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 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.

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ACADEMY ACTIVITIES

Academy News (Covering period from January 1, 2024 to April 30, 2024)

Joint Activities with erstwhile Science and Engineering Research Board (SERB) (which has now merged with Anusandhan National Research Foundation (ANRF)

I. SERB-INAE Collaborative Initiative in Engineering

INAE jointly with SERB had taken a new initiative in the year 2022 to conduct various events under SERB-INAE Collaborative Initiative in Engineering. As an outcome, the following four initiatives under the umbrella of 'Collaborative Initiative in Engineering' were organized during this year.

a. SERB-INAE Conclaves on *Atmanirbhar* Technologies - Engineering Secured Future
b. SERB-INAE Woman Engineers Program
c. SERB-INAE Outreach Programs for NE, J&K and Ladakh
d. SERB-INAE Innovation Hackathon

INAE has received a tremendous response and the initiative has progressed well with the conduct the above listed events efficiently under all the four verticals. The events/programs organized during the period January to April 2024 are given below:

a) SERB-INAE Conclaves on *Atmanirbhar* Technologies - Engineering Secured Future

No event was held under this sub-head during the period Jan to Mar 2024

b) SERB-INAE Woman Engineers Program

(i) **Workshop on 'Sustainability in Water & Environment' under the aegis of SERB-INAE Collaborative Initiative in Engineering at Indian Institute of Technology (BHU), Varanasi**

Indian National Academy of Engineering (INAE) and Science and Engineering Research Board (SERB), DST in collaboration with IIT (BHU) organized a workshop on 'Sustainability in Water & Environment' on February 26 and 27, 2024. Thirty (30) young women engineers (< 45 years of age) from Engineering and Technological Institutions/Universities covering eight Northern India states (Uttar Pradesh, Uttarakhand, Himachal Pradesh, Jammu & Kashmir, Ladakh, Punjab, Haryana, Bihar) participated in this workshop. Keeping in mind the large footfall of pilgrimages and tourists, sessions on 'Water and Environment' were planned, covered various engineering-based technological solutions to mitigate the problem of pollution (including in the river Ganges) due to various wastes, emission from vehicles, etc. Eminent speakers delivered lectures highlighting their research work to address the above-mentioned challenges. The participants not only gained knowledge on such advanced technologies, but also were equipped to carry out similar research in their own institutes. At the end of each session, the participants were divided into smaller group to encourage them discuss the problems and challenges, pertaining to the topic of each session. They also made short presentation on the same at the end of the session, based on which deliberations were done to come up with research ideas with the goal of better/improved sustainability solutions for this region. Further details are given below.

The overall program coordinator on behalf of INAE was Dr Sharmila Mande, FNAE, Advisor, TCS Life Sciences Research, Ayush Distinguished Scientist Chair, Ministry of Ayush, GoI. The Resource Persons for 26th February were Prof Ligy Philip, FNAE, IIT Madras, Prof MM Ghangrekar, FNAE, IIT Kharagpur, Dr Swadha Anand, TCS Research Pune and Prof Sachchinanda N Tripathi, FNAE from IIT Kanpur. For the second day, the resource persons were Dr VM Tiwari, CSIR-NIST, Prof Suparna Mukherji, FNAE, IIT Bombay, Prof Prasenjit Mondal, IIT Roorkee and Prof PK Mishra, IIT BHU. The final two talks were chaired by Prof SN Upadhyay, FNAE, Professor Emeritus at Department of Chemical Engineering & Technology at IIT, BHU.

The program consisted of an inaugural session in which after the welcome address by Prof PK Mishra, IIT BHU, Lt Col Shobhit Rai (Retd), Officiating Executive Director, INAE delivered an address on INAE and its schemes for engineers. Dr Sharmila Mande elaborated about the program on the said Workshop on Sustainability in Water & Environment and vote of thanks was delivered by Dr Bhawna Verma of IIT BHU. Over the duration of these two days, 30 women delegates in engineering profession from various institutes across India participated in the said workshop. They layout of the program included a brain storming session by the delegates who were divided into four groups in, where in, after an hour of internal deliberations, each of the four groups presented possible solutions to live engineering challenges related to water and environment and their solutions were vetted by the resource persons and were offered pertinent suggestions to sharpen their solutions. Further, each group was then given time to further distil their proposals and submit the final two-page solutions to the resource persons within 10 days of the conclusion of the Workshop, wherein the best proposed solution was awarded a certificate.

Resource persons addressing the women engineers during the two-day workshop at IIT BHU

Group Photograph of Delegates at IIT BHU

All the delegates were put through team building exercises wherein each of them was carefully placed in four groups so that they are from different institutes and diverse technical background so that each could contribute in a multi-disciplinary approach to engineering problem solving. The program concluded with a valedictory session in which Prof PK Tiwari and Dr Sharmila Mande summarizing the

event and summarizing the gains which accrued from this two-day workshop with thanks to erstwhile SERB, DST; INAE and IIT BHU for extending all the help. Certificates of participation were presented to all the delegates by the resource persons and each of the delegates were invited to speak briefly on the conduct of the workshop to summarize their gains and take feedback for improving the program further. For a detailed report on the workshop **click here ….**

c) SERB-INAE Outreach Programs for NE, J&K and Ladakh

(i) Two days' Workshop on "Skilling, Reskilling and Upskilling - Need of the Hour for Self-Reliant India" held at NIT Srinagar during March 4-5, 2024

Indian National Academy of Engineering (INAE) in association with Science and Engineering Research Board organized a two days' workshop of two days' workshop on "Skilling, Reskilling and Upskilling - Need of the Hour for Self-Reliant India" held at NIT Srinagar during March 4-5, 2024. The workshop was organized under the umbrella of SERB-INAE Outreach Program for NE, J&K and Ladakh. The objective of this two-day skill development workshop was to create an eco-system and importance of skilling and upskilling. The aim was to create ecosystem of employability initiatives of youths with special target towards youths and of J&K. The two-day workshop aimed to address these issues and impart knowledge and skill in CNC Milling, CNC Turning, Welding operations (Developing AR-VR-XR based welding training program), 3D printing, EDM (Electric Discharge Machining). This workshop would aim to equip interested students, faculty, professionals, and industrial workers with essential knowledge in advanced machining and welding techniques which is contributing to both academic and industrial excellence as well as enhancing employability. The objective of the workshop was to give basic information of skill development initiatives in these areas which include inculcating competencies such as positive attitude, innovative and entrepreneurial mind set, knowledge enhancement, networking, collaborations etc and to understand the advancements in industrial technology with focus of industry 4.0and 5.0.

In the inaugural session, dignitaries from various sectors converged to underscore the significance of skill development landscape in Jammu and Kashmir. Government officials, educational leaders, and industry experts shared their insights and perspectives on the importance of enhancing employability through specialized initiatives. The session commenced with welcoming remarks, highlighting the collaborative efforts to impart essential skills to the youth and professionals of the region. Keynote speakers emphasized the need for skill-based training in CNC technologies, welding, and allied fields to meet the evolving demands of the job market. Government representatives reaffirmed their commitment to supporting skill development initiatives and fostering an entrepreneurship mindset among participants. The inaugural session set the tone for the training program, inspiring a sense of purpose and determination among attendees to acquire new skills and pursue job opportunities in emerging industries. Following eminent speakers attended the inaugural session Prof. Sivaji Chakravorti, Vice President, INAE, Prof. A. Ravinder Nath, Director, NIT Srinagar, Mr Saurabh Bhagat, Commissioner/Secretary to Govt., Science & Technology Department, Prof. Atikur Rehman, Registrar, NIT Srinagar, Prof. Adnan Qayoom, Head of Department of Mechanical Engineering, NIT Srinagar, Dr. Saad Parvez, Head, IIED Centre, NIT Srinagar. These dignitaries provided valuable insights and expertise, contributing to the comprehensive discussions and sessions held throughout the workshop.

On the culminating day of the workshop, participants and organizers gathered for the valedictory session, marking the conclusion of two days filled with insightful discussions and hands-on learning experiences. The session commenced with words of gratitude and appreciation extended to all stakeholders, including participants, organizers, resource persons, and experts, for their invaluable contributions towards making the workshop a resounding success. As a symbol of recognition and appreciation, tokens of appreciation and certificates were distributed to acknowledge the dedication and effort invested by each individual in enriching the workshop with their insights, expertise, and active participation

Participants attending the sessions during the workshop

Amidst an atmosphere of camaraderie and accomplishment, recipients received their certificates and tokens of appreciation, signifying not only their individual achievements but also their collective commitment to advancing skill development and fostering innovation. The distribution of certificates served as a poignant reminder of the knowledge gained, skills honed, and connections forged throughout the workshop, empowering participants to embark on their professional journeys with renewed confidence and enthusiasm. Additionally, the ceremony provided an opportunity for reflection on the collective achievements and the enduring impact of collaborative efforts in nurturing talent, driving progress, and shaping a brighter future for the nation.

Certificate distribution during Valedictory Session

(ii) **"Workshop on Pedagogy Training for Teaching and Research Excellence" held at Indian Institute of Technology Guwahati during 15th - 16th March 2024**

Indian National Academy of Engineering (INAE) in association Science and Engineering Research Board organized a two days' workshop on "Pedagogy Training for Teaching and Research Excellence" held at Indian Institute of Technology Guwahati during March 15-16, 2024. The workshop was organized under the umbrella of SERB-INAE Outreach Program for NE, J&K and Ladakh. It was a focused workshop for faculties of different institutes to equip them with pedagogy and teaching paradigms for better teaching and communication. Conventional forms of teaching and assessment techniques are sometimes not sufficient to cope up with ever changing modern education. Faculty needs to be equipped with new challenges associated with modern teaching and learning. Faculty training and pedagogy sessions provides a platform for improving teaching learning outcomes. Technology-based teaching and discussion forums are essential tools that can improve student-to-teacher interaction. This workshop aimed to bring faculty teaching in various technical institutes in North East India under one umbrella and share the best practices in teaching and learning.

The topics covered during the subject workshop were:

- Effective classroom management techniques and innovative assessment techniques.
- Need for coexistence of teaching as well as research for achieving academic excellence.
- Social skills necessary for collaboration, professional growth, personnel management.
- Tips for research paper writing, paper reviewing, project proposal writing.
- Use of ICT systems and technologies for effective teaching.
- Tips for introducing Problem Based Learning and Outcome Based Learning.
- Psychological aspects of teaching.

The resource persons of the workshop were Prof. Sivaji Chakravorti, Vice-President, INAE, Prof. Sukumar Nandi, IIT Guwahati, Prof. T. Venkatesh, IIT Guwahati, Dr. Antony Franklin, IIT Hyderabad, Dr. Samit Bhattacharya, IIT Guwahati, Dr. John Jose, IIT Guwahati, Dr. Moumita Patra, Assistant Professor at IIT Guwahati, Dr. Abraham Cyril Issac, IIT Guwahati, Dr. B. Spoorthi, NIT Warangal, Dr. Ruchika Gupta, Chandigarh University.

During the inaugural session held on March 15,2024, the coordinator of the event, Dr. John Jose welcomed the dignitaries and the participants and threw light on the objectives and rationale for organizing the workshop and urged the participants to make optimum utilization of the workshop. The Chief Guest of the Inaugural session was Prof. Sivaji Chakravorti, Vice-President, INAE. Prof. Chakravorti also gave a session on Useful Pointers and Ethics in Writing a Good Technical Paper. Dr. B. Spoorthi gave a talk on Pedagogy in Flux: Navigating Change, Prof. Ruchika Gupta gave a talk on Crafting Effective Connection with Students by Right Communication, Dr. Moumita Patra on Problem based Learning: Ideas for a Self-reflective and Planned Teacher and Prof. Antony Franklin on How to Write Good Project Proposals for Research Funding. On day-two, Dr. Abraham Cyril Issac gave a talk on Authenticity at Work: the precursor to Human Potential Realization and Dr. Samit Bhattacharya's talk was on Channelizing Curiosity to Novelty – Learning to do Empirical Research. Dr. John Jose gave two talks titled Teaching as a Profession - Challenges and Opportunities and How Can You Become and Infectiously Inspiring Teacher. Prof. T. Venkatesh gave the final talk on Good Teaching Practices to Prepare Students for Higher Education Entrance Exams. The workshop was concluded with the valedictory session wherein the participation certificates were distributed, and feedback was collected from the participants who appreciated the event.

Group Photograph of all the Resource Persons, Participants and the organizers

Dignitaries during the Inaugural session held on March 15, 2024

The feedback from all the participants were encouraging and appreciative. The sessions and hospitality were highly appreciated. Most participants demonstrated enthusiasm to attend such workshops for the future and looked forward towards them.

Participants attending the detailed lecture on Day 2

d) SERB-INAE Innovation Hackathon

No event was held under this sub-head during the period Jan to March 2024

II. SERB-INAE Digital Gaming Research Initiative

The SERB, DST-INAE Online and Digital Gaming Research Initiative was launched at the behest of DST as a unique program to leverage Digital Gaming Research and Industry in India and to achieve self-reliance in advanced Augmented Reality (AR)/ Virtual Reality (VR) technologies to create indigenous gaming platforms for a number of applications ranging from education to leisure with the backdrop of Indian Ethos, for desktop and hand-held devices. This initiative is in line with national

priorities. The **SERB, DST-INAE Online and Digital Gaming Research Initiative** launched to leverage Digital Gaming Research and promote such Industry in India is progressing well. Forty-three proposals were received for execution shortly based on the merit of the proposal and guidelines thereof. Presentation Meetings were held on May 26-27, 2023. The experts committee, chaired by Prof PJ Narayanan, FNAE, Director IIIT Hyderabad, recommended deserving proposals for consideration of selection. Based on the recommendation, the Empowered Committee of SERB, DST in its meeting on Aug 4, 2023 approved thirteen proposals. A workshop was held on March 12, 2024 to monitor and review the course of action initiated/planned to be initiated by the PIs. During the workshop PIs were invited to make presentation before the Program Management and Advisory Committee (PMAC) chaired by Prof PJ Narayanan, FNAE.

III. INAE -SERB Abdul Kalam Technology Innovation National Fellowship

Indian National Academy of Engineering (INAE) and Science and Engineering Research Board (SERB), Department of Science and Technology (DST) had launched the INAE-SERB, DST Abdul Kalam Technology Innovation National Fellowship in the year 2017 to recognize, encourage and support translational research by Individuals working in various capacities of engineering profession, in public funded institutions in the country. As per the guidelines of the fellowship, the duration of the Fellowship will be initially for three years, extendable by up to two more years depending on the performance. The fellowship can be held for a maximum of 5 years. All fellowships are reviewed on completion of three years, and if the progress is found to be in line with the proposal, an extension of additional two years is granted to the fellow. Ten new Kalam Fellows were selected for this year on 29-30th August 2023. Altogether, 57 professionals have been conferred this fellowship so far. At present, 43 fellows are on the roll. Several of the translational research projects pursued by these Kalam Fellows have reached the stage of technology transfer and creation of start-ups including filing up of over 91 patents and setting up of a few technology ventures.

INAE Events

INAE's Participation in the IISF 2023- Science, Technology and Innovation Exhibition held from January 17-20, 2023 at Faridabad, Haryana.

In response to an invite from DST, INAE participated in the IISF 2023- Science, Technology and Innovation Exhibition held from January 17-20, 2023 at Faridabad, Haryana, coordinated by DST and the National Innovation Foundation. INAE took up a stall wherein nine posters were exhibited highlighting the background, objectives and major technical activities including joint international events undertaken with the mandate of fostering engineering and technology in the country. The posters of INAE were in consonance with the theme of IISF 2023 viz "Science and Technology Driven Nav Bharat in *Amritkal"*.

Some Glimpses of INAE Stall at IISF-2023

INAE's Stall


Student Visitors at INAE's Stall

National Science Day 2024 Talk by Prof U**day B Desai, Vice President INAE** and Former Director IIT Hyderabad on "Innovations, Entrepreneurship and Creating an Ecosystem" was held on February 28, 2024 in virtual mode. This talk took a 40,000 feet view of how innovations and development in technology are shaping the future of society. The talk also delved into how innovations have historically evolved and what it takes to create an innovations ecosystem. It explored the current evolution of innovations through technologies like artificial intelligence, cyber physical systems, smart mobility, 6G communication, and some more. Then a brief mention of about how an innovative ecosystem can spur deep tech entrepreneurship was made. By and large the talk revolved around digital technologies, which are all pervasive and will remain so for the foreseeable future.

38th INAE Foundation Day Celebrations held on April 22, 2024 at New Delhi

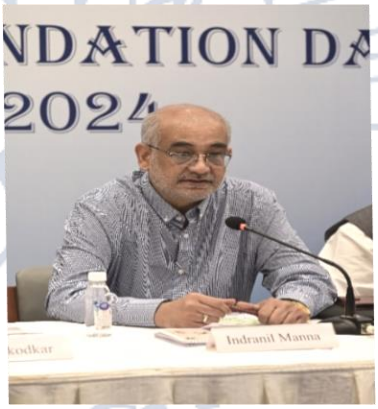
Indian National Academy of Engineering (INAE) was founded on 20th April 1987 to promote excellence in Engineering and Technology (E&T) in the country. INAE celebrates this landmark as its Foundation Day each year to rededicate itself to the professed goals. Accordingly, INAE celebrated its **38th Foundation Day** on **22nd April 2024** in virtual/hybrid mode. Dr. Anil Kakodkar, *FNAE*, Chancellor, HBNI, Mumbai; Former President, INAE, and Former Chairman of Atomic Energy Commission and Secretary to Government of India, Department of Atomic Energy Mumbai was the Chief Guest at the said INAE Function. The celebrations commenced with the delivering of the Welcome Address by Prof. Indranil Manna, President, INAE and Vice Chancellor, Birla Institute of Technology (BIT), Mesra, Ranchi wherein he highlighted the importance of the occasion and gave an overview of the major activities and achievements of the Academy during the last one year. This was followed by the Address by Vice-Presidents of INAE viz Prof. UB Desai, FNAE, Professor Emeritus, IIT Hyderabad, Former Director, Indian Institute of Technology, Hyderabad; Prof. Sivaji Chakravorti, FNAE, Professor, Electrical Engineering Department, Jadavpur University, Kolkata and former Director, NIT Calicut and Mr. JD Patil, FNAE, Member of Executive Committee of Management & Advisor (Defence & Smart Technologies) to L&T Chairman & MD, Larsen & Toubro Limited – Defense, Mumbai who touched upon the important milestones in their concerned areas of responsibilities.

Former Presidents Dr BN Suresh and Dr Sanak Mishra also addressed the online audience with pertinent ideas on the way forward. The Address by Chief Guest, Dr Anil Kakodkar, Chancellor, HBNI, Mumbai; Former President, INAE; and Former Chairman of Atomic Energy Commission and Secretary to Government of India, Department of Atomic Energy was enlightening and informative. He elucidated that the Academy has made its presence felt on the national/international domain and is making strides on the road to fiscal and functional autonomy in line with directives and concerted efforts are ongoing to see that the Academy continues to make a mark in promoting the growth and cause of engineering and technology by furtherance of meaningful activities in line with the objectives. The function was a grand success.

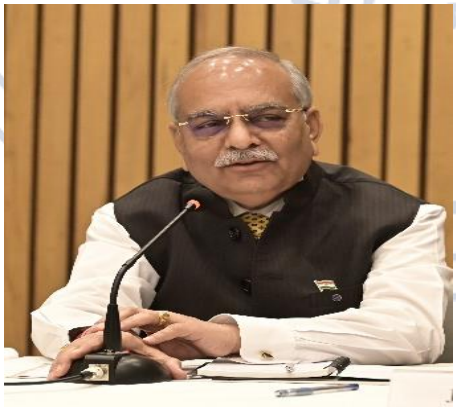
38th INAE Foundation Day Celebrations held on April 22, 2024 at New Delhi

Panelists

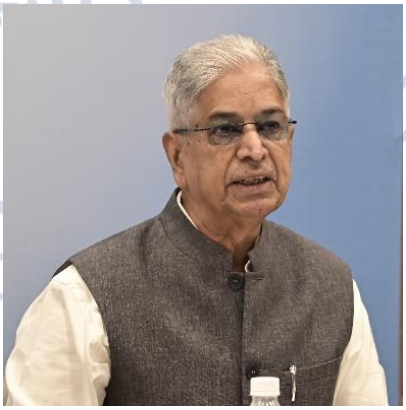
Dr Anil Kakodkar, former President, INAE



Prof Indranil Manna, President, INAE



Mr JD Patil, Vice-President, INAE



Dr BN Suresh, former President, INAE

Seminar on "Green Hydrogen" jointly organized by INAE Delhi Chapter and International Solar Alliance on April 22, 2024 at New Delhi in hybrid mode.

The 38th Foundation Day Celebrations of INAE was followed by a **Seminar on "Green Hydrogen"** organized jointly by INAE Delhi Chapter and International Solar Alliance (ISA) at New Delhi in hybrid mode. The Seminar commenced with Welcome Remarks by Mr. Pradeep Chaturvedi, FNAE, Chairman, INAE Delhi Chapter followed by Opening Remarks by Prof Indranil Manna, President, INAE and Special Address by Dr. Ajay Mathur, FNAE, Director-General, International Solar Alliance and Chairman, INAE Forum on Energy. Shri Bhupinder Singh Bhalla, Secretary, Ministry of New and Renewable Energy, Government of India was the Chief Guest of the function and he delivered an illuminating address covering all aspects relevant to the propagation of a Green Hydrogen economy in the National context. The main objective of the Seminar was to bring out a "Guidance Document" based on the deliberations on the following three thematic areas covering sectors such as Railways, Steel, fertilizers, and refineries. The Sessions were on Green Hydrogen- Relevance, Policy, Standards, and Regulations; Economics of Green Hydrogen in the Indian context and Demand creation for Green Hydrogen in the Indian context.

The First Session on Green Hydrogen- Relevance, Policy, Regulations and Standards covered the following aspects: Hydrogen has long been recognized as a pathway to deep decarbonization, particularly in hard-to-abate sectors. There is a renewed global interest in this versatile energy resource, with several governments announcing Green Hydrogen policies, strategies, and targets, and global multilateral and private sector organizations increasingly recognizing Hydrogen in their near-to mid-term strategies. This session brought together policymakers and experts to analyse the role of existing policies, regulations, and standards in ensuring the scaling up of green hydrogen deployment in India. The objectives of the session were to Assess policy and regulatory frameworks and incentives that can accelerate green hydrogen ecosystem readiness and approach for market creation and harmonization of global standards for domestic consumption and export.

The second session on Economics of Green Hydrogen in the Indian context covered the issues as follows. India has established green hydrogen as a core pillar of its decarbonization and net zero strategy. India's National Green Hydrogen Mission (NGHM) sets out a roadmap for using hydrogen to meet its climate targets and make India a green hydrogen hub. This mission aims to enable India to become a global hub for the production, usage, and export of green hydrogen and its derivatives. This session delved into the current economic landscape of green hydrogen in India. It explored factors influencing its cost competitiveness, including renewable energy prices, electrolyzer technology advancements, green hydrogen production and use; and infrastructure development. The objectives of the session were to analyze existing and emerging business models for off-take of green hydrogen in India and identify key economic factors and policy instruments that can drive down green hydrogen costs.

The third session on Demand creation for Green Hydrogen in the Indian Context covered the following issues: The National Green Hydrogen Mission demarcates the sectors and the market development approach. The highest priority is accorded to those sectors where green hydrogen would support the replacement of fossil fuels and fossil fuel-based feedstocks. These include: replacement of fossil fuel-derived hydrogen with green hydrogen in ammonia production and petroleum refining; blending of green hydrogen in City Gas Distribution (CGD) systems and production of steel with green hydrogen. The objective of the session was to understand the emerging demands of green hydrogen in various sectors across India and examine effective strategies to accelerate green hydrogen demand in India.

This panel discussion delved into the current landscape of green hydrogen demand in India, identified the key challenges and opportunities that exist. By exploring strategies to stimulate demand across different applications, it was felt that a thriving green hydrogen ecosystem may be promoted in India. The sessions were followed by a Panel Discussion and Audience interaction and way forward wherein the outcomes of the deliberations were summarized and collated to get a comprehensive roadmap of the way forward in each of the technical, policy and research areas discussed during the seminar. Eminent

experts from Academia, R&D, Government Agencies and Industry from India and abroad participated in the deliberations adding to their relevance, importance and impact in making a paradigm shift towards a Green Hydrogen Economy which is a much-needed regime for the futuristic technologies and for reducing the carbon footprint. The seminar was attended by about 160 persons online and was an outstanding success in meeting the envisaged objectives.

Glimpses of Seminar on "Green Hydrogen" jointly organized by INAE Delhi Chapter and International Solar Alliance on April 22, 2024 at New Delhi in hybrid mode.

Panelists during Seminar on "Green Hydrogen"

Shri BS Bhalla, Secretary, Ministry of New Renewable Energy, Govt of India

Dr Ajay Mathur, Director-General, International and Solar Alliance

Left to Right: Shri BS Bhalla, Dr Ajay Mathur and Prof Indranil Manna

Local Chapter Activities and Webinar Series held during January 2024 to March 2024

The following Webinars/activities/meetings/Technical Lectures were conducted during January to April 2024 by INAE and Local Chapters.

INAE Bhubaneswar Chapter

(i) The 30th Lecture of Distinguished Lecture Series (Lecture-30) jointly organized by jointly with SOA University, CSIR-IMMT Bhubaneswar, IIT Bhubaneswar and IEEE Bhubaneswar Sub-section was delivered by Dr. Debendra K. Das, Professor of Mechanical Engineering Emeritus, University of Alaska Fairbanks (UAF), USA on 31st January 2024 on "Experimental Evaluation of Nanofluids In Building Heating Coils (Part-I). Computational Analysis of Nanofluids for Cooling in Microchannel Heat Exchangers (Part-II)."

(ii) The 31st Lecture of Distinguished Lecture Series (Lecture-31) jointly Organized by INAE Bhubaneswar Chapter, SOA University, CSIR-IMMT Bhubaneswar, IIT Bhubaneswar and IEEE Bhubaneswar Sub-section on February 17, 2024 which was delivered by Prof. Manoj Kumar Tiwari, FNAE, Director, IIM Mumbai, on the topic "Key Issues and Solutions Through Large Language Models in Supply Chain Management. There were 51 participants in the webinar. The YouTube Link to the Video is as follows: https://youtu.be/jJiFXmi9oS4

(iii) The 32nd lecture of Distinguished Lecture Series was organized by INAE Bhubaneswar Chapter, jointly with SOA University, CSIR-IMMT Bhubaneswar, IIT Bhubaneswar, NISER Bhubaneswar on 1st March, 2024 featuring lecture by Prof. Deepankar Choudhury, Prof. T. Kant Chair Professor (HAG) and Head, Department of Civil Engineering, Indian Institute of Technology Bombay on "Foundation Design for ATAL SETU – An Engineering Marvel and Sustainable Foundation Solutions for various Mega Structures". Sixty-eight participants attended the lecture online.

(iv) The **33rd Distinguished Lecture** of the Distinguished Lecture Series was organized by INAE Bhubaneswar Chapter jointly with SOA University, CSIR-IMMT Bhubaneswar, IIT Bhubaneswar, NISER Bhubaneswar and IEEE Bhubaneswar Sub-section on 20th March 2024 featuring lecture on "Building A Future Ready India: Vision, Plan & Strategy For Technical Education By 2047" delivered by Prof. (Dr.) TG Sitharam, FNAE, Chairman, All India Council for Technical Education (AICTE), New Delhi. There were 127 participants in the webinar.

(v) INAE, Bhubaneswar Chapter, jointly with SOA University, CSIR-IMMT Bhubaneswar, IIT Bhubaneswar, NISER Bhubaneswar and IEEE Bhubaneswar Sub-section organized the 34th lecture of the Distinguished Lecture Series by Prof. Anupam Basu, Raja Ramanna Chair

Professor, Jadavpur University on 21st March 2024 on "Where Language meets Technology" in virtual mode. Ninety-two persons attended the online lecture.

INAE Mumbai Chapter

(i) Webinar on **"Economy, Energy, and Ecology: Some personal thoughts" was delivered by** Dr. Ajit Sapre, FNAE, Group President, Reliance Industries **on April 28, 2024 in hybrid mode.** Dr. Ajit Sapre has more than 40 years of industrial experience in oil & gas, refining, petrochemicals, renewable energy, sustainability, biotechnology, etc., working for Reliance Industries, and ExxonMobil, USA.

International Affairs

Seminar on "Green Hydrogen: Indian National Academy of Engineering (INAE)-Royal Academy of Engineering (RAEng), UK Exchange program" held at CSIR- NCL, Pune on January 31, 2024-February 2, 2024

INAE interacts and undertakes various bilateral programs with Member-Academies of CAETS. In this regard a Royal Academy of Engineering, UK (RAEnG)- INAE Seminar was held as part of Bilateral Policy Exchange on "Green Hydrogen" from January 31-Feb 2, 2024 at National Chemical Laboratory (NCL), Pune. The Program was steered by Dr Ashish K Lele, Director, CSIR-NCL, Pune from India and Prof Nigel Brandon, OBE FREng FRS & Dean of Faculty of Engineering, Imperial College London from UK respectively. The objective of this exchange program on Green Hydrogen was to explore opportunities for cross-national learning to aid acceleration towards Green Hydrogen transition in India and UK. The event commenced with the inaugural session which began with a welcome address by Dr. Ashish K Lele followed by a Presidential Address by Prof. Indranil Manna, President, INAE wherein he emphasized the importance of sustainability and role of green hydrogen economy. The Addresses by Mr JD Patil, Vice-President, INAE & Member of Executive Committee of Management & Advisor (Defence & Smart Technologies) to Chairman & Managing Director, Larsen & Toubro Limited gave an overview of the Indian scenario whereas the talks by the distinguished guests viz Prof Nigel Brandon and Dr Nick Starkey, Director of Policy and International Academy, RAEng UK highlighted the situation in UK and they emphasized that UK is focusing both on green and blue hydrogen and market intervention is one of the salient factors for the transition to hydrogen economy .

The invitees at the event were subject domain experts from a mix of Academia, Government Labs and Industry which contributed towards effective interactions and deliberations with meaningful outcomes. Subsequent to the inaugural session, participants had an opportunity to engage in a networking exercise thereby fostering connections and discussions. After the conduct of the inaugural session, a Panel Discussion – I on Green Hydrogen: Production, Storage, Mobility moderated by Dr. Ashish K Lele, was held. This session featured keynote lectures by Prof. RR Sonde, FNAE, Professor, Department of Chemical Engineering, IIT Delhi and Formerly Executive Vice President, CTO and Member on Board of Executive Council, Thermax Ltd. representing INAE and Mr. Mahesh Natarajan, Vice President, Low Carbon Pathway Innovation, BP representing perspective from the UK side. Prof Sonde during his lecture has shared his thoughts on "Twin track on Hydrogen Value Chain: Pushing current state-of-art to next stage while deep dive into disruptive developments" covering topics related to technology elements, water electrolysis, beyond electrolyser, power electronics and proposed technologies, distributed hydrogen etc. Mr Mahesh Natarajan spoke on the topic pertaining to "Green Hydrogen Production, Storage, and End-Use" and covered the broad spectrum of future of global energy, production and transportation technology, customer and anchor demands, renewable energy, and shared key lessons across value chain. The keynote speakers set the stage for panelists to initiate the panel discussion. The Panelists included eminent experts from both countries from academia, Government Labs and organizations and Industry and discussed crucial aspects of Green Hydrogen, including production, storage, and mobility and the way forward.

A second Panel Discussion – II on Green Hydrogen: Standards, Policies, Hubs/Valleys, Industry Use Cases was held as the afternoon session, moderated by Prof Nigel Brandon. The deliberations during the panel discussion focused on standards, policies, and industry use cases. The Keynote speaker Mr. Antony Green FREng, Director - Future of Energy, SGN provided insights, followed by discussions with experts from India and the UK. During his keynote speech he focused on "the role of green hydrogen" from the Scotland perspective. The day concluded with remarks by Prof Indranil Manna, extended by the networking opportunities with a dinner event, fostering a collaborative atmosphere and allowed participants to further exchange ideas and build connections.

The second day started with the visit to CSIR's Hydrogen Technology (H2T) Mission Program and Pune Hydrogen Valley Innovation Cluster, which was coordinated by Dr. CS Gopinath, Outstanding scientist CSIR-NCL, Pune. Before proceeding to the visit to CSIR lab, an overview on (H2T) Mission Program was conducted by Dr Gopinath. The overview by Dr Gopinath was followed by a brief lecture by Dr. Vishal Dhavale, CECRI on "Low-Temperature Polymer Electrolyte Membrane Fuel Cells (LT-PEMFC) Components and Technology Advancement". Lectures were delivered by Dr. Kavita Joshi, NCL on "Machine Learning and Synthesis in Action: Paving the Way for Efficient Solid-State Hydrogen Storage Solutions", by Dr. Jayanta Mukhopadhyay, CGCRI on "Solid Oxide Fuel Cell and Electrolyser Cell Technology at CSIR-CGCRI: A Short Perspective in Indian Scenario", and Dr. K. Selvaraj, NCL on "Affordable AEM Water Electrolyser and Indigenous Technology Development Efforts at CSIR India"

Subsequent to the presentation of overview and lectures, the participants explored CSIR's initiatives in Hydrogen technology and Pune's Hydrogen Valley Innovation Cluster. A Lab Visit for CSIR's Hydrogen Technology Mission Program, Incubator Visit, fuel cell testing lab, storage lab, utilization lab for hydrogen followed by the visit to Automotive Research Association of India (ARAI) were held. The participants toured and gained valuable insights into hydrogen-related research. The event concluded with the third day where in industry visits were planned to KPIT Technologies Ltd., Pune, ENPRO to H2E Power System Inc. The UK delegation met with leadership, and a visit to "Impact Automotive Solutions Ltd." was organized wherein indigenously developed hydrogen buses and engines were showcased along with the fuel cylinders. The program concludes with exchange of knowledge achieving its objective. This comprehensive program facilitated knowledge exchange, networking, and collaboration, laying the foundation for future initiatives in the field of Green Hydrogen.

Seminar on "Green Hydrogen: Indian National Academy of Engineering (INAE)-Royal Academy of Engineering (RAEng), UK Exchange program" held at CSIR- NCL, Pune on January 31, 2024-February 2, 2024

Prof Indranil Manna, President, INAE delivering the Presidential Address during the event
***L to R:** Mr JD Patil, Dr Nick Starkey, Prof Nigel Brandon, Lt. Col. Shobhit Rai (Retd)and Dr Ashish Lele*

Dr Ashish Lele delivering Address

Prof Nigel Brandon delivering Address

Concluding Day-1: UK and Indian Participants at the event

CAETS Engineering Education Working Group

The CAETS Engineering Education Working Group (EEWG) has been created to help CAETS in contributing to continuous improvement and modernization of engineering education and practice internationally and promoting ethics in engineering education, research and practice. Prof Indranil Manna, President, INAE, had been entrusted with the responsibility to Chair the Working Group along with Vice-Chair Dr Katherine Frase of USA-NAE at the behest of CAETS. Representatives from twenty-two-member countries are the members of this Working Group. Four meetings of the CAETS EEWG, comprising of representatives from 22 Member Academies, have been organized so far and a recent meeting was held on February 15, 2024 covering the important aspects pertaining to Medium of

instruction for engineering education and Application of AI & ML in engineering practices. During the meetings, the representatives shared their experience pertaining to their respective countries. It emerged that many of the countries have English as a medium of instruction in engineering institutions, but there are others which deploy native languages and have textbooks and reference books in their respective languages. The report by the Working Group incorporating recommendations from the Members is under preparation for review and finally submission.

CAETS Communication Committee

The CAETS Communication Committee was constituted with an objective of the Committee is to develop and maintain a CAETS Style Guide that sets content and style guidelines and defines templates for all CAETS Communications (statements, reports, videos, website, etc.). The committee also supports review of draft documents. Prof Amit Agrawal, IIT Bombay, FNAE is INAE representative at the CAETS Communication Committee. CAETS Communications Committee quarterly meeting was held online on March 25, 2024 to discuss updates on the status of nominations for the CAETS Communications Prize.

INAE Publications

(i) **Transactions of Indian National Academy of Engineering – An International Journal of Engineering and Technology"**

INAE is currently publishing a Journal named "Transactions of Indian National Academy of Engineering – International Journal of Engineering and Technology" published by M/s Springer which was earlier named INAE Letters. **Transactions of INAE Volume 9, Issue 1, March 2024** was published through Springer Publishers during the period January to March 2024.

Donations to INAE Corpus Fund

Prof Indranil Manna, President, INAE has written several letters addressed to the Fellowship wherein he recalled that the Department of Science and Technology (DST), as directed by the Department of Expenditure, Government of India (GoI) is in the process of disengaging itself from the activities of INAE including providing the annual financial support w.e.f. 01st April 2025. To address the issue of sustainability of INAE, several meetings were held with high level Government officials, former Presidents and senior Fellows of INAE, and industry leaders in the two years since the formal letter from DST (dated 6.5.22) was served to INAE about disengagement. While efforts had been made to impress upon the Government that INAE is essential to realize the country's agenda on engineering and technology, it had become amply clear that INAE must undertake a serious effort to generate an adequate Corpus Fund and attain financial self-sufficiency.

In view of above, Prof Indranil Manna had mentioned in several communications that Engineering is all about evolving viable solution to prevailing or future challenges and aspirations. Hence, the present crisis may be viewed as an opportunity for INAE to emerge stronger and more resolute to fulfil its core objective of serving the profession and the nation in a more comprehensive manner. He sought participation of each Fellow in this noble and many positive responses, donations and contributions have been received from the Fellowship which have been highly appreciated. Prof Manna has mentioned that to tide over this unprecedented and most unfortunate crisis, every single Fellow, Associate, Awardee and mentor of INAE must come forward and make a useful and decisive contribution. In this direction, he apprised that after sustained efforts, INAE has been given the approval by the Competent Authority for the creation of a new corpus fund from INAE's own resources (internal accruals) in accordance with the Rule 229 (iv) & (v) of General Financial Rules (GFR), 2017 of the GoI on 24th March 2023. Contributions have since been received for INAE Corpus Fund from INAE Fellowship and the process is ongoing. The details for forwarding of donations and tax benefits to donors are given below:

Bank Details for receipt of donation to INAE:

Name of beneficiary: **INAE Corpus Fund**
Account Number: **41790835603**
Bank Address: **Jawaharlal Nehru University, New Mehrauli Road, New Delhi**
Type of Account: **Savings**
IFSC: **SBIN0001624**

Tax benefits for donors

The contribution to the **INAE Corpus Fund** qualifies to be considered under the category of donation and is eligible for 50% tax deduction under section 80G. The donors will get a receipt and the 80G certificate within a fortnight.

INAE is extremely grateful to all Fellows who have generously contributed to the INAE Corpus Fund and welcomes further contributions/donations from Fellows, Young Associates, Awardees; Industry Leaders and Industry Houses etc with a view to achieving self-sufficiency in functioning in the near future. A donor wall containing names of Fellows who have generously donated is posted on INAE website at the link https://www.inae.in/donor-wall/

Categories of Memberships Introduced in INAE

During the 35th Annual General Meeting (AGM) of Fellows - (Part - B) held on December 11, 2023 at Siksha O Anusandhan University, Bhubaneswar in hybrid mode it was informed that INAE is committed to raise a Corpus Fund of Rs.100 crores for its sustenance over the next one and a half years' time mainly through six sources of generation of funds, viz., (i) Corporate Donations/Membership; (ii) Institutional Membership (Academic and R&D institutions); (iii) Individual Donations/Membership; (iv) Corporate Social Responsibility (CSR); (v) Government/ Projects; and (vi) Publications.

Larsen & Toubro Ltd. has agreed to be a donor under the Platinum category of INAE, to be released over the next five years in five equal instalments. So far about more than ten premier Educational Institutions/Organizations have already become Institutional Member of INAE/accepted in principle for the same and each of them have/would contribute Rs.10 lakhs against Institutional Membership of INAE in near future. An appeal was made to the Corporate Leaders who have been elected as INAE Fellows affiliated to the category 'Industry" may contribute to this noble cause and help INAE in strengthen its current drive for generation of funds to attain financial and operational autonomy. By virtue of implementing proposed schemes for generation of funds with immediate effect, certain relevant Rules & Regulations of INAE as recommended by the Governing Council were amended with immediate effect. The process of inviting nominations from corporates, institutions and individuals under different categories of Membership has commenced and is being progressed vigorously. The links containing details of Institutional, Corporate and Individual Membership as posted on INAE Website are as follows https://www.inae.in/institutional-membership/; https://www.inae.in/corporate-membership/ and https://www.inae.in/individual-membership/

Important Meetings held during January to April 2024

January 2024

i INAE-DST Consultative Committee Meeting held on January 5, 2024 at New Delhi in hybrid mode.

ii. Meeting of Scouting Committee for recommending suitable nominees from industry to discuss and understand the scouting as well as election process held online on January 16, 2024.

iii. Meeting of Conveners of Sectional Committees with President, INAE to discuss important tasks to be undertaken by the Sectional Committees being held on January 25, 2024 online.

iv. Meeting to discuss INAE Green Hydrogen Exchange Program with Royal Academy of Engineering, UK held online on January 23, 2024.

February 2024

i. Meeting of Steering Committee for generation of Corpus fund held online on February 10, 2024

ii. Fourth Meeting of CAETS Engineering Education Working Group held virtually on February 15, 2024.

iii. 40th Finance Committee meeting held on February 16, 2024 at New Delhi in hybrid mode.

iv. INAE Pune Local Chapter Meeting held on February 21, 2024 at Pune in hybrid mode regarding generation of Corpus Fund.

v. First online meeting of Sectional Committee III (Mechanical Engineering) held on February 21, 2023.

vi. Meeting of INAE Delhi Local Chapter for Election of Executive Committee being held at INAE Office, New Delhi on February 23, 2024 in hybrid mode.

vii. Meeting with Springer Team regarding Transactions of INAE Journal being held on February 29, 2024 over WebEx.

March 2024

i Online Meeting of INAE Forum on Civil Infrastructure held on March 6, 2024.

ii. Meeting of Individual Membership Committee held on March 11, 2024 in virtual mode.

iii. Online Meeting of INAE Local Chapters Chairpersons on March 14, 2024

iv. INAE Governing Council Meeting held on March 21, 2024 in hybrid mode.

v. Online Meeting of the Advisory Committee for generation of INAE Corpus Fund to be held on March 23, 2024

vi. CAETS Communications Committee quarterly meeting to be held online on March 26, 2024

April 2024

i. Meeting of Forum on Civil Infrastructure held on April 8, 2024 over WebEx

ii. Online Meeting of CAETS diversity and Inclusion Group held on April 9, 2024

iii. 38th Foundation day Celebrations held on April 22, 2024 at New Delhi in hybrid mode

iv. 47th Apex Committee Meeting being held on April 26, 2024 over WebEx

v. Meeting of the INAE Forum on Technology Foresight & Management being held on April 26, 2024 in hybrid mode at INAE Office, New Delhi.

vi. Annual General Body Meeting of Mumbai Chapter being held on April 28, 2024 at Mumbai in hybrid mode.

vii. Meeting of INAE Forum on Civil Infrastructure being held on April 30, 2024 over WebEx.

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INTERNATIONAL/NATIONAL CONFERENCES/SEMINARS BEING ORGANIZED BY IITS/OTHER INSTITUTIONS

International conference on applied artificial intelligence and machine learning - online and in-person on 30th to 31st August 2024 at Hyderabad, Telangana
https://conferencealerts.com/show-event?id=262070

3rd International Conference on Power, Control and Embedded Systems (ICPCES–2024) in-person from 4th to 5th September 2024 at Chennai, Tamil Nadu
https://conferencealerts.com/show-event?id=262033

6th International Conference on Engineering and Advancement in Technology - online and in-person on 27th to 28th September 2024 at Hyderabad, Telangana
https://conferencealerts.com/show-event?id=264538

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HONOURS AND AWARDS

(covering the period January 2024 to April 2024)

1	Mr Sunil Bharti Mittal, FNAE the founder and chairperson of Bharti Enterprises, was conferred an Honorary knighthood by King Charles III of the United Kingdom on February 28, 2024 for services to UK and India business relations. Mr Mittal has become the first Indian to receive the Knighthood from King Charles. He was made a Knight Commander of the Most Excellent Order of the British Empire. The Knighthood is one of the highest civilian awards bestowed by the British sovereign. Foreign nationals receive it as an honorary award.
2	Dr BN Suresh, FNAE, Former President, INAE; Chancellor, Indian Institute of Space Science & Technology (IIST) and former Director of Vikram Sarabhai Space Centre was named among Asia's top 100 most outstanding researchers during April 2024. Every year since 2016, Asian Scientist Magazine compiles a list of Asia's most outstanding researchers. Now into its eighth edition, the Asian Scientist 100 list celebrates the success of the region's best and brightest, highlighting their achievements across a range of scientific disciplines. For details click on the link https://www.asianscientist.com/as100/
3	On the occasion of the National Science Day on February 28, 2024, Prof GD Yadav, FNAE, National Science Chair and Emeritus Professor of Eminence, JC Bose National Fellow at the Institute of Chemical Technology, Mumbai was bestowed with the SASTRA CNR RAO Award for excellence in Chemistry and Material Science in SASTRA University Thanjavur TN. Prof GD Yadav was also named among Asia's top 100 most outstanding researchers during April 2024. For details click on the link below https://www.indianchemicalnews.com/people/professor-dr-g-d-yadav-named-among-asias-top-100-scientist-21370
4	Prof Suman Chakraborty, FNAE, Professor of Mechanical Engineering, Indian Institute of Technology Kharagpur was named among Asia's top 100 most outstanding researchers during April 2024. For details click on the link below: https://www.asianscientist.com/as100/
5	Mr Ratan N Tata, FNAE, Chairman of Tata Trusts, was conferred with the prestigious KISS Humanitarian Award 2021, in recognition of his unwavering commitment to social development and exemplary leadership at an award ceremony held on April 22, 2024, at his residence in Mumbai. Established in 2008 by the KISS Humanitarian Award is the highest honour bestowed by Kalinga Institute of Industrial Technology (KIIT), and Kalinga Institute of Social Sciences (KISS).
6	Prof. Mahesh Chandra Tandon, FNAE, Managing Director, Tandon Consultants Pvt. Ltd, New Delhi has been honoured with the Lifetime Achievement Award on February 9, 2024, by the Institution of Bridge Engineers.

7	Prof. Sankar K. Pal, FNAE, Member, European Academy of Sciences & Arts, National Science Chair, SERB, Govt. of India and President, Indian Statistical Institute, Kolkata is Vice-President, International Artificial Intelligence Industry Alliance (AIIA), 2023 and Fellow, Web Intelligence Academy (WIA), 2023. Prof Pal received the 30th Prasanta Chandra Mahalanobis Memorial Lecture award, Department of Science and Technology and Biotechnology, Government of West Bengal, 2023 and delivered the Prof. P.C. Mahalanobis Memorial Lecture, World Meteorological Day, India Meteorological Department (IMD), Govt. of India, Regional Meteorological Center, Calcutta, 2023. He also was conferred the Distinguished Alumni Award 2023 from Ramakrishna Mission Vivekananda Centenary College, Rahara, Calcutta. (This award was given first time to an alumnus in the history of 60 years of the college since its inception in 1963).
8	Prof. Krishna B. Misra, FNAE, Founder and Past Editor-in-Chief, International Journal of Performability Engineering; Editor, Book Series on Performability Engineering, RAMS Consultants, Jaipur received the Lifetime Achievement Award 2024 from the Society for Reliability and Safety on February 22, 2024 for his pioneering contributions to R&D and Academics in Reliability Engineering.

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NEWS OF FELLOWS

(covering the period January 2024 to April 2024)

1,	Dr Rajiv K Tayal, FNAE, formerly: Advisor - DST, Govt. of India has published a new book in March 2024 titled "Who Am I: The Eternal Quest of Human Existence" The Amazon link for the book is https://amzn.eu/d/a4y1LUb
2.	Prof. Dr. S.N. Mukhopadhyay, FNAE, Former Professor, DBEB, IIT Delhi; Former Professor & Head, BERC, IIT Delhi; was an invited speaker in GPB-2024 International Conference held in Singapore in March 2024, for virtual presentation based on the abstract of his talk on "GPB in advancing Bioengineering and Biotechnology (BEBT)".
3.	Prof. K Ramesh, FNAE, Department of Applied Mechanics and Biomedical Engineering, IIT Madras is Conference Chair for the International Conference on Experimental Mechanics 2024 organized by IIT Madras in association with Asian Society of Experimental Mechanics (ASEM) and Indian Society for Applied Mechanics. This will be held at IC&SR conference facilities, IIT Madras. The conference will be from 20th to 23rd October 2024 with a pre-conference workshop on Digital photoelasticity - Advances and Applications. For further details click on the link https://ge.iitm.ac.in/icem-2024/
4.	Prof Prem Vrat, FNAE, Pro-Chancellor; Professor of Eminence and Chief Mentor, The Northcap University, Gurgaon and formerly Former Founder Director, IIT Roorkee; Former VC, UPTU, Lucknow; Former Professor & Director-in-In charge, IIT Delhi; Former Vice-Chancellor and Professor of Eminence, ITM University, Gurgaon has been featured in the prestigious publication "100 Great IITians Dedicated to the Service of the Nation" edited by Commander VK Jaitly. His profile was titled "An Academician par Excellence".
5.	Three INAE Fellows out of the six Professors appointed as IIT Directors in April 2024 are INAE Fellows. Prof Manindra Agrawal, FNAE, professor from the Department of Computer Science and Engineering at IIT Kanpur, has been appointed as the Director of IIT Kanpur; Prof Avinash Kumar Agarwal, FNAE professor at IIT-Kanpur's Department of Mechanical Engineering, has been appointed as the Director of IIT-Jodhpur and Prof Sukumar Mishra, FNAE has been appointed as the Director of IIT Dhanbad.

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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

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Obituaries

Mr Prabhakar Shankar Deodhar

(September 25, 1934– January 28, 2024)

Mr Prabhakar Shankar Deodhar, FNAE, born on September 25, 1934 passed away on January 28, 2024. He was elected to INAE Fellowship in the year 2002 and was affiliated to Engineering Section VI (Electronics and Communication Engineering).

Mr PS Deodhar, Chairman Aplab Limited, Mumbai and Formerly Chairman, Electronics Commission, Govt. of India; Formerly Advisor (Electronics) to the P.M. had made significant contributions to the growth of the Electronics Industry in the country. In 1962, he set up the first private laboratory and Aplab Limited, founded by him developed ATMs for banks and machines for modernization of the retail sector, automated petrol pumps and cable fault detection machines. He also created a device that removes defects in cables and was responsible for manufacturing about 650 electronic devices and products. Along with his notable achievements in the industrial sector, he held the post of Chairman of the Central Government Electronics Commission from 1986 to 1988. He also was the chairman of the broadcast council in 1992-93 which set in motion the privatisation of the electronic media with metro channels. Mr Deodhar left a legacy of pioneering achievements in the country's Electronics and Information Technology sector as an engineering-scientist, industrialist and national policy maker.

May God Bless His Soul to Rest in Peace

Dr. Gopalakrishna Thyagarajan

(2 May 1934 - 24 March 2024)

A Visionary and Enigmatic Leader

When my revered friend, Dr T. Ramasami, a former Secretary of the Department of Science and Technology of the Government of India broke to me the sad news of the passing away of Dr Gopalakrishna Thyagarajan on the 24 January 2024, my highly disturbed mind quickly scanned the images of some of my legendary friends who, by their departure, have created a void in my life. The news brought tears in my eyes and a smile on my face at the same time. Tears naturally came because, we were both fellow travellers for nearly five decades and I will miss him immensely as he has aborted the journey creating a void in my life. The smile on my face came to remind me that our lives on this planet are indeed short, give and take a few years and there are no goodbyes for true friends in the emotional space.

Dr Thyagarajan was my most respected friend, philosopher, and guide. As a friend, he always opened his heart to me and encouraged me in difficult times. As a philosopher, he never failed to share his depth of knowledge and wisdom. And as a guide and mentor, fortuitously, he came to my life right in the formative stage of my professional career, as far back as 1975, to stir my imagination and underscore by his own example that there is no summit of human excellence and deeper we dig, the bigger is the haul. Slowly I discovered that such noble thoughts can be traced back to the Upanishads.

Thyagarajan was born on 2 May 1934 at Tiruvarur in Tamil Nādu. He obtained the degree of M.Sc. in 1956, and Ph. D in 1962, from the Osmania University. Thereafter, he worked as a Post-Doctoral Fellow at the University of California at Berkeley in 1964-65. He was a visionary leader who always thought way beyond the boundaries of his chosen field of speciality making notable contributions in the fields of Chemical Process Industries; synthetic drugs; organo-phosphorous pesticides; leather processing; Chemical Safety; Technology Management and Technology Forecasting. Because of his outstanding academic and professional track record, recognitions and awards naturally followed him as his shadow. He became a Fellow of the Royal Society of Chemistry, London; a Fellow of the Indian National Academy of Engineering, New Delhi; an Honorary Fellow of the Indian Institute of Chemical Engineers and received KG Naik Gold Medal for Industrial Contributions; Vasvik Award for his contributions to Chemical Sciences &Technology, and the Leather Media Award.

In my very long stint with the CSIR spanning over four decades, I find Dr Thyagarajan as the only colleague who had the distinction of heading three national laboratories, stepping from one to the other. In 1974, none other than Dr Y. Nayudamma, the then Director General of CSIR, interviewed, and selected him to serve as the Director of CSIR's Regional Research Laboratory in Jorhat, later renamed as North East Institute of Science and Technology. In the year 1981, when Dr G.S. Sidhu, the then Director of CSIR's Regional Research Laboratory in Hyderabad (now Indian Institute of Chemical technology or IICT) moved to CSIR Headquarter in New Delhi to take charge as Director General of

CSIR, Dr Thyagarajan was appointed as the Director of RRL, Hyderabad (IICT) on 2 February 1981. Finally, he served as Director of Central Leather Research Institute in Chennai in two spells- from 1984-87, and from 1990-94. His mission at CLRI was to turn around CLRI from a position of weakness to one of global leadership. His contributions to CSIR Coordinated Programmes including the integrated development of the rural areas of Karim Nagar in Andhra Pradesh were significant.

During the period 1987-90 between the two spells, he served as the Science Advisor to Commonwealth Secretary General and Secretary of the Commonwealth Secretariat in London. It is heart-warming to recall that he was picked for this coveted position out of the candidature of about 50 Commonwealth Countries.

In the formative period of my career as a CSIR Scientist, I first formally met Dr Thyagarajan at the 4th CSIR Management Training Programme held in the campus of Central Scientific Instruments Organization in Chandigarh during July 21-31, 1975. The entire training programme was built around the young and charismatic Dr Thyagarajan. The lessons he taught us at that time, reverberates in my ears even today. He was very forthright in his statement that Research and Development work at CSIR must address the real-life problems and must necessarily address the felt needs of the society. He convinced us that what we cannot do individually, we can achieve by working as a team regardless of the degree of challenge. Among other things, he laid emphasis on pooling of scattered resources, leveraging of institutional capacities and synergising strengths of the expertise within and between the CSIR laboratories with the objective of taking science to the doorstep of the users. His views resonated with the vision of Dr R.A. Mashelkar, as the Director General of CSIR and of Dr Ramasami as the Secretary, Department of Science and Technology. On several occasions, I heard Dr Ramasami demanding focus on the 'outcome' whenever he came across long list of promises, activities, and outputs in any of project plans or progress reports!

What I learned from Thyagarajan in 1975, once again captured my imagination in December 2005, when I read his speech delivered on the CSIR Foundation Day function of the National Chemical Laboratory in Pune. Speaking on CSIR in India's life, he laid emphasis on invigorating work culture, establishing CSIR Staff College to harnessing new talent, reinventing the international cooperation and preservation of the autonomy of CSIR. I was particularly impressed by his advocacy for recourse to golden handshake to encourage respectful weeding out unwilling professionals and his call for introspection on missed opportunities to see more than that usually meets the eye.

As a fellow traveller, I recall my most rewarding engagement with Dr Thyagarajan during the period 1988-2000 which include his tenure with the Commonwealth Science Council. I particularly recall my meetings with him in the United Kingdom during 17-30 July 1988 and 15-16 June 1989. My first visit, as Director of Central Building Research Institute was aimed at advancing India's ongoing cooperation with the Building Research Establishment of the UK in the area of Fire Research, and my second visit was to participate in an interactive meeting of Directors of Building Research Organisations of Building Research Organisations (DESBRO) from England, New Zealand, Australia, Canada, South Africa, and the USA. Both times, my meetings with Dr Thyagarajan and his Deputy Dr Raul Vicencio, in the office of Secretary Commonwealth Council, were insightful and productive. We also agreed to exchange publications with Commonwealth Secretariat in the areas of Building Materials and Disaster Management. Dr Thyagarajan introduced me to Ms Janet R Stradran, CSC's Executive Officer for Information sharing. The ensuing discussion generated very useful inputs and insights into the rapidly evolving power of information in the modern world of science and the importance of effectively connecting the laboratories of CSIR; nationally and internationally. I also came to know from Dr Thyagarajan a lot about the Software of importance accessible in the public domain.

Some of these ideas developed at our meetings, however, had to be kept on the backburner because, within months of my last meeting with Dr Thyagarajan, I left CSIR to join United Nations-Habitat. Five

years later, in 1995, soon after my return to CSIR, on day one, the idea of establishing International Science and Technology Directorate (ISTAD) at the CSIR Headquarters struck my mind. It got instant seal of approval, thanks to the vision of the then DG, CSIR- Dr RA Mashelkar. Interestingly, Dr Thyagarajan was the Chairman of the Committee which interviewed new recruits for ISTAD and selected Dr Rama Bansal and Dr Purnima Rupal to strengthen it. The former is currently the Head of ISTAD, after serving as India's Science Counsellor in Russia. And the later has recently retired after serving as India's Science Counsellor in Japan and as Director of Indo-French Centre in New Delhi.

By hind sight, I recall that the idea of harnessing the power of Information which had germinated in my meetings with Dr Thyagarajan in the UK, resurfaced and fructified in a different uniform, when in the year 2000, I proposed creation of Disaster Knowledge Network to the High-Powered Committee on Disasters constituted by the Government of India. I defended my proposal at the National Workshop hosted by the Disaster Management Institution of Bhopal at the behest of the High-Powered Committee on 14 and 15 July 2000. As the luck would have it, my proposal was fully backed by Dr Mashelkar, DG CSIR via his letter of 1st September 2000 addressed to Shri J.C. Pant, the Chairman of the High-Powered Committee. The unstinted support to the proposal received from Dr Anil Kakodkar, the then President of the Indian National Academy of Engineering gave wings to the proposal. On 16 November 2000, Shri J. C. Pant, while addressing the media on National Press Day, acknowledged the support to DKN received from Dr Kakodkar and, finally, the HPC included the recommendation in its report submitted to the Government of India in October 2001.

Simultaneously, reminded of my meetings with Dr Thyagarajan in the UK, I also submitted a proposal to the Commonwealth Science Council, on creation of Commonwealth Disaster Knowledge Network. On 28 September 2000, the successor of Dr Thyagarajan at the CSC secretariat wrote to me conveying sanction of 5,000 pounds plus travel to kick-start the DKN activity. The letter also suggested partnering the project with the UNESCO.

Hazardous Waste Management was yet another area of vital national importance on which Dr Thyagarajan made significant contributions. It was in the year 1985 that he served as a Technical Advisor to the Indian side in the Bhopal case before the UN Court and liaised with the American Law Firm representing the Indian case. Subsequently, he laid emphasis on assessment of Industrial Safety in hazardous areas.

During 2003-2004, he served as a Consultant to Joint Parliamentary Committee on pesticide residues in soft drink, and later, during 2004-7, he Chaired a Supreme Court Monitored Committee on Hazardous Waste Management. He availed of every possible opportunity to highlight the staggering contrast between- Industrial Planning as practiced and Environmental Safety. In his lecture on Hazardous Waste Management in India-Ground Realities, delivered in March 2005, at the National Environment Engineering Research Institute, Nagpur, he highlighted the role of Regulatory agencies and Pollution control boards in exercising control over the abuse of the prescribed Codes and Standards. He was particularly critical of the unorganised development of industries such as pharmaceuticals, pesticides, mining, and metallurgy.

As a Science Administrator, he saw the need for giving meaning to the pursuit of science, by fostering, promoting, and sustaining the culture of science, pro bono publico. Towards that end, he endeavoured to improve institutional infrastructure, modernise laboratories, lay emphasis on team building and on finding a down to earth connection between the research outputs and fulfilment of the felt needs of the end users.

Interalia, he also played a significant role in giving fillip to sports promotion activities in the CSIR and I was also motivated to host CSIR's Shanti Swarup Bhatnagar tournament in the campus of Central Building Research Institute in Roorkee.

Though both of us were separated by the geographic distance and rather infrequent meeting opportunities, we remained in touch with each other. The last time I met him in person was at the International Conference on Science and the Small Nations Bridging the Gaps: A Science diplomacy Initiative" held in New Delhi on November 14-16, 2017. It was organised by Zaheer Science Foundation, (ZSF) of which he was the Chairman. While inviting me to be a speaker at the conference, he expressed his deep concern about the plight of the small nations. Of the 197 independent nations at that time, 135 had population of 10 million or less. Of these 135, 45 were small island nations with population of one million or less. Despite these island nations being principal contributors of data and information to feed countless global projects on climate change, extreme weather events, sea level rise, natural disasters, and trans-boundary pollution, they faced the threat of science and technology marginalization. In my presentation, he specifically asked me to suggest what should be done to rectify the imbalances and what policies and strategies can help integrate the small and disadvantaged nations with the ongoing and perceived global scientific initiatives.

In an article on Technology Policy for Global Competition: Lessons from the East Asia, published in the International Journal of Engineering Education (1994, Vol10), Thyagarajan jointly with P.N. Desai underscored that "the third world countries need to examine closely the connection between technology, population growth, environment, and development. It is necessary for them to lay emphasis on quality, design, R & D market research, information, and communication technology, and above all, commercialization, and global competitiveness". What he clearly saw three decades ago, continues to be as relevant even today.

Dr Thyagarajan, while paying tribute to his mentor Dr Yelavarthy Nayudamma via his article titled *Calm and Composed-Even in Crisis* published in his Centenary Volume, wrote: - "He was a man with great deal of patience, could keep cool even in worst circumstances and think clearly. Whatever he did in life, he did gracefully and left a deep imprint on whosoever came in contact with him." The above qualities were his ornaments too, by which we will all remember him for all times to come!

I salute Dr Thyagarajan who will always live in the heart of all those who were fortunate enough to come in his contact. May his soul rest in peace.

R.K. Bhandari
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May God bless his soul to Rest in Peace

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ENGINEERING AND TECHNOLOGY UPDATES

Civil Engineering

1. Green concrete recycling twice the coal ash is built to last

New modelling reveals that low-carbon concrete developed at RMIT University can recycle double the amount of coal ash compared to current standards, halve the amount of cement required and perform exceptionally well over time.More than 1.2 billion tonnes of coal ash were produced by coal-fired power plants in 2022. In Australia, it accounts for nearly a fifth of all waste and will remain abundant for decades to come, even as we shift to renewables. Meanwhile, cement production makes up 8% of global carbon emissions and demand for concrete -- which uses cement as a key ingredient -- is growing rapidly. Addressing both challenges head-on, engineers at RMIT have partnered with AGL's Loy Yang Power Station and the Ash Development Association of Australia to substitute 80% of the cement in concrete with coal fly ash. RMIT project lead Dr Chamila Gunasekara said this represents a significant advance as existing low-carbon concretes typically have no more than 40% of their cement replaced with fly ash. Comprehensive lab studies have shown the team's approach is also capable of harvesting and repurposing lower grade and underutilised 'pond ash'- taken from coal slurry storage ponds at power plants -- with minimal pre-processing. Large concrete beam prototypes have been created using both fly ash and pond ash and shown to meet Australian Standards for engineering performance and environmental requirements. A pilot computer modelling program developed by RMIT in partnership with Hokkaido University' Dr Yogarajah Elakneswaran has now been used to forecast the time-dependent performance of these new concrete mixtures. According to Dr Yuguo Yu, an expert in virtual computational mechanics at RMIT, a longstanding challenge in the field has been to understand how newly developed materials will stand the test of time. This pioneering approach reveals how various ingredients in the new low-carbon concrete interact over time. "We're able to see, for example, how the quick-setting nano additives in the mix act as a performance booster during the early stages of setting, compensating for the large amounts of slower-setting fly ash and pond ash in our mixes," Gunasekara says. "The inclusion of ultra-fine nano additives significantly enhances the material by increasing density and compactness." This modelling, with its wide applicability to various materials, marks a crucial stride towards digitally assisted simulation in infrastructure design and construction. By leveraging this technology, the team aims to instil confidence among local councils and communities in adopting novel low-carbon concrete for various applications. This research was enabled by the ARC Industrial Transformation Research Hub for Transformation of Reclaimed Waste Resources to Engineered Materials and Solutions for a Circular Economy (TREMS). Led by RMIT's Professor Sujeeva Setunge, TREMS brings together top scientists, researchers and industry experts from nine Australian universities and 36 state, industry, and international partners to minimise landfill waste and repurpose reclaimed materials for construction and advanced manufacturing.

Source https://www.sciencedaily.com/releases/2024/05/240515122804.htm

2. A simple quantum internet with significant possibilities

It's one thing to dream up a quantum internet that could send hacker-proof information around the world via photons superimposed in different quantum states. It's quite another to physically show it's possible. That's exactly what Harvard physicists have done, using existing Boston-area telecommunication. fiber, in a demonstration of the world's longest fiber distance between two quantum memory nodes to date. Think of it as a simple, closed internet between point A and B, carrying a signal encoded not by classical bits like the existing internet, but by perfectly secure, individual particles of light. The Harvard team established the practical makings of the first quantum internet by entangling two quantum memory nodes separated by optical fiber link deployed over a roughly 22-mile loop through Cambridge, Somerville, Watertown, and Boston. The two nodes were located a floor apart in Harvard's Laboratory for Integrated Science and Engineering. Quantum memory, analogous to classical computer memory, is an important component of an interconnected quantum computing future because it allows for complex network operations and information storage and retrieval. While other quantum networks have been created in the past, the Harvard team's is the longest fiber network between devices that can store, process and move information. Each node is a very small quantum computer, made out of a sliver of diamond that has a defect in its atomic structure called a silicon-vacancy center. Inside the diamond, carved structures smaller than a hundredth the width of a human hair enhance the interaction between the silicon-vacancy center and light. The silicon-vacancy center contains two qubits, or bits of quantum information: one in the form of an electron spin used for communication, and the other in a longer-lived nuclear spin used as a memory qubit to store entanglement (the quantum-mechanical property that allows information to be perfectly correlated across any distance). Both spins are fully controllable with microwave pulses. These diamond devices -- just a few millimeters square -- are housed inside dilution refrigeration units that reach temperatures of -459 Fahrenheit. Using silicon-vacancy centers as quantum memory devices for single photons has been a multi-year research program at Harvard. The technology solves a major problem in the theorized quantum internet: signal loss that can't be boosted in traditional ways. A quantum network cannot use standard optical-fiber signal repeaters because copying of arbitrary quantum information is impossible -- making the information secure, but also very hard to transport over long distances. Silicon vacancy center-based network nodes can catch, store and entangle bits of quantum information while correcting for signal loss. After cooling the nodes to close to absolute zero, light is sent through the first node and, by nature of the silicon vacancy center's atomic structure, becomes entangled with it. Over the last several years, the researchers have leased optical fiber from a company in Boston to run their experiments, fitting their demonstration network on top of the existing fiber to indicate that creating a quantum internet with similar network lines would be possible. "Showing that quantum network nodes can be entangled in the real-world environment of a very busy urban area, is an important step towards practical networking between quantum computers," Lukin said. A two-node quantum network is only the beginning. The researchers are working diligently to extend the performance of their network by adding nodes and experimenting with more networking protocols.

Source https://www.sciencedaily.com/releases/2024/05/240515122712.htm

Mechanical Engineering

3. Animal brain inspired AI game changer for autonomous robots

A team of researchers at Delft University of Technology has developed a drone that flies autonomously using neuromorphic image processing and control based on the workings of animal brains. Animal brains use less data and energy compared to current deep neural networks running on GPUs (graphic chips). Neuromorphic processors are therefore very suitable for small drones because they don't need heavy and large hardware and batteries. The results are extraordinary: during flight the drone's deep neural network processes data up to 64 times faster and consumes three times less energy than when running on a GPU. Further developments of this technology may enable the leap for drones to become as small, agile, and smart as flying insects or birds. Artificial intelligence holds great potential to provide autonomous robots with the intelligence needed for real-world applications. However, current AI relies on deep neural networks that require substantial computing power. The processors made for running deep neural networks (Graphics Processing Units, GPUs) consume a substantial amount of energy. Especially for small robots like flying drones this is a problem, since they can only carry very limited resources in terms of sensing and computing. Animal brains process information in a way that is very different from the neural networks running on GPUs. Biological neurons process information asynchronously, and mostly communicate via electrical pulses called *spikes*. Since sending such spikes costs energy, the brain minimizes spiking, leading to sparse processing. Inspired by these properties of animal brains, scientists and tech companies are developing new, *neuromorphic* processors. These new processors allow to run spiking neural networks and promise to be much faster and more energy efficient. This energy efficiency is further boosted if neuromorphic processors are used in combination with neuromorphic sensors, like neuromorphic cameras. Such cameras do not make images at a fixed time interval. Instead, each pixel only sends a signal when it becomes brighter or darker. The advantages of such cameras are that they can perceive motion much more quickly, are more energy efficient, and function well both in dark and bright environments. Moreover, the signals from neuromorphic cameras can feed directly into spiking neural networks running on neuromorphic processors. Together, they can form a huge enabler for autonomous robots, especially small, agile robots like flying drones. In an article, researchers from Delft University of Technology, the Netherlands, demonstrate for the first time a drone that uses neuromorphic vision and control for autonomous flight. Specifically, they developed a spiking neural network that processes the signals from a neuromorphic camera and outputs control commands that determine the drone's pose and thrust. They deployed this network on a neuromorphic processor, Intel's Loihi neuromorphic research chip, on board of a drone. Thanks to the network, the drone can perceive and control its own motion in all directions. The first module learns to visually perceive motion from the signals of a moving neuromorphic camera. It does so completely by itself, in a self-supervised way, based only on the data from the camera. This is similar to how also animals learn to perceive the world by themselves. The second module learns to map the estimated motion to control commands, in a simulator. This learning relied on an artificial evolution in simulation, in which networks that were better in controlling the drone had a higher chance of producing offspring. Over the generations of the artificial evolution, the spiking neural networks got increasingly good at control, and were finally able to fly in any direction at different speeds. We trained both modules and developed a way with which we could merge them together. The advantages of tiny drones are that they are very safe and can navigate in narrow environments like in between ranges of tomato plants. Moreover, they can be very cheap, so that they can be deployed in swarms. This is useful for more quickly covering an area, as we have shown in exploration and gas source localization settings.

Source https://www.sciencedaily.com/releases/2024/05/240515164207.htm

Chemical Engineering

4. Carbon-capture batteries developed to store renewable energy, help climate

Researchers at the Department of Energy's Oak Ridge National Laboratory are developing battery technologies to fight climate change in two ways, by expanding the use of renewable energy and capturing airborne carbon dioxide. This type of battery stores the renewable energy generated by solar panels or wind turbines. Utilizing this energy when wind and sunlight are unavailable requires an electrochemical reaction that, in ORNL's new battery formulation, captures carbon dioxide from industrial emissions and converts it to value-added products. ORNL researchers recently created and tested two different formulations for batteries that convert carbon dioxide gas, or CO_2, into a solid form that has the potential to be used in other products. One of these new battery types maintained its capacity for 600 hours of use and could store up to 10 hours of electricity. Researchers also identified, studied and overcame the primary challenge, a deactivation caused by chemical build-up, that had been an obstacle for the other battery formulation. Batteries operate through electrochemical reactions that move ions between two electrodes through an electrolyte. Unlike cell phone or car batteries, those designed for grid energy storage do not have to function as a portable, closed system. This allowed ORNL researchers to create and test two types of batteries that could convert CO_2 from stationary, industrial sources. For example, CO_2 generated by a power plant could be pumped through a tube into the liquid electrolyte, creating bubbles similar to those in a carbonated soft drink. During battery operation, the gas bubbles turn into a solid powder. Each component of a battery can be made of different elements or compounds. These choices determine the battery's operational lifetime, how much energy it can store, how big or heavy it is, and how fast it charges or consumes energy. Of the new ORNL battery formulations, one combines CO_2 with sodium from saltwater using an inexpensive iron-nickel catalyst. The second combines the gas with aluminum. Each approach uses abundant materials and a liquid electrolyte in the form of saltwater, sometimes mixed with other chemicals. The batteries are safer than existing technology because their electrodes are stable in water, said lead researcher Ruhul Amin. Very little CO_2 battery research has been conducted. The previously-tried approach relies on a reversible metal-CO_2 reaction that regenerates carbon dioxide, continuing to contribute greenhouse gases to the atmosphere. In addition, solid discharge products tend to clog the surface of the electrode, degrading the battery performance. However, the CO_2 batteries developed at ORNL do not release carbon dioxide. Instead, the carbonate byproduct dissolves in the liquid electrolyte. The byproduct either continuously enriches the liquid to enhance battery performance, or it can be filtered from the bottom of the container without interrupting battery operation. Battery design can even be tuned to create more of these byproducts for use by the pharmaceutical or cement industries. The only gases released are oxygen and hydrogen, which do not contribute to climate change and can even be captured to produce energy or fuel. RNL researchers used an almost completely new combination of materials for these CO_2 batteries. The few similar previous designs worked for only short periods or incorporated expensive metals. The sodium-carbon dioxide, or Na-CO_2, battery was developed first and faced some obstacles. For this system to function, the electrodes must be separated in wet and dry chambers with a solid ion conductor between them. The barrier slows the movement of ions, which in turn slows down battery operation, reducing battery efficiency. One significant challenge for this Na-CO_2 battery is that after prolonged use, a film forms on the electrode surface, which eventually causes the battery to deactivate. Studying how the film formed helped researchers understand how to break it down again. They were intrigued to realize the battery could be reactivated, or prevented from deactivating at all, simply through operational changes in the charge/discharge cycle. Uneven pulses of charging and discharging prevented film buildup on the electrode. Next, researchers focused on the design of the aluminum-carbon dioxide, or Al-CO_2, battery. The team experimented with various electrolyte solutions and three different synthesis processes to identify the best combination. The result was a battery which provides enough storage for more than 10 hours of electricity to be used later. The cherry on top is that this battery captures almost twice as much carbon dioxide as the Na-CO_2 battery. It can be designed for the system to operate in a single chamber, with both electrodes in the same liquid solution, so there is no barrier to ion movement.

Source https://www.sciencedaily.com/releases/2024/05/240515164330.htm

Electrical Engineering

5. Innovative sensing platform unlocks ultrahigh sensitivity in conventional sensors

Optical sensors serve as the backbone of numerous scientific and technological endeavors, from detecting gravitational waves to imaging biological tissues for medical diagnostics. These sensors use light to detect changes in properties of the environment they're monitoring, including chemical biomarkers and physical properties like temperature. A persistent challenge in optical sensing has been enhancing sensitivity to detect faint signals amid noise. New research from Lan Yang, the Edwin H. & Florence G. Skinner Professor in the Preston M. Green Department of Electrical & Systems Engineering in the McKelvey School of Engineering at Washington University in St. Louis, unlocks the power of exceptional points (EPs) for advanced optical sensing. In a study Yang and first author Wenbo Mao, a doctoral student in Yang's lab, showed that these unique EPs -- specific conditions in systems where extraordinary optical phenomena can occur -- can be deployed on conventional sensors to achieve a striking sensitivity to environmental perturbations. Yang and Mao developed an EP-enhanced sensing platform that overcomes the limitations of previous approaches. Unlike traditional methods that require modifications to the sensor itself, their innovative system features an EP control unit that can plug into physically separated external sensors. This configuration allows EPs to be tuned solely through adjustments to the control unit, allowing for ultrahigh sensitivity without the need for complex modifications to the sensor. By decoupling the sensing and control functions, Yang and Mao have effectively skirted the stringent physical requirements for operating sensors at EPs that have so far hindered their widespread adoption. This clears the way for EP enhancement to be applied to a wide range of conventional sensors -- including ring resonators, thermal and magnetic sensors, and sensors that pick up vibrations or detect perturbations in biomarkers -- vastly improving the detection limit of sensors scientists are already using. With the control unit set to an EP, the sensor can operate differently -- not at an EP -- and still reap the benefits of EP enhancement. As a proof-of-concept, Yang's team tested a system's detection limit, or ability to detect weak perturbations over system noise. They demonstrated a six-fold reduction in the detection limit of a sensor using their EP-enhanced configuration compared to the conventional sensor. "With this work, we've shown that we can significantly enhance our ability to detect perturbations that have weak signals," Mao said. "We're now focused on bringing that theory to broad applications. I'm specifically focused on medical applications, especially working to enhance magnetic sensing, which could be used to improve MRI technology. Currently, MRIs require a whole room with careful temperature control. Our EP platform could be used to enhance magnetic sensing to enable portable, bedside MRI."

Source https://www.sciencedaily.com/releases/2024/04/240405231830.htm

6. Learning the imperfections: New approach to using neural networks for low-power digital pre-distortion (DPD) in mmWave systems

Engineers at Tokyo Institute of Technology (Tokyo Tech) have demonstrated a simple computational approach for improving the linearization of power amplifiers (PA), such as those used in mmWave systems and other telecommunication systems. The proposed technique involves training small neural networks to directly estimate the coefficients of a polynomial for digital pre-distortion (DPD) based on their frequency response during calibration sweeps. In the world around us, a quiet but very important evolution has been taking place in engineering over the last decades. As technology evolves, it becomes increasingly clear that building devices that are physically as close as possible to being perfect is not always the right approach. That's because it often leads to designs that are very expensive, complex to build, and power-hungry. Engineers, especially electronic engineers, have become very skilled in using highly imperfect devices in ways that allow them to behave close enough to the ideal case to be successfully applicable. Historically, a well-known example is that of disk drives, where advances in control systems have made it possible to achieve incredible densities while using electromechanical hardware littered with imperfections, such as nonlinearities and instabilities of various kinds. A similar problem has been emerging for radio communication systems. As the carrier frequencies keep increasing and channel packing becomes more and more dense, the requirements in terms of linearity for the radio-frequency power amplifiers (RF-PAs) used in telecommunication systems have been getting stringent. Traditionally, the best linearity is provided by designs known as "Class A," which sacrifice great amounts of power to maintain operation in a region where transistors respond in the most linear possible way. On the other hand, highly energy-efficient designs are affected by nonlinearities that render them unstable without suitable correction. The situation has been getting worse because the modulation systems used by the latest cellular systems have a very high-power ratio between the lowest- and highest-intensity symbols. Specific RF-PA types such as Doherty amplifiers are highly suitable and power-efficient, but their native non-linearity is not acceptable. Over the last two decades, high-speed digital signal processing has become widely available, economical, and power-efficient, leading to the emergence of algorithms allowing the real-time correction of amplifier non-linearities through intentionally "distorting" the signal in a way that compensates the amplifier's physical response. These algorithms have become collectively known as digital pre-distortion (DPD) and represent an evolution of earlier implementations of the same approach in the analog domain. Throughout the years, many types of DPD algorithms have been proposed, typically involving real-time feedback from the amplifier through a so-called "observation signal," and fairly intense calculations. While this approach has been instrumental to the development of third- and fourth-generation cellular networks (3G, 4G), it falls short of the emerging requirements for fifth-generation (5G) networks, due to two reasons. First, dense antenna arrays are subject to significant disturbances between adjacent elements, known as cross-talking, making it difficult to obtain clean observation signals and causing instability. The situation is made considerably worse by the use of ever-increasing frequencies. Second, dense arrays of antennas require very low-power solutions, and this is not compatible with the idea of complex processing taking place for each individual element. The most recent types of RF-PAs based on CMOS technology, even when they are heavily nonlinear, tend to have a relatively simple response, free from memory effects. " Through a dedicated hardware architecture, the engineers at the Nano Sensing Unit of Tokyo Tech were able to implement a system that automatically determines the polynomial coefficients for DPD, based on a limited amount of data that could be acquired within the course of a few milliseconds. Performing calibration in the "foreground," that is, one path at a time, reduces issues related to cross-talk and greatly simplifies the design. While there is no observation signal needed, the calibration can adjust itself to varying conditions through the inputs of additional signals, such as die temperature, power supply voltage, and settings of the phase shifters and couplers connecting the antenna. While standards compliance may pose some limitations, the approach is in principle widely applicable.

Source https://www.sciencedaily.com/releases/2024/05/240510111406.htm

Aerospace Engineering

7. ISRO Successfully Tests 3D-Printed Rocket Engine - A Major Breakthrough

ISRO has successfully conducted a long-duration test of its PS4 engine, re-designed for production using cutting-edge additive manufacturing (AM) techniques -- also known in common parlance as 3D printing -- and crafted in Indian industry, the space agency said recently. The new engine, now a single piece, saves 97 per cent of raw materials and reduces production time by 60 per cent, ISRO said. ISRO achieved the major milestone with the successful hot testing of a liquid rocket engine manufactured through AM technology for a duration of 665 seconds on May 9, a release from the space agency said. The engine used is the PS4 engine of PSLV (Polar Satellite Launch Vehicle) upper stage. The PS4 engine manufactured in the conventional machining and welding route has been in use for the fourth stage of PSLV which has a thrust of 7.33 kN in vacuum condition. The same engine is also used in the Reaction Control System (RCS) of the first stage (PS1) of PSLV, the release said. The engine uses the earth-storable bipropellant combinations of Nitrogen Tetroxide as oxidiser and Mono Methyl Hydrazine as fuel in pressure-fed mode. It was developed by ISRO's Liquid Propulsion Systems Centre (LPSC).
LPSC redesigned the engine making it amenable to the Design for Additive Manufacturing (DfAM) concept thereby gaining considerable advantages. The Laser Powder Bed Fusion technique employed has brought down the number of parts from 14 to a single-piece, and eliminated 19 weld joints, saving significantly on the raw material usage per engine (13.7 kg of metal powder compared to the 565 kg of forgings and sheets for conventional manufacturing process) and reduced 60 per cent in the overall production time, the ISRO release said. The manufacturing of the engine was done in Indian industry (M/s WIPRO 3D), and the engine was hot tested at ISRO Propulsion Complex, Mahendragiri, Tamil Nadu. As part of the development programme, the injector head of the engine was realised and successfully hot tested earlier. Detailed flow and thermal modelling, structural simulation, and cold flow characterisation of the proto hardware were carried out to gain confidence for the hot test, ISRO said.
Consequently, four successful developmental hot tests of integrated engine were conducted for a cumulative duration of 74 seconds which validated the engine performance parameters. Furthermore, the engine was successfully tested for the full qualification duration of 665 seconds and observed that all the performance parameters were as expected. It is planned to induct this AM PS4 engine into the regular PSLV programme, ISRO added.

Source https://www.ndtv.com/india-news/isro-successfully-tests-3d-printed-rocket-engine-a-major-breakthrough-5637114

Mining, Metallurgical and Materials Engineering

8. A powerful tool speeds success in achieving highly efficient thermoelectric materials

Thermoelectric materials could play an important role in the clean energy transition, as they can produce electricity from sources of heat that would otherwise go to waste without generating additional greenhouse gases or requiring large up-front investment. But their promise has been slowed by the fact that most current thermoelectric materials don't efficiently produce enough power to be useful for many practical applications. The search for new, more efficient materials involving complex chemical compositions has been labor-intensive, requiring experimental testing of each proposed new multi-material composition, and has often involved the use of toxic or rare elements. In a paper researchers from the University of Houston and Rice University report a new approach to predict the realization of band convergence in a series of materials and, after demonstrating that one so-designed material, a p-type Zintl compound, would offer highly efficient thermoelectric performance, fabricated a thermoelectric module. They reported a heat-to-electricity conversion efficiency exceeding 10% at a temperature difference of 475 kelvin, or about 855 degrees Fahrenheit. Zhifeng Ren, director of the Texas Center for Superconductivity at UH (TcSUH) and corresponding author for the paper, said the materials' performance remained stable for more than two years. While a variety of approaches have been used to improve efficiency, a concept known as electronic band convergence has gained attention for its potential to improve thermoelectric performance. "It is normally difficult to get high performance from thermoelectric materials because not all of the electronic bands in a material contribute," Ren said. "It's even more difficult to make a complex material where all of the bands work at the same time in order to get the best performance**."** For this work, he said, the scientists first focused on devising a calculation to determine how to build a material in which all the different energy bands can contribute to the overall performance. They then demonstrated that the calculation worked in practice as well as in theory, building a module to further verify the obtained high performance at the device level. Band convergence is considered a good approach for improving thermoelectric materials because it increases the thermoelectric power factor, which is related to the actual output power of the thermoelectric module. But until now, discovering new materials with strong band convergence was time-consuming and resulted in many false starts. To efficiently predict how to create the most effective material, the researchers used a high-entropy Zintl alloy, $Yb_xCa_{1-x}Mg_yZn_{2-y}Sb_2$, as a case study, designing a series of compositions through which band convergence was achieved simultaneously in all of the compositions. Ren described how it works like this: If a team of 10 people try to lift an object, the taller members will carry most of the load while the shorter members do not contribute as much. In band convergence, the goal is to make all the band team members more similar -- tall band members would be shorter, in this example, and short members taller -- so all can contribute to carrying the overall load. Here, the researchers started with four parent compounds containing five elements in total -- ytterbium, calcium, magnesium, zinc and antimony -- running calculations to determine which combinations of the parent compounds could reach band convergence. Once that was determined, they chose the best among these high-performance compositions to construct the thermoelectric device. The calculation method could be used for other multi-compound materials, too, allowing researchers to use this approach to create new thermoelectric materials. Once the proper parent compounds are identified, the calculation determines what ratio of each should be used in the final alloy.

Source https://www.sciencedaily.com/releases/2024/05/240516205155.htm

Energy Engineering

9. Shedding light on perovskite hydrides using a new deposition technique

Perovskites are currently a hot topic in materials science due to their remarkable properties and potential applications, including sustainable energy technologies, catalysis, and optoelectronics, to name a few. Perovskites hydrides, whose molecular structure contains hydrogen anions (H^-), attract special attention because of their hydrogen-derived properties. Many experts believe these compounds could be key in the study and development of hydrogen storage technologies, such as fuel cells and next-generation batteries, as well as energy-saving superconducting cables.

Even though perovskite hydrides represent a unique platform for applied materials science, characterizing their physical properties has proven challenging. In particular, measuring the H^- conductivity of these crystalline materials is not straightforward. In most studies, researchers use powdered samples in their characterization analyses, meaning that H^- conduction is affected by the irregularities ('grain boundaries') in the crystals. To get true values for the intrinsic H^- conductivity of a given perovskite, one needs to produce a uniform, continuous single crystal with as few imperfections as possible. For complex ternary perovskite hydrides, achieving this is difficult, and very few research groups have attempted it. In a recent study, a team of researchers including Doctoral course student Erika Fukushi from the Department of Regional Environment Systems of the Graduate School of Engineering and Science at Shibaura Institute of Technology (SIT), Japan, decided to stand up to the challenge. Using an innovative approach to produce high-quality single crystals, the team performed some of the first intrinsic conduction measurements on ternary perovskite hydrides. To produce the perovskite single crystals, the researchers developed and pioneered a powerful method called 'H-radical reactive infrared laser deposition.' This approach involves shining an infrared laser onto a rotating disk-shaped pellet containing the metal atoms of the desired perovskite. In their study, the researchers wanted to produce $MLiH_3$ (where M is either Sr or Ba), and thus the pellet was made of a crudely compressed mix of MH_2 and LiH powders. As this pellet was heated up by the laser, the metals were released from it into a surrounding H-radical-rich atmosphere, obtained by injecting hydrogen into the reaction chamber through a heated tungsten filament. Nearby the pellet was a carefully selected substrate, onto which the hydrogen and metals spontaneously combined to form the desired perovskite. As atoms began to pile up onto the substrate, they spontaneously arranged and aligned themselves in a consistent manner with the crystal layers below them. This led to the epitaxial growth of a nanofilm on the substrate. "Our approach is unique in its ability to perform deposition in a radical hydrogen atmosphere, significantly promoting the reaction between the metal and hydrogen," explains Fukushi. "This results in the synthesis of single-phase hydride thin films by fully hydrogenating the metal atoms that naturally tend to persist in the film." The researchers performed multiple laser depositions under a variety of conditions and thoroughly characterized the resulting thin films. Using many advanced techniques, including X-ray diffraction, atomic force microscopy, and scanning electron microscopy, they determined the elemental distribution and crystallinity of each of the films. In this way, they determined the optimum conditions in their experimental setup for growing well-ordered, single-crystal $MLiH_3$. After confirming the absence of grain boundaries in the films, the team could finally carry out H^- conductivity measurements. Worth noting, these were the first measurements of the intrinsic H^- conductivity of these crystals, a crucial information for selecting materials in many hydrogen-related applications. With any luck, this newfound strategy for growing high-quality perovskite hydride crystals will open up new frontiers in hydrogen materials science and pave the way to sustainability.

Source https://www.sciencedaily.com/releases/2024/05/240516122550.htm

Interdisciplinary and Special Engineering Fields and Leadership in Academia, R&D and Industry

10. Researchers use artificial intelligence to boost image quality of metalens camera

Researchers have leveraged deep learning techniques to enhance the image quality of a metalens camera. The new approach uses artificial intelligence to turn low-quality images into high-quality ones, which could make these cameras viable for a multitude of imaging tasks including intricate microscopy applications and mobile devices. Metalenses are ultrathin optical devices -- often just a fraction of a millimeter thick -- that use nanostructures to manipulate light. Although their small size could potentially enable extremely compact and lightweight cameras without traditional optical lenses, it has been difficult to achieve the necessary image quality with these optical components. "Our technology allows our metalens-based devices to overcome the limitations of image quality," said research team leader Ji Chen from Southeast University in China. "This advance will play an important role in the future development of highly portable consumer imaging electronics and can also be used in specialized imaging applications such as microscopy." In a recent paper, the researchers describe how they used a type of machine learning known as a multi-scale convolutional neural network to improve resolution, contrast and distortion in images from a small camera -- about 3 cm × 3 cm × 0.5 cm -- they created by directly integrating a metalens onto a CMOS imaging chip. "Metalens-integrated cameras can be directly incorporated into the imaging modules of smartphones, where they could replace the traditional refractive bulk lenses," said Chen. "They could also be used in devices such as drones, where the small size and lightweight camera would ensure imaging quality without compromising the drone's mobility." The camera used in the new work was previously developed by the researchers and uses a metalens with 1000-nm tall cylindrical silicon nitride nano-posts. The metalens focuses light directly onto a CMOS imaging sensor without requiring any other optical elements. Although this design created a very small camera the compact architecture limited the image quality. Thus, the researchers decided to see if machine learning could be used to improve the images. Deep learning is a type of machine learning that uses artificial neural networks with multiple layers to automatically learn features from data and make complex decisions or predictions. The researchers applied this approach by using a convolution imaging model to generate a large number of high- and low-quality image pairs. These image pairs were used to train a multi-scale convolutional neural network so that it could recognize the characteristics of each type of image and use that to turn low-quality images into high-quality images. "A key part of this work was developing a way to generate the large amount of training data needed for the neural network learning process," said Chen. "Once trained, a low-quality image can be sent from the device to into the neural network for processing, and high-quality imaging results are obtained immediately." To validate the new deep learning technique, the researchers used it on 100 test images. They analyzed two commonly used image processing metrics: the peak signal-to-noise ratio and the structural similarity index. They found that the images processed by the neural network exhibited a significant improvement in both metrics. They also showed that the approach could rapidly generate high-quality imaging data that closely resembled what was captured directly through experimentation. The researchers are now designing metalenses with complex functionalities -- such as color or wide-angle imaging -- and developing neural network methods for enhancing the imaging quality of these advanced metalenses. To make this technology practical for commercial application would require new assembly techniques for integrating metalenses into smartphone imaging modules and image quality enhancement software designed specifically for mobile phones. "Ultra-lightweight and ultra-thin metalenses represent a revolutionary technology for future imaging and detection," said Chen. "Leveraging deep learning techniques to optimize metalens performance marks a pivotal developmental trajectory. We foresee machine learning as a vital trend in advancing photonics research."

Source https://www.sciencedaily.com/releases/2024/05/240515122715.htm

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ENGINEERING INNOVATION IN INDIA

Chandrayaan -2 Discovers Water Reserves Inside Lunar Polar Crater

The Chandrayaan-2 mission, spearheaded by the Indian Space Research Organisation (ISRO), has in May 2024 made a ground-breaking discovery that could redefine our understanding of the Moon. Recent findings from the mission have revealed the presence of substantial water reserves within the Moon's polar craters. This discovery is a scientific triumph and opens up future possibilities of lunar exploration and long-term human habitation on the Moon. A collaborative effort between ISRO's Space Applications Centre (SAC) and esteemed institutions such as IIT Kanpur, the University of Southern California, the Jet Propulsion Laboratory, and IIT (ISM) Dhanbad, led to this significant finding. The study indicates that the subsurface ice in lunar polar craters is estimated to be 5 to 8 times more abundant than the surface ice, particularly within the first couple of meters. The implications of this discovery are far-reaching. Accessing these water reserves will be a significant aspect of supporting future lunar missions. The study also sheds light on the regional disparities in water ice distribution. The northern polar region of the Moon boasts twice the amount of water ice compared to the southern polar region. This insight is invaluable for mission planning and site selection for future lunar expeditions. The methodology employed by the research team was comprehensive, utilizing seven instruments aboard NASA's Lunar Reconnaissance Orbiter (LRO). These included radar, laser, optical, neutron spectrometer, ultraviolet spectrometer, and thermal radiometer, which collectively contributed to a deeper understanding of the origin and distribution of water ice on the Moon. The insights gained from this study are not only crucial for ISRO's future in-situ volatile exploration plans on the Moon but also for selecting landing and sampling sites for missions aimed at exploring and characterizing lunar volatiles. As spacefaring nations around the world set their sights on the Moon, the presence of water ice becomes a strategic asset. It could potentially reduce the cost and complexity of lunar missions by providing in-situ resources, thereby accelerating the pace of space exploration. The discovery by ISRO scientists is a pivotal moment in our quest to understand the Moon and harness its resources. It is a reminder of the relentless pursuit of knowledge and the spirit of collaboration that drives Chandrayaan -2.

Source https://timesofindia.indiatimes.com/etimes/trending/chandrayaan-2-discovers-water-reserves-inside-lunar-polar-crater/articleshowprint/109837400.cms

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Note: *Fellows are requested to forward their achievements/achievements of their organziation to be featured under the heading "Engineering Innovation in India".*

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