



15TH NATIONAL FRONTIERS OF ENGINEERING (NatFoE) SYMPOSIUM

JULY 9-10, 2021

INDIAN INSTITUTE OF TECHNOLOGY HYDERABAD &
INDIAN NATIONAL ACADEMY OF ENGINEERING



SUMMARY

The National Frontiers of Engineering Symposium (NatFoE) is one of the annual flagship events of the Indian National Academy of Engineering (INAE). It was started in 2006 and was successfully conducted for 15 years. It brings together young and exceptional engineering professionals from businesses, industries, universities, and research organizations to discuss emerging and cutting-edge engineering and technology research and development.

Indian Institute of Technology Hyderabad hosted the 15th NatFoE symposium online from July 9 to 10, 2021. The themes conveyed in this symposium were Artificial Intelligence & Machine Learning, Advances in Materials & Manufacturing Technology, Infrastructure & Unconventional Energy, and Rural Entrepreneurship. In addition, as a part of the Diamond Jubilee celebrations of Indian Independence, a special session titled “Azadi Ka Amrit Mahotsav” was held to commemorate breakthroughs in the field of science and technology. A national level competition “Innovation in Manufacturing Processes” also formed a part of NatFoE.



ORGANIZERS

PROF. BS MURTY
Director, IIT Hyderabad



**ARTIFICIAL
INTELLIGENCE &
MACHINE
LEARNING**



DR. AMIT ACHARYYA



**DR. VINEETH N
BALASUBRAMANIAN**

**ADVANCES IN
MATERIALS &
MANUFACTURING
TECHNOLOGY**



DR. SUHASH RANJAN DEY



DR. SURYAKUMAR S

**INFRASTRUCTURE &
UNCONVENTIONAL
ENERGY**



**DR. CHANDRA SHEKHAR
SHARMA**



**DR. MAHENDRAKUMAR
MADHAVAN**

**RURAL
ENTREPRENEURSHIP**



DR. MUDRIKA KHANDELWAL



DR. SUSHMEE BADHULIKA

July 9, 2021 (Friday)

EVENTS & SUMMARY

INAUGURATION



INAUGURAL SESSION (9:00-9:25)

The event started with the welcome remarks by Prof. B. S. Murthy, Director, IIT Hyderabad, followed by Prof. Sivaji Chakravorti, Vice President, INAE, who gave a brief talk about the NatFoE symposium. Prof. Indranil Manna, President, INAE, gave the presidential remarks, followed by releasing the Symposium Abstract Booklet. Finally, the vote of thanks was provided by Dr. Chandra Shekhar Sharma, Coordinator, NatFoE 2021



Prof. Murthy B S
Director, IIT Hyderabad



Prof. Sivaji Chakravorti
Vice President, INAE



Prof. Indranil Manna
President, INAE



Dr. Chandra Shekhar Sharma
Coordinator, NatFoE 2021





ARTIFICIAL INTELLIGENCE & MACHINE LEARNING

The list of speakers and participants are as follows:

SESSION 1 (9:30-11:30)

The session started at 9.30 hrs. and continued till 10.45 hrs. Several experts and professors shared their insights on Artificial Intelligence & Machine Learning. This was followed by a 45 minutes discussion amongst participants and speakers.

SPEAKERS



Towards Explainable and Robust AI Practice

Dr. Vineeth N Balasubramanian
IIT Hyderabad



Learning Continually Without Forgetting Past Knowledge

Dr. Piyush Rai
IIT Kanpur



New Frontiers for Automatic Speech Recognition

Dr. Preethi Jyothi
IIT Bombay



Continual Learning Machines

Dr. Sunny Manchanda
DRDO DYSL AI



AI For Next Generation Healthcare Systems Design

Dr. Amit Acharyya
IIT Hyderabad

PARTICIPANTS



Dr. Sai Subrahmanyam Gorthi
IIT Tirupati



Dr. Mridula Verma
IDRBT



Dr. Abhijnan Chakraborty
IIT Delhi



Dr. Debangshu Dey
Jadavpur University



Dr. Yamuna Prasad
IIT Jammu



Dr. Mansi Sharma
IIT Madras

The talks in the session constituted a healthy mix of theory, methods and applications of AI in contemporary systems. The topics covered fundamental problems in emerging AI areas such as continual learning and learning with limited supervision, the application of contemporary deep learning models to low-resource Indian speech settings, the embedding of AI algorithms in hardware devices for healthcare applications, as well as recent frontiers in responsible AI including explainable AI. The talks were followed by thought-provoking discussions between the speakers and the attendees on the abovementioned topics, as well as more general trends on the future of AI.

KEY TAKE
AWAY
POINTS

- a) Need for explainable and robust AI practice -- key pillars of Responsible AI strategy proposed by NITI Aayog
- b) Important to also consider privacy issues while addressing explainable AI
- c) As AI and ML models mature for what is called “narrow AI”, increased need to learn “continually” by managing tradeoff between stability and plasticity of models
- d) Discussions on handling “how much models can realistically learn” - pointers to existing theory and failure prediction models was presented
- e) Discussions on learning models under chaos, challenges of gap between “lab-level” models and deployment scenarios
- f) Developing practical systems that leverage AI algorithms and models is essential, a nice set of examples for healthcare was presented
- g) Discussion on handling machine learning models on edge devices
- h)many other interesting questions!

A WAY
FORWA
RD

- 1. Need to collect datasets relevant to the Indian context, especially in areas related to speech and text, where India has many indigenous languages and dialects; this is especially essential for technology solutions for rural India
- 2. Need for holistic educational and research programs that bring together all stakeholders -- ML scientists, ML practitioners, ML hardware creators, end users -- to a common ground
- 3. Need to focus on AI/ML research that addresses learning under uncertainty/chaos/changing data distributions/noise/corruptions/etc
- 4. Responsible AI an important charter for integration of AI models in risk-sensitive application domains - an important focus laid down by Govt of India also, including perspectives of fairness, accountability, transparency and ethics
- 5. Funding programs for startups to take lab prototypes to the field and consumers’ hands



INNOVATION IN MANUFACTURING PROCESSES

IMP
SESSION
National
Level
Project
Competition
(12:00-13:00)

- IMP is a national-level project competition held for Engineering students (UG & PG) and Startups.
- Eighteen (18) entries were shortlisted for the final round (each six from UG, PG, and Startups)
- The selected entries were allowed to showcase their innovation through a walkthrough demo portal active along with NatFoE reference

Related Links : [IMP - 2021 Flyer](#) [NATFOE - 2021](#) [IIT Hyderabad](#) [INAE](#)

IMP
Innovation in Manufacturing Processes

IMP-2021 is a National Level Project Competition organized by INAE and IIT Hyderabad together with NATFOE-2021. It is open to all Engineering students and practitioners (UGs, PGs and startups). This website showcases the selected entries to the competition. Winners amongst these entries will be announced on 10th July, 2021

Navigation: All, UG, PG, Startup, Smart Workplace, Sustainability, Product Manufacturing, Mobility, Misc

Project 1: Design and Testing of Liquid Rocket (Diagram)

Project 2: Headlight System for Automobile (Image)

Project 3: Automatic Sanitizer Dispenser (Image)

Webex Meeting Info | Hide Menu Bar

File Edit Share View Audio & Video Participant Meeting Breakout Sessions Help

Participants: IIT Hyderabad NATFOE IMP, ajay nagila, ananya gangadharan, Arjun, Asma Jamesh, B H Shekar, C Krishna Mohan, C. Vishnu, CC-Office Host, Chandra Shekhar Sharma Co-host

Controls: Mute, Stop video, Share, Close



ADVANCES IN MATERIALS & MANUFACTURING TECHNOLOGY

The list of speakers and participants are as follows:

SESSION 2

(14:30-16:30)

The session started at 14.30 and continued till 16.30, where several experts and professors shared their insights on Advances in Materials & Manufacturing Technology.

Motivation: The world's economic growth in the 21st century lies in technical innovations in Advanced Materials and Manufacturing (United Nations Industrial Development Organization Vienna 2013)

SPEAKERS



Electrochemical Process for Design and Development of New Age Materials

Dr. Suhash R. Dey
IIT Hyderabad



Metal Oxide Nanomaterials with Spiky Morphology for Multifunctional Applications

Dr. Neena S. John
Center for Nano and Soft Matter Sciences (CeNS)



Towards Faster Qualification of Powder Bed Fusion Process Through Multiscale Linked Surrogate Models

Dr. Senthilkumar K
IIIT DM Kancheepuram



Solid-State Sintering Using Friction Processing

Dr. Vikranth Racherla
IIT Kharagpur



Studies on Additive Manufacturing of Large Metallic Components

Dr. Suryakumar S
IIT Hyderabad

PARTICIPANTS



Dr. Tapasi Sen
INST



Dr. Chandra Sekhar
Tiwary
IIT Kharagpur



Raghu Adla
Founder & CEO,
Paninian India Pvt.
Ltd.



Dr. D. Venkata Kiran
IIT Tirupati



Ms. Priyanka Nadig
CYIENT



Dr. I. A. Palani
IIT Indore

KEY TAKE
AWAY
POINTS

1. The Talks were mainly focused on Fabrication Techniques/Simulations (electrochemical, microwave, additive manufacturing, friction processing) and Applications of Advanced Materials of various architectures (high entropy alloys-thin films & nanowires, spiky molybdenum trioxide, large metallic components).
2. Q&A session led the Speakers to think more in the following areas
 - a) Utilization of spoken fabrication techniques either for delivering the final product or for post-processing needs. One example query was how to change the surface hardness of tool steel.
 - b) Cost-effectiveness and ease of complete utilization of the advanced materials processing like from nanoparticle synthesis to Additive Manufacturing.
3. Discussion among the participants led to the following takeaway points
 - a) Additive Manufacturing (AM) is currently marred by three troubles: (i) Residual Stress, which leads to cracks and scrapping of manufactured items. One way is to adopt a specific scan strategy like chequered patterning to manage Residual Stress, and another way may be controlled post thermal treatment. (ii) Generation of Defects during AM can be predicted and controlled through advanced level of Numerical Modelling and Artificial Intelligence/Machine Learning (AI/ML) models. (iii) Microstructural Homogeneity, which can be tackled through AI/ML simulations.
 - b) Next-generation digital tools (AI/ML) for enabling AM are a must. But this generates terabytes of data for each simulation and having a data constraint environment like in India. A consortium approach to pool dataset (called **fleet learning**) can be made at IITs like IIT Hyderabad. By sharing datasets and analyses, innovations shall be democratized, but fundamentally the startup's ecosystem shall be enriched, and this shall serve the AM-based industries of India.
 - c) The constraint of printing space, the weight of the parts, and the flexibility of the usage of the AM process directly in the field are also major challenges. For example, for making complex-shaped aerospace parts or Oil & Gas sector, Wire Arc AM (WAAM) technique is told to be more suitable. AAM may also be applied to fabricate Pseudoelastics for Industry 4.0 applications and defect repairs.
 - d) The challenges associated with the AM of advanced functional materials are even higher. For manufacturing Shape Memory Alloy Actuators, a new Electrochemical Sintering technique is proposed.
 - e) In the Advanced Materials section, the industrial-scale realization of the practical outcome of lab-done research remains minimal. For example, many researchers are working on biosensors, but rarely a practically usable sensor has come out in the market. Two suggestions were proposed: Complementary Collaboration with others and Knowledge-sharing by joining National/International Societies. Another example was pointed out during the after-talk discussion of Prof. Tapas K. Maji's presentation under Azadi ka Amrit Mahotsav on making practical CO₂ converters using MOFs.

A WAY
FORWARD

1. Additive manufacturing, together with advanced digital tools, can produce structural materials for direct usage. But additive manufacturing of advanced functional materials remained a challenge.
2. So fabrication and Industrial-level scale-up of Advanced Materials for high-end applications require new-age manufacturing technologies like Wire Arc Additive Manufacturing, Electrochemical Sintering, and the help of computational simulations.
3. To enable faster advancement in Additive Manufacturing, a consortium approach to pool dataset (fleet learning) can be made at IITs and access several startups/small industries.
4. Bringing out lab-scale research on Advanced Materials into a practical product from molecular level sensors into the Device Level requires Complementary Collaborations and Knowledge Sharing Associations. INAE could take some initial steps.
5. Skilled manpower generation programs can be initiated in this theme.



VIRTUAL TOUR

(17:00-17:15)

IITH VIRTUAL TOUR



PRE – DINNER TALK

(17:15-18:00)

ADVANCES IN AEROSPACE MATERIALS AND MANUFACTURING TECHNOLOGIES



Dr. Tessa Thomas

Distinguished Scientist & Director General - Aeronautical Systems (AS)
DRDO, Ministry of Defence, Government of India



CULTURAL EVENT

(18:30-19:30)

SUFI QAWWALI

By AHMED BROTHERS



Venue: A Block Auditorium, IIT Hyderabad (Live Streamed on Youtube)

July 10, 2021 (Friday)



SESSION 3
(09:30-11:30)

The session started at 09.30 AM and continued till 10.45 hrs., where several experts and professors shared their insights on Infrastructure & Unconventional Energy. Later discussion session was held for 45 minutes

INFRASTRUCTURE & UNCONVENTIONAL ENERGY

The list of speakers and participants are as follows:

SPEAKERS



Cold-Formed Steel for Sustainable Construction

Dr. Mahendra K. Madhavan
IIT Hyderabad



Quantification and Spatial Mapping of Atmospheric Corrosion Hazards in Indian Context

Dr. Arjun Sil
NIT Silchar



Stabilization of Ballasted Rail Tracks to carry High-Speed Trains

Dr. Syed K. K. Hussaini
IIT Patna



Improvisation in Carbonaceous Materials and their Implication in Metalair Battery and Third Generation Ammonia Synthesis

Dr. Ramendra S. Dey
INST Mohali



Metal-CO₂ Battery: An Indigenous Technology for India's Mars Mission and An Attempt to Fix CO₂ Emissions on Earth

Dr. Chandra Shekhar Sharma
IIT Hyderabad

PARTICIPANTS



Dr. Abhishek Rajput
IIT Indore



Dr. Raheena M
IIT Ropar



Dr. Jothi Saravanan
IIT Bhubaneshwar



Dr. R. Vinu
IIT Madras



Dr. Mukesh Kumar
IIT Ropar



Dr. Ananya G.
GODI Energy



INFRASTRUCTURE & UNCONVENTIONAL ENERGY

KEY HIGHLIGHTS

Cold-Formed Steel for Sustainable Construction

Dr. Mahendrakumar Madhavan presented the importance of sustainable construction; Shift in construction from concrete to structural steel. He emphasized the need to develop design specifications for cold-formed steel to meet the “Housing for All” objectives of the GoI. An immediate need is to establish “Center for Excellence in Cold-formed Steel” to promote sustainable construction to solve the housing crisis in India

Quantification and Spatial Mapping of Atmospheric Corrosion Hazards in Indian Context

Dr. Arjun Sils's talk mainly focused on corrosion dynamics and mapping in a spatial, temporal manner for the Indian subcontinent based on the real atmospheric dataset (relative humidity, temperature, chloride & sulphate) for 39 years. In this study global empirical model was developed with a 95% confidence limit statistically. The results show this proposed model behaved as per corrosion mechanism reliably and mapped the entire country dividing spatially into five corrosive zones that would help Govt, planners, and industries for better future planning in a cost-effective manner.

Stabilization of Ballasted Rail Tracks to carry High-Speed Trains

Dr. Syed presented on the investigation of geogrid and Polyurethane in strengthening the ballasted tracks to cater to high-speed trains. The use of the right type of geogrid can significantly reduce the deformation and degradation of ballast. Further, Polyurethane is found to enhance the track performance better than geogrid. However, suitable field investigations are to be conducted before implementing these stabilization techniques in practice.

Improvisation in Carbonaceous Materials and their Implication in Metal-air Battery and Third Generation Ammonia Synthesis

Dr. Dey presented the active electrode materials development for metal-air batteries and ambient NH₃ synthesis. He has demonstrated the role of single, dual, and binary transition metal-doped carbon matrix as a bifunctional electrocatalyst for Zn-air battery. He has also emphasized the different types of electrode materials for electrochemical nitrogen reduction reactions. The role of transition metal-doped carbon, defect engineering nanomaterials, and interface engineering to have better Faradic efficiency and yield of NH₃.

Metal-CO₂ Battery: An Indigenous Technology for India's Mars Mission and An Attempt to Fix CO₂ Emissions on Earth

Dr. Sharma presented a battery technology which can be used on Mars Mission, where the extreme environment poses a grand challenge. Since Mars atmosphere primarily consists of CO₂, Metal (M)-CO₂ battery technology is proposed to be a viable option. This would reduce the payload mass and launch cost. The batteries developed from the proposed work can be applied in energy conversion and storage systems as it offers higher energy density than the currently used lithium-ion batteries.



SPECIAL SESSION (11:30-13:00)

This was a special session to mark the Diamond Jubilee celebration for Indian independence where one speaker from each theme was selected.

AZADI KA AMRIT MAHOTSAV

The list of speakers and participants are as follows:



CHAIR



Prof. Indranil Manna
President, INAE



SPEAKERS



Rural Entrepreneurship Model for Improving Menstrual Hygiene
Dr. Suhani Mohan
Saral Design



Green Synthesized Hybrid Nanostructured Materials for Green Hydrogen Generation
Dr. Pooja Devi
CSIR-CSIO



Samanantar: The Largest Publicly Available Parallel Corpora Collection for 11 Indic Languages
Dr. Mitesh Khapra
IIT Madras



Metal-organic 'Soft' Hybrids for Photocatalytic CO₂ Reduction and H₂ Production
Dr. Tapas Kumar Maji
JNCASR



AZADI KA AMRIT MAHOTSAV

Rural Entrepreneurship Model for Improving Menstrual Hygiene

Ms. Suhani presented the novelty in terms of machine that produces faster production than the manual method. But it is slower than the large manufacturers' method but the cost of 50% compared to large manufacturers. It is a midway solution between manual and large manufacturers where the cost is moderate, but at the same time, there is no compromise on quality.

Samanantar: The Largest Publicly Available Parallel Corpora Collection for 11 Indic Languages

Dr. Mitesh Khapra demonstrated the application of AI for language translation. Translations can be made from English to ethnic Indian languages and vice versa. This is done using the existing data on the internet to identify language and phrase patterns in translation. The usage is currently limited to translation of supreme court judgments so that lower courts can use the judgments for faster delivery of verdicts. A lot more work to be done in this area for better translation. This will not replace 100% manual translation but will significantly improve the manual translation process for better efficiency.

Green Synthesized Hybrid Nanostructured Materials for Green Hydrogen Generation

Dr. Pooja Devi emphasized on the emerging deficit in demand and supply of energy, and that escalating global air pollution makes it necessary to develop alternative solutions. Amongst varied sources of renewable energy, hydrogen holds a key place due to its high combustion energy, low ignition, fast flame propagation speed, wide operational range, and clean combustion. However, in present scenario its high production cost and low efficiency, limit its techno commercial viability. She presented her group's work on green route obtained carbon and plasmonic materials as an efficient photosensitizer for wide band gap materials for photo electrochemical water splitting in this direction.

Metal-organic 'Soft' Hybrids for Photocatalytic CO₂ Reduction and H₂ Production

Dr. Maji presented rational design and synthesis of several LWMG and their self-assembly with metal ions towards novel functional hybrid materials. In general such materials are built by the self-assembly of low molecular weight gelators (LWMG) based linker and metal ions. The inclusion of metal ions into low molecular weight gelator systems has proven to be advantageous in combining the functionality of traditional coordination chemistry with the wide array of exciting applications. Stimuli responsive behaviour is an additional benefit. These soft hybrids can also be exploited in energy and environmental applications.



SESSION 4 (14:30-16:30)

The session started at 14.30 and continued till 15.45 am, where several experts and professors shared their insights on Advances in Materials & Manufacturing Technology. Later a discussion session was held till 16:30 hrs.

Motivation: To Bring entrepreneurs, academics, and technologists together for sharing issues, and possibilities for the development and improvement of lives in rural areas

RURAL ENTREPRENEURSHIP

The list of speakers and participants are as follows:

SPEAKERS



Role of Technology and Design in Rural Development

Dr. Omkar Prasad
IIT Hyderabad



Entrepreneurship Opportunities in Indian Livestock

Dr. Rajib deb
ICAR - NDRI Karnal



Steering Data-Driven Agriculture in India: A Way Towards Lower Cost Better Output

Dr. Shailendra Tiwari
Fasal



A Way Towards Sand Based Add-On Filter For Zero Bacteria Drinking Water

Dr. Sriparna Chatterjee
CSIR-Institute of Minerals and Materials Technology, Bhubaneswar



Antimicrobials For Preservation of Fresh Produce and Hygiene

Dr. Mudrika Khandelwal
IIT Hyderabad

PARTICIPANTS



Dr. Poonam Kumari
IIT Guwahati



Dr. Swati Ghosh Acharrya
HCU



Dhruv Gupta
Head of Operations,
iTIC Incubator, IIT
Hyderabad



Dr. Priya Jadhav
IIT Bombay



Dr. Siddhartha Singha
IIT Guwahati



Dr. Sushmee Badhulika
IIT Hyderabad

Role of Technology and Design in Rural Development

Dr. Prasad Onkar talked about the role of technology and design in Rural Development, including case studies in specific areas like education, construction materials, craft rehabilitation. He mentioned the need to utilize resource-constrained spaces best to enhance abilities.

Entrepreneurship Opportunities in Indian Livestock

Dr. Rajib Dey discussed Entrepreneurship Opportunities in Indian Livestock. How tremendous opportunities can be generated in the livestock sector that will result in rural entrepreneurship in India. Opportunities in terms of contributing towards health and nutrition of the household, complementing incomes and technology.

Steering Data-Driven Agriculture in India: A Way Towards Lower Cost Better Output

Dr. Shailendra Tiwari, founder of Fasal - Usage of various sensors integrated with AI and IoT and crop science, Fasal looks at predicting answers to questions such as - How much irrigation? When should the crop be irrigated? Chances and mitigation of diseases?

A Way Towards Sand Based Add-On Filter For Zero Bacteria Drinking Water

Dr. Sriparna Chatterjee- safe drinking water zero bacteria drinking water satisfying the WHO standard development of an add-on technology to remove all kinds of bacteria/microorganism contamination. It will find wider acceptability and dissemination in all sections of society. She also spoke about the development of methods and testing.

Antimicrobials For Preservation of Fresh Produce and Hygiene

Dr. Mudrika Khandelwal demonstrated the usage of traditional knowledge to deploy antimicrobial in a modern way to mitigate fresh produce storage and rural hygiene issues. This effort supports the need for nutritional security, an efficient and healthy working population, and gender inequality

KEY TAKE AWAY POINTS

1. Design and innovation are not enough for rural entrepreneurship. It is important to consider marketability and emotional connection.
2. There are programs like Unnat Bharat Abhiyan which can help to integrate academics to rural needs
3. Technological intervention for automation, processing, and preservation to promote rural entrepreneurship profitability
4. Interventions in Agritech can tackle Decision uncertainty, poor resource utilization, productivity, food safety, and sustainability – drive for precision agriculture
5. Natural materials can be leveraged and modified for common purposes such as filtration
6. Academics and research labs can support the development of testing and training sessions
7. Focus on infection management for various areas such as shelf life extension and health/hygiene

A WAY FORWARD

- I. It is important to control migration from rural to urban by making rural entrepreneurship lucrative
- II. All step integration is needed for real impact on rural entrepreneurship and, in particular, the last step to the grassroots
- III. Entrepreneurs and academics need to join hands for efficient and quick translation
- IV. Specific push needed in sectors like livestock, local crafts pottery, education agriculture to generate revenue
- V. Technological interventions are necessary
- VI. Design innovation marketability and emotional connect; Knowledge dissemination can further enable this culture



IMP SESSION
(17:00-17:45)

IMP GRAND FINALE

Out of eighteen entries, six were selected by the experts from INAE and IIT Hyderabad. The first and second place winners in each of the three categories were announced by Jury-Chair, Prof. Sivaji Chakravorti. This was followed by a quick bite from the winners



PRE – DINNER TALK
(17:45-18:30)

EVOLUTION OF HIGH STRENGTH AUTOMOTIVE STEELS AND THEIR FUTURE



Dr. Debashish Bhattacharjee

Vice President (Technology and New Materials Business), Tata Steel



VALEDICTORY
SESSION
(18:30-19:30)

VALEDICTION

A summary of the whole event, road map and concluding remarks were presented



Prof. Sivaji Chakravorti

Vice President, INAE

