produces."

Source https://www.sciencedaily.com/releases/2021/06/210615132305.htm

Mechanical Engineering

3. **Innovative Batteries Put Flying Cars on The Horizon**

Jet packs, robot maids and flying cars were all promises for the 21st century. We got mechanized, autonomous vacuum cleaners instead. Now a team of Penn State researchers are exploring the requirements for electric vertical takeoff and landing (eVTOL) vehicles and designing and testing potential battery power sources. "I think flying cars have the potential to eliminate a lot of time and increase productivity and open the sky corridors to transportation," said Chao-Yang Wang, holder of the William E. Diefender Chair of Mechanical Engineering and director of the Electrochemical Engine Center, Penn State. "But electric vertical takeoff and landing vehicles are very challenging technology for the batteries." "Batteries for flying cars need very high energy density so that you can stay in the air," said Wang. "And they also need very high-power during take-off and landing. It requires a lot of power to go vertically up and down." Wang notes that the batteries will also need to be rapidly recharged so that there could be high revenue during rush hours. He sees these vehicles having frequent take-offs and landings and recharging quickly and often. "Commercially, I would expect these vehicles to make 15 trips, twice a day during rush hour to justify the cost of the vehicles," said Wang. "The first use will probably be from a city to an airport carrying three to four people about 50 miles." Weight is also a consideration for these batteries as the vehicle will have to lift and land the batteries. Once the eVTOL takes off, on short trips the average speed would be 100 miles per hour and long trips would average 200 miles per hour, according to Wang. The researchers experimentally tested two energy-dense lithium-ion batteries that can recharge with enough energy for a 50-mile eVTOL trip in five to ten minutes. These batteries could sustain more than 2,000 fast-charges over their lifetime. Wang and his team used technology they have been working on for electric vehicle batteries. The key is to heat the battery to allow rapid charging without the formation of lithium spikes that damage the battery and are dangerous. It turns out that heating the battery also allows rapid discharge of the energy held in the battery to allow for take offs and landings. The researchers heat the batteries by incorporating a nickel foil that brings the battery rapidly to 140 degrees Fahrenheit. "Under normal circumstances, the three attributes necessary for an eVTOL battery work against each other," said Wang. "High energy density reduces fast charging and fast charging usually reduces the number of possible recharge cycles. But we are able to do all three in a single battery." One entirely unique aspect of flying cars is that the batteries must always retain some charge. Unlike cellphone batteries, for example, that work best if fully discharged and recharged, a flying car battery can never be allowed to completely discharge in the air because power is needed to stay in the air and to land. There always needs to be a margin of safety in a flying car battery. When a battery is empty, internal resistance to charging is low, but the higher the remaining charge, the more difficult it is to push more energy into the battery. Typically, recharging slows as the battery fills. However, by heating the battery, recharging can remain in the five- to ten-minute range. "I hope that the work we have done in this paper will give people a solid idea that we don't need another 20 years to finally get these vehicles," said Wang. "I believe we have demonstrated that the eVTOL is commercially viable.

Source https://www.sciencedaily.com/releases/2021/06/210607161204.htm

4. Nanomaterials with laser printing

An interdisciplinary team from the Max Planck Institute of Colloids and Interfaces present for the first time a laser-driven technology that enables them to create nanoparticles such as copper, cobalt and nickel oxides. At the usual printing speed, photoelectrodes are produced in this way, for example, for a wide range of applications such as the generation of green hydrogen. Previous methods produce such nanomaterials only with high energy input in classical reaction vessels and in many hours. With the laser-driven technology developed at the institute, the scientists can deposit small amounts of material on a surface and simultaneously perform chemical synthesis in a very short time using high temperatures from the laser. The discovery turned into a new and environmentally friendly method for synthesizing materials that can, among other things, efficiently convert solar energy into electricity. Without detours with sunlight to hydrogen: 'Nowadays most of green hydrogen is produced from water using electricity generated by solar panels and stored in batteries. By employing photoelectrodes we can use solar light directly,' says researcher Dr. Aleksandr Savateev. The newly developed principle works with so-called transition metal oxides, mainly copper, cobalt and nickel oxides, all of which are good catalysts. The special feature of these oxides is the variety of their crystal forms (nanocrystals such as nanorods or nanostars), which affect their surface energy. Each structure can have a different effect on catalytic reactions. Therefore, it is important that these nanostructures can be made targeted -- or even untargeted, but repeatable. The developed technology could also be used to find quickly and efficiently new catalysts. 'Laser dot by laser dot, we can create different catalysts side by side by simply varying the composition and conditions, and then also test them in parallel right away,' says Dr. Felix Löffler adding, 'But now we need to work on making the catalyst systems more persistent in all applications'. Similar to the principle of a typewriter, material is transferred from a donor to an acceptor carrier. On the former is the 'ink', a solid polymer, which is mixed with metal salts, the latter consists of a thin carbon nitride film on a conductive electrode. Targeted laser irradiation transfers the salts to the acceptor along with the molten polymer. The brief high temperatures cause the salts to react within milliseconds and they transform into metal oxide nanoparticles with desired morphology.

Source https://www.sciencedaily.com/releases/2021/06/210602130326.htm

Electrical Engineering

5. Engineers Devise Novel Approach to Wirelessly Power Wearable Devices

Advancements in wearable technology are reshaping the way we live, work and play, and also how healthcare is delivered and received. Wearables that have weaved their way into everyday life include smart watches and wireless earphones, while in the healthcare setting, common devices include wearable injectors, electrocardiogram (ECG) monitoring patches, listening aids, and more. A major pain point facing the use of these wearables is the issue of keeping these devices properly and conveniently powered. As the number of wearables one uses increases, the need to charge multiple batteries rises in tandem, consuming huge amounts of electricity. Many users find it cumbersome to charge numerous devices every day, and inconvenient service disruptions occur when batteries run out. A research team, led by Associate Professor Jerald Yoo from the Department of Electrical and Computer Engineering and the N.1 Institute for Health at the National University of Singapore (NUS), has developed a solution to these problems. Their technology enables a single device, such as a mobile phone placed in the pocket, to wirelessly power other wearable devices on a user's body, using the human body as a medium for power transmission. The team's novel system has an added advantage -- it can harvest unused energy from electronics in a typical home or office environment to power the wearables. To extend battery life and sustain fully autonomous -- yet wireless -- operations of wearable devices, power transmission and energy harvesting approaches are required. However, conventional approaches for powering up body area wearables are limited by the distance that power can be transmitted, the "path" the energy can travel without facing obstacles, and the stability of energy movement. As such, none of the current methods have been able to provide sustainable power to wearables placed around the entire human body. The NUS team decided to turn the tables on these limitations by designing a receiver and transmitter system that uses the very obstacle in wireless powering -- the human body -- as a medium for power transmission and energy harvesting. Each receiver and transmitter contains a chip that is used as a springboard to extend coverage over the entire body.A user just needs to place the transmitter on a single power source, such as the smart watch on a user's wrist, while multiple receivers can be placed anywhere on the person's body. The system then harnesses energy from the source to power multiple wearables on the user's body via a process termed as body-coupled power transmission. In this way, the user will only need to charge one device, and the rest of the gadgets that are worn can simultaneously be powered up from that single source. The team's experiments showed that their system allows a single power source that is fully charged to power up to 10 wearable devices on the body, for a duration of over 10 hours. As a complementary source of power, the NUS team also looked into harvesting energy from the environment. Their research found that typical office and home environments have parasitic electromagnetic (EM) waves that people are exposed to all the time, for instance, from a running laptop. The team's novel receiver scavenges the EM waves from the ambient environment, and through a process referred to as body-coupled powering, the human body is able to harvest this energy to power the wearable devices, regardless of their locations around the body. On the benefits of his team's method, Assoc Prof Yoo said, "Batteries are among the most expensive components in wearable devices, and they add bulk to the design. Our unique system has the potential to omit the need for batteries, thereby enabling manufacturers to miniaturise the gadgets while reducing production cost significantly. More excitingly, without the constraints of batteries, our development can enable the next generation wearable applications, such as ECG patches, gaming accessories, and remote diagnostics."The NUS team will continue to enhance the powering efficiency of their transmitter/receiver system, with hopes that in future, any given power-transmitting device, be it a user's mobile phone or smart watch, can satisfy the network power demands of all other wearables on the body, thus enabling a longer battery lifetime.

Source https://www.sciencedaily.com/releases/2021/06/210614110819.htm

6. 'Privacymic': For A Smart Speaker That Doesn't Eavesdrop

Microphones are perhaps the most common electronic sensor in the world, with an estimated 320 million listening for our commands in the world's smart speakers. The trouble is that they're capable of hearing everything else, too. But now, a team of University of Michigan researchers has developed a system that can inform a smart home -- or listen for the signal that would turn on a smart speaker -- without eavesdropping on audible sound. The key to the device, called PrivacyMic, is ultrasonic sound at frequencies above the range of human hearing. Running dishwashers, computer monitors, even finger snaps, all generate ultrasonic sounds, which have a frequency of 20 kilohertz or higher. We can't hear them -- but dogs, cats and PrivacyMic can. The system pieces together the ultrasonic information that's all around us to identify when its services are needed, and sense what's going on around it. Researchers have demonstrated that it can identify household and office activities with greater than 95% accuracy. PrivacyMic can filter out audible information right on the device. That makes it more secure than encryption or other security measures that take steps to secure audio data after it's recorded or limit who has access to it. Those measures could all leave sensitive information vulnerable to hackers, but with PrivacyMic, the information simply doesn't exist. While smart speakers are an obvious application, the research team envisions many others that, while less common, may be more important. In-home ultrasonic devices, for example, could monitor the homes of the elderly for signs that they need help, monitor lung function in respiratory patients or listen to clinical trial participants for sonic signatures that could reveal medication side effects or other problems. "A conventional microphone placed in somebody's home for months at a time could give doctors richer information than they've ever had before, but patients just aren't willing to do that with today's technology," Sample said. "But an ultrasonic device could give doctors and medical schools unprecedented insight into what their patients' lives are really like in a way that the patients are much more likely to accept." The idea behind PrivacyMic began when the team was classifying previously recorded audio. Looking at a visual graph of the data, they realized that audible sound was only a small piece of what was available. "We realized that we were sitting on a lot of interesting information that was being ignored. We could actually get a picture of what was going on in a home or office without using any audio at all," said Yasha Iravantchi, a graduate student in electrical engineering and computer science and first author on a new paper on the research. Armed with this insight, a laptop and an ultrasonic microphone, the team then went to work capturing audio from tooth brushing, toilet flushing, vacuuming, running dishwashers, using computer monitors and hundreds of other common activities. They then compressed the ultrasonic signatures into smaller files that included key bits of information while stripping out noise within the range of human hearing -- a bit like an ultrasonic MP3 -- and built a Raspberry Pi-based device to listen for them. The device, which can be set to filter out speech or to strip out all audible content, accurately identified common activities more than 95% of the time. The team also conducted a trial where study participants listened to the audio collected by the device and found that not a single participant could make out human speech. While the device is a proof of concept at this stage, Sample says that implementing similar technology in a device like a smart speaker would require only minor modifications -- software that listens for ultrasonic sound and a microphone capable of picking it up, which are inexpensive and readily available. While such a device is likely several years off, the team has applied for patent protection through the U-M Office of Technology Transfer. "Smart technology today is an all-or-nothing proposition. You can either have nothing or you can have a device that's capable of constant audio recording," Sample said. "PrivacyMic offers another layer of privacy -- you can interact with your device using audio if you choose or you can have another setting where the device can glean information without picking up audio."

Source https://www.sciencedaily.com/releases/2021/06/210609084706.htm

Aerospace Engineering

7. Origami-Inspired Antenna Technology for Use in Small Satellites

Modern telecommunication systems rely on satellites to relay signals across the globe quickly and reliably, enabling users to send messages across the world in an instant, watch live television, or – more recently – hold conference calls with global partners right from the kitchen table! Communications satellites use high-frequency radio waves to transmit data, with antennas acting as a two-way interface, converting electric current provided by the transmitter into radio waves, and vice versa when paired with a receiver. Antennas are therefore vital pieces of equipment, without which satellites and ground receivers would be practically useless. However, despite advances in modern satellite design and performance, antenna technology remains a limiting factor for next-generation telecommunications such as 6G. Engineers struggle to miniaturize antennas for nanosatellites without compromising on their cost or performance. For instance, nanosatellites like CubeSats can be as small as a 10 cm3 cube, but manufacturing a communication antenna small enough to be stored inside it during launch and flight is expensive and technologically challenging. "Many high-performance antennas reported for CubeSat systems are deployable, foldable, or inflatable." explains Dr. Sangkil Kim from Pusan National University in South Korea. Recently, Dr. Kim and his colleagues at Pusan National University and the University of Alabama, USA, developed a new deployable antenna for CubeSats used in low-earth orbit (LEO). Interestingly, their design was inspired by the mathematics of "origami," the Japanese art of paper folding -- specifically a field called spatial mapping -- which enabled them to decide on the best geometry for a foldable, deployable antenna. With the design on paper, they set out to manufacture the antenna and test it. With remarkable dimensions of 32.5 mm3 when folded and weighing merely 5 grams, the prototype antenna fits snugly within a CubeSat. The researchers used an inexpensive material to make the bulk of the antenna, using special joints to fold the square boards into a cube, which can easily be stored during launch and flight. Once in orbit, the antenna can be deployed outside of the CubeSat, ready to receive and transmit data. Prof. Kim and his team went one step further and set up different deployment modes, depending on whether satellites needed to communicate with each other or with Earth. "The volume, radiation patterns, and polarizations of the antenna are reconfigurable according to the required operation mode," Dr. Kim explains. This configuration enabled the researchers to optimize the antenna's performance for each type of communication. With such promising results, the scientists hope their design will inspire future deployable designs for nanosatellite antenna technology and pave the way for next-generation communication systems, such as 6G. Not only will their prototype reduce the cost of future nanosatellites and improve their overall performance, but it can also be scaled up to larger satellites in geostationary orbit and other communication platforms on Earth..

Source: https://www.sciencedaily.com/releases/2021/02/210211113922.htm

Mining, Metallurgical and Materials Engineering

8. Inkjet Printing Show Promise as New Strategy for Making E-Textiles, Study Finds

In a new study, North Carolina State University researchers demonstrated they could print layers of electrically conductive ink on polyester fabric to make an e-textile that could be used in the design of future wearable devices. Since the printing method can be completed at room temperature and in normal atmospheric conditions, researchers believe inkjet printing could offer a simpler and more effective method of manufacturing electronic textiles, also known as e-textiles. In addition, researchers said the findings suggest they could extend techniques common in the flexible electronic industry to textile manufacturing. "Inkjet printing is a rapidly advancing new technology that's used in flexible electronics to make films used in cellphone displays and other devices," said the study's corresponding author Jesse S. Jur, professor of textile engineering, chemistry and science at NC State. "We think this printing method, which uses materials and processes that are common in both the electronics and textiles industries, also shows promise for making e-textiles for wearable devices." In the study, researchers described how they used a FUJIFILM Dimatix inkjet printer to create a durable and flexible e-textile material, what they did to reliably create the e-textile, and its properties. Part of their challenge was to find the right composition of materials, so the liquid ink would not seep through the porous surface of the textile materials and lose its ability to conduct electricity. They created the e-textile by printing layers of electrically conductive silver ink like a sandwich around layers of two liquid materials, which acted as insulators. They printed those sandwich layers on top of a woven polyester fabric. After they printed the layers of silver ink and insulating materials -- made of urethane-acrylate, and poly(4-vinylphenol) -- they monitored the surface of the material using a microscope. They found that the chemical properties of the insulating materials, as well as of the textile yarns, were important to maintaining the ability of the liquid silver ink to conduct electricity, and prevent it from penetrating through the porous fabric. "We wanted a robust insulation layer in the middle, but we wanted to keep it as thin as possible to have the entire structure thin, and have the electric performance as high as possible," Kim said. "Also, if they are too bulky, people will not want to wear them." The researchers evaluated the electrical performance of the e-textile after they bent the material multiple times. They tested more than 100 cycles of bending, finding the e-textile didn't lose its electrical performance. In future work, they want to improve the materials' electrical performance compared to e-textiles created using methods that require special facilities and atmospheric conditions, as well as increase the material's breathability. Eventually, they want to use the printing method to create an e-textile that could be used in wearable electronics such as biomedical devices that could track heart rate, or used as a battery to store power for electronic devices. "We were able to coat the ink on the fabric in a multi-layer material that's both durable and flexible," Kim said. "The beauty of this is, we did everything with an inkjet printer -- we didn't use any lamination or other methodologies."

Source https://www.sciencedaily.com/releases/2021/06/210616094101.htm

9. China's 'Artificial Sun' burns at 120 mn degree Celsius: Scientists replicate Sun's fusion reaction on Earth

The core of the Sun burns at 15 million degrees Celsius by nuclear fusion of hydrogen nuclei into helium, but now scientists have designed an 'Artificial Sun' on Earth that has sustained a temperature of 120 million degrees Celsius. The Experimental Advanced Superconducting Tokamak (EAST) fusion reactor designed by China burns at eight times the Sun's core temperature. The reactor broke the record by reaching a plasma temperature of 120 million degree Celsius for 101 seconds and 160 million Celsius for 20 seconds. Located at the Hefei Institutes of Physical Science of the Chinese Academy of Sciences, the reactor has been designed to replicate the nuclear fusion process that occurs naturally in the sun and stars to provide almost infinite clean energy. In a fusion reaction, two light nuclei merge to form a single heavier nucleus. The process releases energy because the total mass of the resulting single nucleus is less than the mass of the two original nuclei. The leftover mass becomes energy. In a bid to push for clean energy and reach such high temperatures, hydrogen isotopes are placed inside a fusion device to create a plasma state where ions and electrons are separated. During the process, ions are heated and maintained at high temperatures. China's EAST reactor had previously reached 100 million degrees Celsius in 2018. According to Global Times, EAST is part of the International Thermonuclear Experimental Reactor (ITER) facility, which is a global science project jointly constructed by China, the EU, India, Japan, South Korea, Russia and the US. While the reactor has already made a massive record, scientists believe it will at least take another decade for a fully functional reactor to take shape from the experimental design. The experimental reactor's main goal is to create nuclear fusion like the Sun, using deuterium from the sea to provide a steady stream of clean energy. Around 300 scientists and engineers mobilised to support the operation of the doughnut-shaped experiment facility, which includes a vacuum system, RF wave system, laser scattering system, and microwave system, Xinhua reported. Scientists had begun upgrading the experimental reactor for about a year to reach higher temperatures. The raw material required to generate energy in the reactor is deuterium, which is found in abundance on Earth unlike other non-renewable sources like coal and oil. According to research, through fusion reaction deuterium in one litre of seawater can produce the amount of energy equivalent to 300 litres of gasoline. Previously, EAST had generated an electron temperature of 100 million degrees Celsius in its core plasma in November 2018, which is seven times the temperature that is experienced at the core of the Sun. The reactor had sustained the 100 million degrees Celsius temperature for 20 seconds in 2020 as well. The experimental reactor first began operations in 2006 and has since been one of the key sources for research around fusion. With the world switching towards green energy, the fusion reactor once operational could pave the way for a clean source of an unlimited supply of energy.

Source https://www.indiatoday.in/science/story/explained-china-s-artificial-sun-nuclear-fusion-clean-energy-renewables-1810740-2021-06-04

10. Researchers 3D Print Rotating Microfilter for Lab-On-A-Chip Applications

Researchers have fabricated a magnetically driven rotary microfilter that can be used to filter particles inside a microfluidic device. They made the tiny turning filter by creating a magnetic material that could be used with a very precise 3D printing technique known as two-photon polymerization. Microfluidic devices, also known as lab-on-a-chip devices, can be used to perform multiple laboratory functions inside a chip that usually measures a few square centimeters or less. These devices contain intricate networks of microfluidic channels and are becoming more and more complex. They may be useful for a variety of applications such as screening molecules for therapeutic potential or performing blood tests that detect disease. "By changing the direction of external magnetic field, the microfilter we made can be remotely manipulated on demand to either filter certain-sized particles or to allow them all to pass," said Dong Wu, a member of the research team from the University of Science and Technology of China. "This functionality could be used for many types of chemical and biological studies performed in lab-on-a-chip devices and, importantly, makes it possible for the chips to be reused." The researchers have shown that their new rotary microfilter filters can sort particles in a microfluidic device with high performance. "This filter could eventually be used to sort cells of different sizes for applications such as isolating circulating tumour cells for analysis or detecting abnormally large cells that may indicate disease," said Chaowei Wang from University of Science and Technology of China. "With further development it might even be possible to use it in devices placed inside the body for cancer detection." Filters with micrometer-sized holes are often used in microfluidic chips as a passive way to sort particles or cells based on sizes of the holes. However, because the number and shape of holes in the filter cannot be dynamically changed, available devices lack the flexibility to sort different types of particles or cells on demand. To expand the usefulness of microfluidic devices, the researchers developed a filter that can freely switch between modes such as selective filtering and passing. They created the new filter using two-photon polymerization, which uses a focused femtosecond laser beam to solidify, or polymerize, a liquid light-sensitive material known as photoresist. Thanks to two-photon absorption, the polymerization can be done in a very precise manner, enabling fabrication of complex structures on the micron scale. To make the microfilter, the researchers synthesized magnetic nanoparticles and mixed them with the photoresist. Fabricating the rotary microfilter required them to optimize the laser power density, number of pulses and scanning intervals used for polymerization. After testing its magnetically driven properties on a glass slide, they integrated the microfilter into a microfluidic device. To filter larger particles, a magnetic field perpendicular to the microchannel is applied. After the filtering process is complete, the large particles can be released by applying a magnetic field that is parallel to the microchannel, which will rotate the microfilter by 90°. The filtering process can then be repeated as needed. The researchers verified the filtering performance of the filter using polystyrene particles with diameters of 8.0 and 2.5 microns that were mixed in an alcohol solution. "It was clear that particles smaller than the pore size easily passed through microfilter while bigger ones were filtered out," said Chenchu Zhang from University of Science and Technology of China. "When in passing mode, any larger particles captured by the filter were washed away with the fluid, which prevents filter clogging and allows reuse of the microfilter."

Source https://www.sciencedaily.com/releases/2021/06/210615145607.htm

Back to Main Page

ENGINEERING INNOVATION IN INDIA

ISRO contributes to India's COVID-19 Fight with Low-Cost, Advanced Ventilators and Oxygen Contractors

The first and second waves of COVID-19 have affected the schedule of the core space-related activities at ISRO, but, its scientists have been immensely contributing to the country's fight against the pandemic by developing crucial medical equipment such as ventilators, oxygen concentrators etc.

Dr S. Somanath, Director, Vikram Sarabhai Space Center (VSSC), Thiruvananthapuram, elucidated on the in-house medical technologies that are ready for industry adoption, free of cost. Under the series 'Prana', three variants of ventilators that are fitted with displays and controls, have been developed by the ISRO teams from VSSC, based on modifications to existing designs and also based on their own unique, patented designs. The first one is similar to the Ambu-bags (artificial manual breathing unit), but this home-grown variant can deliver a good amount of volume and pressure, thanks to its unique design and proper actuation system. A high-end ventilator, with pneumatic regulation (operated by air under pressure), has also been developed by this team and this offering is said to cost around Rs 1 lakh, which is just about half or one-third the price of similar industry offerings. The most unique of them all is a ventilator that does not require power or an electric motor, drive. Using compressed air and certain other technological features, it can facilitate the inhale-exhale cycle. In designing and developing the Oxygen Concentrator- 'Shwaas', ISRO took some valuable lessons from the country's upcoming human spaceflight programme Gaganyaan, for which they were developing Carbon Dioxide removal systems. Despite the technology of oxygen concentrators being well-known and established, the vast majority of the oxygen concentrators being used in India are imported ones. Hence, ISRO focussed on engineering one with a unique technology that absorbs nitrogen (the largest constituent gas) from the air using molecular absorption. Simply put, the air is pumped through a chemical column, which absorbs the nitrogen and provides oxygen of around 95% purity. This equipment can function non-stop for up to a year, following which the chemical used in the absorption process (which is available in the market) will have to be replaced. With the capability to provide 10 litres of Oxygen per minute, it can simultaneously provide support for two regular patients or one critical patient. The prototype of this variant is already in operation at the VSSC hospital and it is expected to cost no more than Rs.50,000.

ISRO has also been providing liquid oxygen to State Governments in Kerala, Tamil Nadu and Andhra Pradesh, from their manufacturing facilities or from existing stock. It is important to note that Liquid Oxygen, known as (Lox) in aerospace parlance, is a crucial resource for any modern space agency, as it is used as an oxidizer in cryogenic engines that power large rockets. ISRO Propulsion Complex (IPRC) in Mahendragiri, Tamil Nadu, which is responsible for the production of Cryogenic fuels has been supplying liquid Oxygen to the State Governments in Tamil Nadu and adjoining Kerala. ISRO has also

provided the large capacity fuel tanks at their facilities to be repurposed and used as stores of liquid oxygen in various states. These tanks serve as a hub for mass storage of liquid oxygen, following which they can be distributed to the healthcare facilities in the region.

Source https://zeenews.india.com/india/exclusive-isro-contributes-to-indias-covid-19-fight-with-low-cost-advanced-ventilators-and-oxygen-contractors-2362085.html

Back to Main Page