

## 16<sup>th</sup> National Frontiers of Engineering (NatFoE) Symposium, 2022

The inaugural program was presided over by the INAE President Prof. Indranil Manna. During the inaugural session, Prof. Sivaji Chakravorti, Vice President, INAE delivered the Welcome address and explained the objective of the symposium. He emphasized the critical role of the symposium in shaping the course of future research in cutting-edge engineering disciplines by bringing together young, talented and enterprising engineering professionals to deliberate on their research outcomes. Prof. Indranil Manna in his presidential address delved into the activities of INAE in forwarding the engineering education, research and knowledge transfer at various levels. He also enumerated how INAE contributes towards nation building by advancing expertise to various governmental and non-governmental organizations. Prof. Ashutosh Sharma, Chair Professor of IIT Kanpur and former Secretary Department of Science and Technology delivered the inaugural address of the symposium as the Chief Guest. He engrossed the audience with his inspiring speech covering a wide areas of research scope and elaborated the ways how the young researchers should carry forward research overcoming disciplinary barrier. He also stressed upon the presentation of the research results in addition to the quality of research. Pro Vice-Chancellor, Jadavpur University Prof. Chiranjib Bhattacharjee delivered a speech as the Guest of Honour. He elaborated the contribution of Jadavpur University towards education and research in the various Engineering disciplines. Prof. Amitava Datta, Coordinator of the Symposium moved the vote of thanks and expressed heartfelt gratitude to INAE for giving Jadavpur University an opportunity to organize the prestigious event. He also thanked everyone who helped in organizing the symposium.

There were four thematic areas in the symposium and a separate technical session was held in each of the thematic areas. The session of each thematic area was designed to have one plenary talk and four invited talks by experts from the relevant discipline. All the technical sessions were conducted by the respective theme conveners. In addition, a special session on *Azadi ka Amrit Mahotsav* was organized to commemorate the seventy-fifth year of Indian independence and the achievements of the country during this period. The young participants attending the symposium also presented their research in a poster session separately organized for them. All the speakers and participants have been chosen by the theme conveners, symposium coordinator and Prof. Sivaji Chakravorti as adviser very critically after thorough review of their research activities. It has also been ensured that the participation is across the entire country giving a national perspective to the symposium.

The first technical session was conducted by Prof. Ranjan Ganguly of Jadavpur University as the theme convener. The session began with a Plenary Lecture by Dr. Dhananjaya Dendukuri of Achira Labs Pvt. Ltd. In his talk titled “Rapid advances in point-of-care testing through microfluidic technologies, in a post COVID world,” Dr. Dendukuri discussed the market opportunities of microfluidics-enabled point-of-care testing (PoCT) and immunoassays and shared the experience of Achira Labs in translating the technology from *Lab to Market* through a few real-life examples. In the first invited lecture of the session, Dr. Pallab Sinha Mahapatra of IIT Madras deliberated upon a highly interesting topic titled “3D paper-based milk adulteration detection device” where he showed how capillary-driven flow through paper-substrates can be leveraged to detect the presence of milk adulteration. The next invited lecture was delivered by Dr. Pranab Kumar Mandal of IIT Guwahati, who spoke on a topic titled “Low-cost POC devices for detection of vitamin D-deficiency in blood.” Dr. Mandal described his research endeavour on the development of a paper-based miniaturized microfluidic biosensor that can detect the vitamin-D level in whole blood sample and diagnose its deficiency – a common health problem in a large section of Indian women population, especially those belonging to lower socio-economic groups. In the third lecture, titled “High-performance miniaturized physical sensors based on nanocomposite materials and nanostructures,” Dr. Shrutidhara Sarma of IIT Jodhpur shared her pursuit with nanocomposite materials towards fabrication of a miniature physical sensor that can fit into a smart wearable architecture. The fourth and the last invited lecture was delivered by Dr. Dibyendu Das of IISER, Kolkata, who presented a futuristic paradigm of biosensing through his talk titled “Short Peptide-based Nanostructures as Micro-swimmers for Potential Biosensor Applications.” He deliberated on how nanomotor chassis, constructed from biological precursors and powered by

biocatalytic transformations, can emulate the advanced traits of bacterial motility, and such transport can be deployed in microfluidic architecture to develop smart biosensors that will feature high sensitivity and specificity.

The thematic session on “Waste Valorization and Circular Economy” was chaired by theme convener Prof. Achintya Mukhopadhyay of Jadavpur University. In the plenary lecture of the session entitled “Biomass Gasification – Science, Technology and Applications”, Prof. M.R. Ravi of IIT Delhi briefly introduced the different types of gasifiers and discussed the science, technology and applications of gasification, highlighting how biomass gasification can be used as a potential solution to the environmental issues caused by stubble burning. Following it, in the first invited lecture entitled “Hydrothermal Liquefaction of Diverse Feedstocks for Sustainable Solid Waste Management and Energy Production in Indian Context”, Prof. R. Vinu from IIT Madras deliberated on generation of liquid biofuel from municipal solid waste, which in the Indian context, is largely unsegregated and heterogeneous. He also narrated the journey of a IIT Madras-based startup that has come up as a consequence of their research. In the second invited talk entitled “Waste Valorization in a Circular Symbiotic Network”, Prof Jayakrishna Kandasamy of Vellore Institute of Technology spoke on circular symbiotic network and sustainable manufacturing. He showed how the focus on areas like machine learning, Industrial IOT and design for disassembly highlights the importance of a multidisciplinary approach in this field. In the third invited talk entitled, “Circular Economy on Utilization of Waste Biomass in Pollution Control and Energy Generation”, Prof. Papita Das from Jadavpur University talked on circular bioeconomy as a convergence of circular economy and bioeconomy. She described the research of her group on generation of bioethanol from peanut shell. In the last invited lecture of the session entitled “Green Biorefineries Towards Circular Economy: In Search of Healthy Alternatives”, Prof Amit Arora of IIT, Bombay brought up the issue of utilization of waste generated from food processing industry and food products and explained how it could alleviate the problem of a sustainable supply chain.

In the third thematic session titled “Resource-constrained Translational Technology” Prof. Rajib Bandyopadhyay of Jadavpur University chaired the session as convener. The plenary talk of the session was delivered by Dr Arpan Pal of TCS Research who presented a few examples on AI and IOT applications, where their research team has been working extensively for a few decades. Dr Pal then elaborated the challenges of resources, particularly in the context of edge computing, which are limiting the applications of big data computation for translational technologies. The first invited speaker Dr. Kumaravel S. of NIT Calicut elaborated the applications of different appliances used for power system and the challenges in this area. He mentioned about the wide gap between the researchers and the power industries to translate the novel concepts or solutions and mentioned some key points for minimizing this gap. The second invited speaker Dr Debangshu Dey of Jadavpur University presented the problems associated with the distribution of electrical power in our country and highlighted the need for condition-based monitoring systems instead of time-based systems. He concluded mentioning a few advanced signal processing techniques based on AI models and Rough Set theory for condition-based monitoring systems of high voltage electrical appliances. Dr Sri Krishna Kumar of IIT Kharagpur highlighted the need for real-time decision making and elaborated the financial implications for appropriate real-time decision making in supply chain management in the manufacturing sector. He also mentioned the role of IOT in the manufacturing industries and how it can be utilized towards implementation of Industry 4.0. The last invited speaker of this session was from Dr. Chirasree Roy Chaudhuri of IEST Shibpur. She explained the diagnostic technologies using various types of biosensors with emphasis on the resource constraints due to small sample volume and highlighted the uses of FET biosensor, graphene and zinc oxide nanorod based sensors.

The fourth thematic session in the symposium on “Nanostructured Surfaces for Functional Materials and Systems” was conducted by Prof. Samit K. Ray of IIT Kharagpur as the theme convener. The session covered lectures on nanomaterials-based surface engineering, nano-sensors and materials for energy harvesting with one Plenary and three Invited lectures. The Plenary lecture on “Liquid Infused

Slippery Surfaces: From Fabrication to Functionalities” was delivered by Prof. Suman Chakraborty, IIT, Kharagpur. The plenary speaker reviewed some fundamental scientific and technological aspects concerning the stabilization dynamics of liquid infused slippery interfaces (LISS), which yield self-healing and long-lasting surface finish in engineering materials. By harnessing rose-petal mimicking microstructures, the speaker illustrated several examples on controlling the surfaces, which contain self-propelling features of soft moieties having emerging applications in energy harvesting and medical diagnostics. The first invited talk was delivered by Dr. Ritesh Kumar, CSIR-Central Scientific Instrumentation Organization, Chandigarh on “Understanding Olfactory Spaces: A Journey from Molecule to Machine learning and instrumentation”. Dr. Kumar discussed the odour source localization technique extensively in biology, organic chemicals and food products and demonstrated the efficacy of machine learning technique for odour and smell sensing. Finally, he highlighted his work on the development of Electronic Nose and Tongue systems. The second invited talk was delivered on “Functionalized Graphitic Carbon Nitride (g-C<sub>3</sub>N<sub>4</sub>) Nanosheets for Flexible and Wearable Triboelectric Nanogenerators” by Dr. Sayan Bayan from Rajiv Gandhi University, Arunachal Pradesh. Dr. Bayan discussed the mechanism of Triboelectric Nanogenerators (TENGs) for mechanical energy harvesting through appropriate surface functionalization of graphitic carbon nitride nanosheets. The third invited lecture was delivered by Dr. Gururaj Telasang, ARCI, Hyderabad. Dr. Gururaj described the use of Plasma and Laser Surface Texturing and coatings to prepare multifunctional surfaces with emerging applications in engineering products. The presentation included the use of hierarchical micro-nanostructures using femtosecond laser pulses to improve the machinability of tool inserts by reducing diffusion wear; creation of microchannels on cyclic olefin polymer films for the microfluidic field etc.

The special session of *Azadi ka Amrit Mahotsav* had four very distinguished keynote speakers from different fields of engineering science and technology. The first talk of the session was delivered by Prof. Samir Kumar Pal of S.N. Bose Centre for Basic Sciences, who introduced the potential of nanomedicine to cure many fatal diseases. He demonstrated how the spectroscopic analysis can be used to develop advanced medical diagnostic tools and emphasized the importance of interfacial dynamics of nanocomposites in medical diagnostics. In the second lecture of the session, Prof. Avinash Kumar Agarwal of IIT Kanpur talked about the methanol economy under the Indian perspective. He discussed the potential of methanol as a transportation fuel along with its technical and economic viabilities. The opportunities and challenges of methanol as a fuel and the gap areas in the translation to the commercial use were discussed. In the third lecture, Prof. Mahati Chittem of IIT Hyderabad dealt with the social science approach to the medical technology analysing the behaviour of the people through personal interactions with stakeholders, like doctors, nurses, technicians and of course patients. Study results were presented on the difficulties in performing peripheral vein intrusion to reach at important conclusions which can bring relief to the patients. Finally, in the last lecture of the session, Mr. K. Rashid of Genrobotics Innovation, a start-up company from Kerala, explained their work in eliminating manual scavenging by sanitation workers leading to upliftment of the society and helping to overcome fatal diseases.

A plenary talk was delivered by Prof. P.P. Chakrabarti, former Director, IIT Kharagpur, in a special session on 18<sup>th</sup> June evening. Prof. Chakrabarti in his unparalleled style enthralled the audience with an overview of Artificial Intelligence and Machine Learning and portrayed the future perspectives of the subject. All the talks of every session led to engaging discussions following the presentations and also beyond the session during the symposium. Strong synergistic areas were identified by the speakers and other participants in these domains, and engaging research collaborations are expected as a future outgrowth. During the valedictory session, the theme conveners summarized the outcome of the sessions of their respective theme areas and the participants expressed their opinions on the symposium. All the participants spoke highly about the organization of the symposium and stated that the peer interactions and discussions held during the symposium will help them in their future research. Participation certificates were distributed during the valedictory sessions by Prof. Purnendu Ghosh and Prof. Sivaji Chakravorti, Vice Presidents of INAE.