IIM
Metallurgy
Materials Engineering

THE INDIAN INSTITUTE OF METALS

ABSTRACT e-BOOK

International Conference on Advanced Materials and Manufacturing for Sustainable Future

Date: 13th November 2021

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- Anindita Chakraborty
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75th Annual Technical Meeting of Indian Institute of Metals and International Conference, 2021

Jointly Organized by:
Indian Institute of Metals Jamshedpur & Kolkata Chapters
and Tata Steel Limited

International Conference on Advanced Materials and Manufacturing for Sustainable Future

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Preface

The Indian Institute of Metals (IIM) is celebrating its 75 years of service to the nation through a year-long bouquet of events. On this occasion, an International Conference, titled Advanced Materials and Manufacturing for Sustainable Future is being organized by the Institute on 13th November 2021. The program is being hosted virtually.

The keynote lecture will be delivered by the Chief Guest of this event, Dr K VijayRaghavan, Principal Scientific Advisor, Govt. of India.

This will be followed by two technical sessions with invited presentations and one panel discussion by world-renowned academicians, professionals and industry leaders from all over the world. The theme of the conference will revolve around the topic of sustainability with a focus on the development and application of advanced materials and manufacturing technology.

A broad outline of the conference is given below:

- Material synthesis/development/design – covering the aspects of (a) Integrated Computational Materials Engineering (ICME) and materials genome in process technology, (b) Emerging technology in 2D and functionally graded materials development and, (c) Material development for energy transition
- Modern application development and trends – covering the aspects of (a) Light weighting and safety in mobility and e-mobility, (b) Green building and construction solution and, (c) Additive manufacturing
- Panel discussion on sustainability (cradle to grave) – focusing on future material technologies for circular economy/urban mining, hydrogen as an alternate energy, future trends in Carbon Capture and Sequestration (CCS) in metal & materials industry etc.

We are thankful to all the presenters and the panelists for their valuable contribution without which this volume might not have taken the present shape. We are also indebted to Prof Rangan Banerjee, IIT Bombay for moderating the panel discussion session.

Content

Keynote lecture

Professor K.VijayRaghavan

Principal Scientific Adviser to the Government of India

Professor K. VijayRaghavan is the Principal Scientific Adviser to the Government of India, succeeding Dr R. Chidambaram on April 3, 2018 and the Chairperson of Prime Minister's Science, Technology & Innovation Advisory Council (PM-STIAC). He was Secretary, Department of Biotechnology (DBT), Government of India from January 28, 2013 to February 2, 2018.

The Principal Scientific Adviser works with all arms of the Government, with our States, our citizens, national and international agencies. The goal is that the benefits of science, technology and innovation solutions reach the most needy, for the sustainable development of India and for the well being of our planet.

VijayRaghavan is also a Distinguished Professor at the National Centre of Biological Sciences (NCBS), Tata Institute of Fundamental Research Bangalore (TIFR) and was the NCBS Director till 2013. He studied Chemical Engineering at the Indian Institute of Technology, Kanpur, holds a Ph.D. in Molecular Biology from the Tata Institute of Fundamental Research was a Senior Research Fellow at the California Institute of Technology. His research is on nerves and muscles and how complex behaviour emerges during animal development.

VijayRaghavan is a Fellow of the Indian Science Academies, the Royal Society, the Academy of Medical Sciences (UK) and a Foreign Associate of the US National Academy of Sciences. He was awarded the Padma Shri by the Government of India in 2013.

SESSION I :
Material Synthesis/ Development/Design

K Ananth Krishnan

Executive Vice President & Chief Technology Officer,
Tata Consultancy Services

Ananth directs Research, Innovation and Co-Innovation in TCS. Under his leadership, TCS has created a significant range of new products and services with a wide IP portfolio. Ananth has architected an agile model for innovation at scale, across the entire organization. He has been a member of the TCS Corporate leadership team since 1999 and has led several strategic initiatives.

Ananth has served on several Governing Councils of Academia, Industry Advisory boards, and Government and Alumni committees.

He was elected a Fellow at the Indian Academy of Engineering (INAE) in recognition of his contributions towards engineering in 2013. He was named a Distinguished Alumnus of IIT Delhi in 2009. He has been listed in Computerworld's Premier 100 IT Leaders (2007), and in Infoworld's Top 25 CTOs (2007).

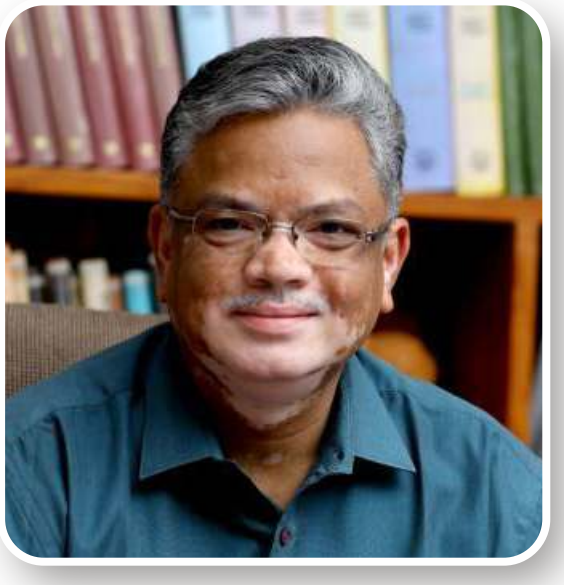
Ananth is an M. Tech. in Computer Science and an M. Sc in Physics from the Indian Institute of Technology, Delhi.

The Potential of Digitization and Knowledge Driven Systems

K Ananth Krishnan
Executive Vice President and Chief Technology Officer, TCS

Abstract

Digital Technologies have disrupted every industry, holding out new opportunities. The materials industry is no exception. Integrated Computational Materials Engineering (ICME) and Materials Genome (MG) Exploration are two approaches that show high potential for accelerated materials discovery, development and speedy industrial deployment. Advanced simulation tools based on computational materials science and application of artificial intelligence/machine learning to reap the benefits of data generated in experiments and simulations are increasingly used for these approaches. While this has led to faster development cycles, the true potential of ICME and MG can be realized only when these are used in an appropriate integrated framework with systems engineering approaches with tacit knowledge guiding product development. Ananth will demonstrate these ideas with some real-world industry examples.



Dr G U Kulkarni

President, Jawaharlal Nehru Centre for Advanced Scientific Research (JNCASR) & CeNS

Dr Kulkarni has done his Ph.D in Solid State and Structural Chemistry, from Indian Institute of Science, 1992 followed by his postdoctoral research at Indian Institute of Science, 1992 – 1993. He was a postdoctoral research fellow under UNILEVER project at Cardiff University, UK 1993-95.

His present research interests are focused on new strategies in synthesis of nanomaterials, nanopatterning and nanodevice fabrication including of molecular systems. The recipes emphasize the importance of simple design, near ambient working conditions, solution-based processing as well as low cost instrumentation. Our group strives to translate nanoresearch finding into affordable technology. Dr Kulkarni and his teams have made contributions in many areas- nanomaterials, developing nanotools and prototype device fabrication, molecular systems and their properties etc. There is a concrete underlying theme, which makes the contributions unique. They have employed solid-state chemistry principles to nanomaterial synthesis which paved way, for the first time, to direct patterning by various lithography tools. Thus, the potential of metal-organic precursors as single source precursors for patterned synthesis of a variety of nanomaterials has been realized which has been applied effectively in e-beam lithography and soft molding. The functionality of the patterned materials is clearly demonstrated in prototype devices such as sensors. This is a fine example of chemistry applied to high-end device research.

Dr Kulkarni has many awards and accolades to his name. Sir C. V. Raman Young Scientist award, 1999, B.M.Birla Science prize in Chemistry, 2002, Chemical Research Society of India Lecture medal, 2003, Prof. C.N.R. Rao Oration award, 2006, International Senior Fellowship of University of Bayreuth 2016, MRSI-Distinguished Lectureship Award (2019-20), The Prof. C.N.R. Rao National Prize for Chemical Research-2020, by Chemical Research Society of India (CRSI), Kannada Rajyotsava Award – 2021 – to name a few of them.

There 21 doctoral theses supervised by him. He has more than 300 publications and more than 25 patents to his credit.

Low-cost rapid synthesis of graphene and its derivatives on different substrates for diverse applications

Giridhar U. Kulkarni
President
Jawaharlal Nehru Centre for Advanced Scientific Research, Bangalore
also Adjunct Professor at Centre for Nano and Soft Matter Sciences, Bangalore

Abstract

Graphene along with its derivatives is a fine example of the widely studied 2D materials. 2D materials, in general, possess exceptional properties. It is no wonder that Graphene and related 2D materials are proposed for use in fast switching transistors, transparent conducting electrodes, sensors, corrosion-resistant coatings, hydrophobic coatings, flexible electronics and so on. However, the conventional synthesis methods involving high operating temperatures (~1000°C) and harsh chemical conditions make the production expensive as well as tedious involving multiple steps and not quite friendly for the industrial scale-up.

The presentation will begin with conceptual foundations on the topic and bring out pertinent issues associated with scale-up production and taking forward the product into applications. Taking graphene/reduced graphene layers as examples, attempts made in the TSAMRC laboratory at CeNS towards applications, will be described.

Prof Philip J Withers

Regius Professor of Materials at the University of Manchester and Chief Scientists of the Henry Royce Institute

Philip Withers is the Regius Professor of Materials and Chief Scientist of the Henry Royce Institute. He is a Fellow of the Royal Society, Royal Academy of Engineering and a Foreign Member of the Chinese Academy of Engineering. He is the Chief Scientist of the Henry Royce Institute based around capabilities at the Universities of Manchester, Sheffield, Leeds, Liverpool, Cambridge, Oxford and Imperial College as well as the National Nuclear Labs, and the Atomic Energy Authority at Culham. founded in 2016 to become a national instate for materials research His research focusses on applying advanced techniques to follow the behaviour of materials in real time and 3D often performing under demanding environments. To this end he exploits electron, lab and synchrotron X-ray and neutron beams to illuminate materials behaviour. He was the founding Director of BP International Centre for Advanced Materials. In 2008 he set up the Henry Moseley X-ray Imaging Facility, a world-leading suite of X-ray imaging systems, which in 2020 became a founding part of the National Research Facility in Lab. CT.

Advancing materials towards a sustainable society

Regius Prof Philip J Withers, FRS, FREng.
Chief Scientist, Henry Royce Institute for Advanced Materials
Regius Professor of Materials, University of Manchester

Abstract

Advanced materials shape the world in which we live. Today we face the global challenge of climate change and the need to move towards net zero carbon emissions. At the same time we need to recognise that materials are a finite resource. The carbon footprint of the majority of manufactured products is dominated by that associated with the raw materials and their processing, while the development of new and refined materials systems are critical if we are to develop technologies that takes us towards net zero, whether that be improved batteries, light weight materials for transport or low energy technologies for data storage. If we are to develop the new materials we need for tomorrow we need to start today and we need to accelerate the rate of maturation of new materials technologies. This presents a tremendous and timely challenge for materials scientists everywhere.

In this talk I consider the drivers for the materials of tomorrow and the opportunities for what is sometimes termed Materials 4.0 to accelerate materials innovation. This requires the bringing together of high throughput small scale make, test and characterisation along with new data driven modelling bringing together the physical and digital twins. Critical to materials science is the understanding of the relationship between composition, processing, microstructure and properties. I consider the challenge of including microstructural data in machine learning approaches. Further by constructing a digital thread through manufacturing chains and potentially linking this to in service performance and ultimately end of life we have the opportunity to significantly improve the materials and products we manufacture within a more sustainable framework.

SESSION II :
Modern Application Development and Trends

Mr Andrew Foster, MA FIMechE

Chief Engineer, Body Exteriors, JLR, UK

He has served Jaguar Land Rover since 1984 in a variety of roles associated with Body and Vehicle Engineering. He is currently Chief Engineer, Body Exteriors, responsible for the development of all Body Structures, Closures and Exterior Trim for Jaguar Land Rover vehicles. He graduated in Engineering at Cambridge University, UK

Mrs Rebecca Hitch, BEng MSc MIMechE

Senior Manager for Materials Engineering and Product Sustainability, JLR, UK

She began her JLR career in the Body-in-White Material Engineering department. She has since led the upper structure development of the Jaguar F-Type coupe and has managed the bonnet and fenders design group. She has also led roles in Research and System Engineering. In 2021 she became senior manager for Materials Engineering and Product Sustainability which oversees all material development and is driving JLR's sustainability product roadmap. Mrs Hitch holds a BEng from Exeter University, UK and an MSc in advance Materials from Cranfield University, UK

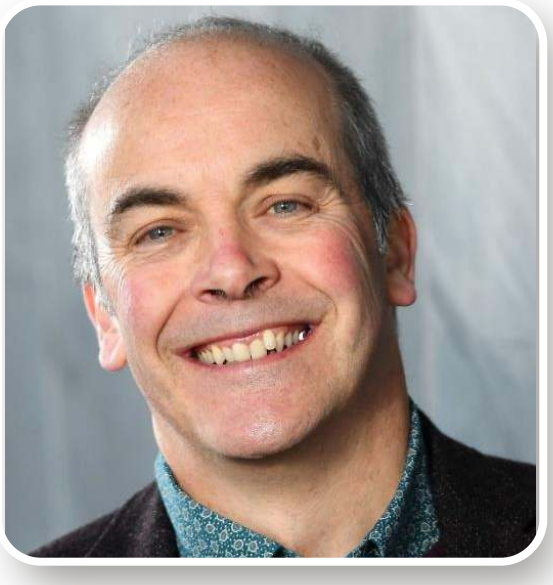
Light weighting and safety in mobility and e-mobility

Andrew Foster, MA FIMechE
Chief Engineer Body Component, JLR

Rebecca Hitch, BEng MSc MIMechE
Senior Manager for Materials Engineering and Product Sustainability, JLR, UK

Abstract

The Jaguar Land Rover presentation will discuss the considerations between an ICE and BEV structural architecture, managing load paths in a BEV architecture and lightweight design. It will also examine the shift from tailpipe to embedded CO_2 and the effects of material choice with regard to sustainability and global warming potential.



Prof David Worsley

Personal Chair, Materials Science and Engineering
Swansea University, UK

As a Tata Steel sponsored Professor at Swansea University, Dave leads a number of national and international consortium projects supporting the transformation of industry to a lower carbon future. To date he has led the development of over £120M investment in collaborative training, research and innovation.

With his research background in advanced materials for solar energy and functional coatings, Dave has pioneered the concept of 'Active Buildings®' - buildings that can generate, store and release their own heat and electricity by using integrated renewable energy technologies. To account for the shift to electric vehicles being championed globally, charging facilities have also incorporated in the demonstration building design.

In 2011 he led the creation of the SPECIFIC® Innovation and Knowledge Centre, a consortium of more than 50 partners from industry, academia and government to develop this concept. SPECIFIC® specialises in the scale-up of new technology from the lab to full-scale building demonstrators and collaborates extensively to support early commercialisation and adoption of new renewable technologies and systems. The Centre has strategic academic collaborations with many UK institutions plus internationally in India, Mexico, Kazakhstan and USA.

Proving the concept works at full-scale, the Active Classroom® and Active Office® buildings on the Swansea University Bay Campus have both won numerous industry awards. In 2017, the GCRF-funded SUNRISE was added to the Portfolio – taking the concept of Active Buildings® overseas to rural Indian communities. Working with Indian industrial partners, the first demonstrator is to be built at IISc Bangalore in Spring 2022.

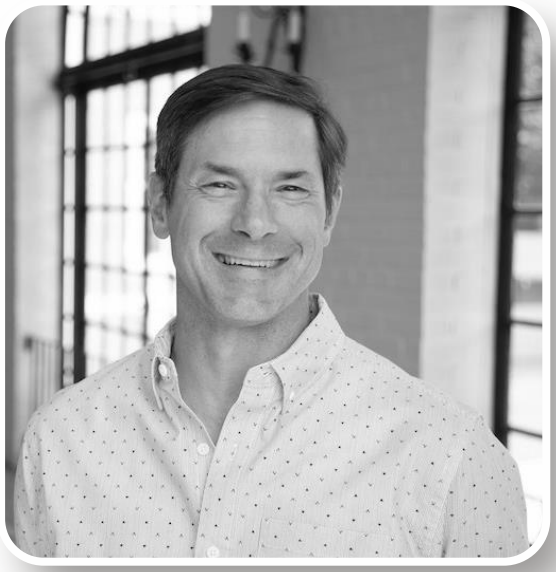
With steel products and energy integral to the supply of materials in the manufacture of land, air and sea transport and construction, by employing Active Buildings® there is an opportunity to address the UK Steel Industry's 2050 de-carbonisation targets.

Power to the people democratisation driven by coated steel products

Prof David Worsley
Personal Chair, Materials Science and Engineering
Swansea University, UK

Abstract

Each year Tata Steel in the UK produces 100 million square metres of building cladding that ends up as the facades and roofs of buildings. Globally, steel building cladding is orders of magnitude more than this. In the UK, innovation in coating technology for metallic and organic systems now gives these lifetimes guaranteed for up to 40 years. These products are essentially stable but 'dumb' in that they do not do anything but look nice and keep the rain out! Given their lifetime is around twice that of a current solar panel coupled with the innovation that is occurring in printed solar cells which can be produced in the laboratory with efficiencies now over 28% and solar thermal collectors which can combine with inter-seasonal storage, it seems an obvious step to explore the potential of these materials to have integrated generation technology to absorb the sun's energy. Considering the area of cladding made in the UK alone and that one sun is roughly equivalent to 1000 Watts, if we can apply a 10% solar cell to the steel this equates to around 1GW peak power per year of production! In this lecture Professor Dave Worsley will describe progress to-date on achieving this goal in relation to both applications in the UK and in India and Mexico where the Team are engaged with local communities to repurpose simple printing presses to make solar cells local to where they are needed. Real world examples of solar powered buildings will be discussed together with the way in which spare power can be deployed to drive the electric vehicle revolution or provide power for communities who may never have grid connections in the way we view them currently.



Dr Kirk Rogers, Ph.D

Principal ADDvisor® and Technical Excellence leader
The Barnes Groups Advisors (TBGA)

Dr Rogers has used additive technologies to solve manufacturing, repair & supply chain problems for the last 10 years. He began consulting full time in 2018 after leading the technical team in startup of a $40M Additive Manufacturing R&D center. The majority of Kirk's nearly 20-year career at GE was in medical device manufacturing. Dr Rogers has 25 years of experience in materials processing, metal additive manufacturing, powder metallurgy, and ceramic matrix composites. He has authored and co-authored nearly 50 publications and has been invited to speak on advanced manufacturing topics numerous times. Kirk obtained his Ph.D in Materials Science and Engineering from Purdue University.

Additive's Future in Manufacturing

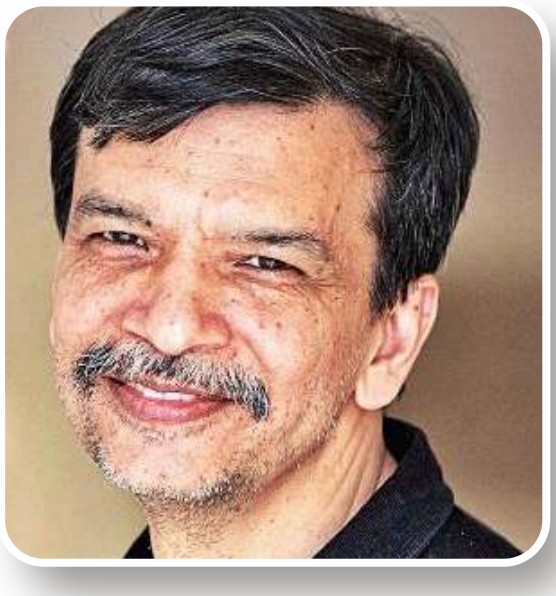
Kirk Rogers
Principal ADDvisor® and Technical Excellence leader
The Barnes Global Advisors, LLC

Abstract

Find out how AM is evolving to produce functional results. Kirk shares how industry leaders are pushing the limits of manufacturing using AM. He will discuss how AM modalities such as fused deposition modeling, laser powder bed fusion and hybrid manufacturing are changing the economics of manufacturing. He will further touch on how AM is impacting design, materials, production, and servicing across industries from aerospace, power and automobile to medical, architectural, and consumer applications with some real-world examples.

SESSION III :
Panel Discussion on Sustainability (Cradle to Grave)

Panel Discussion Session Moderator



Prof Rangan Banerjee

Professor at Department of Energy Science and Engineering IIT Bombay

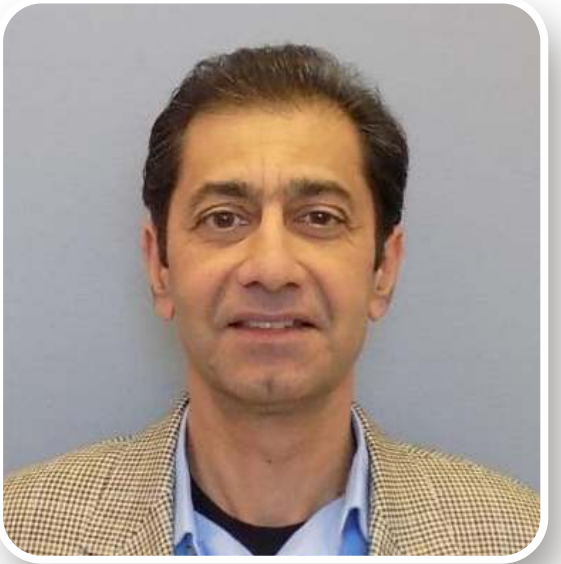
Rangan Banerjee is the Forbes Marshall Chair Professor in the Department of Energy Science and Engineering at IIT Bombay - a Department that he helped start in 2007. His areas of interest include energy management, modelling of energy systems, energy planning and policy, hydrogen energy and fuel cells.

Professor Banerjee is on the editorial board of International Journal of Sustainable Energy, International Journal of Sustainable Engineering and International Journal of Thermodynamics, Solar Energy Advances and Frontiers in Energy Research. He has been involved in setting up a Megawattscale Solar Thermal Power Testing, Simulation, Research Facility sponsored by the Ministry of New and Renewable Energy. He was the faculty advisor to Team Shunya the first Indian Student team selected for the finals of the Solar Decathlon 2014 held in Europe that involves designing and constructing a fully functional Solar house.

He was a member of the TIFAC Technology Vision 2035 - Apex Committee and Chairman of the Energy Technology Theme. He was a Convening Lead Analyst for Industrial End Use Efficiency and a member of the executive committee for the Global Energy Assessment (2008-2011) coordinated by the International Institute for Applied Systems Analysis. He was a Member of International committee to review UK's Energy Research Programme in 2010 (RCUK Review of Energy). He was a member of the Working Group on New and Renewable Energy for the Elleventh and Twelfth Five Year Plans and a member of the Planning Commission's Integrated Energy Policy. He has been involved in advising the city, state regulatory commission and energy agency, Planning commission, Niti Aayog, MNRE on energy issues.

Professor Banerjee has co- authored a book on Planning for Demand Side Management in the Power sector, a book on Energy Cost in the Chemical Industry and a book on Engineering Education in India. He is also an Adjunct faculty (Honorary) in the Department of Engineering & Public Policy, Carnegie Mellon University and is a Fellow of the Indian National Academy of Engineering.

Panelist



Dr Pinakin C. Chaubal

Vice President and Chief Technology Officer, ArcelorMittal

Dr Chaubal is a graduate of the Indian Institute of Technology Madras, and obtained his M.S. from the Missouri University of Science and Technology and PhD from the University of Utah in USA, all in in Metallurgical Engineering. He joined the steel industry in 1988 and has been involved in various aspects of process technology developments from raw materials to finishing processes in the steel production chain. At the inception of ArcelorMittal he was responsible for worldwide R&D programs in Process technology development. Currently, he is Group Chief Technology Officer, and a member of the Management Committee.

Panelist

Ms Deeksha Vats

Chief Sustainability Officer, Aditya Birla Group

Deeksha is a sustainability professional with over 27 years of work experience in consulting and corporate set-ups. She is currently the Chief Sustainability Officer for the Aditya Birla Group (ABG), where she drives the sustainable business transformation agenda across all its locations on strategic, operational, communication and advocacy aspects of sustainability. Prior to this at ABG, she led the sustainability agenda at group flagship metals and mining business, Hindalco Industries Limited. At Hindalco, she worked across geographies, functions and aspects towards mainstreaming sustainability in the business. This was a follow-up to her role where she led the environmental sustainability agenda at Aditya Birla Group on topics of climate change, energy transition, water, waste, emissions and biodiversity.

Prior to joining ABG, Deeksha led the Sustainability & Climate Change practice at PwC at their Mumbai office for over 8 years. Over years, through her work at prestigious firms like EY, Engineers India Limited and Chemtex Engineering Limited, Deeksha has worked across diverse industry sectors. A regular speaker, panelist at sustainability events, she has been at the forefront of sustainability agenda in India through participation in working groups, industry bodies and expert networks.

Panelist

Dr (Mrs) N. Kalaiselvi

Director, CSIR-Central Electrochemical Research Institute (CSIR-CECRI)

Dr N. Kalaiselvi is the first women Director of CSIR-CECRI (CSIR-Central Electrochemical Research Institute), Karaikudi.

She obtained bachelor's degree in Chemistry from Government Arts College Tirunelveli, affiliated to Madurai Kamaraj University, Madurai, Post Graduate in Chemistry from Government Arts College Coimbatore and PhD at Annamalai University, Chidambaram.

Her research work of more than 25 years is primarily focused on electrochemical power systems particularly, development of electrode materials, custom designed synthesis methods, optimization of reaction parameters and electrochemical evaluation of in-house prepared electrode materials for their suitability in energy storage device assembly. Her research interests include lithium and beyond lithium batteries, Supercapacitors and waste-to-wealth driven electrodes and electrolytes for energy storage and electrocatalytic applications. A glimpse of her R&D activities includes: modified electrode materials for high energy and high-power lithium battery applications, novel/tailor-made electrodes for aqueous and non-aqueous lithium battery, development of polymer based electrolytes, characterization and deployment of polymer films as electrolytes, Ionic liquid based electrodes and electrolytes, exploration of bio ionic liquids crystalline electrolytes for extended electrochemical potential windows.

Apart from the galaxy of projects falling under extramural research, collaborative and sponsored categories funded by DST, MNRE and CSIR, Dr Kalaiselvi has served as a Nodal Scientist for MULTIFUN [Multifunctional Electrodes and Electrolytes for Futuristic Technologies – a Twelfth five-year plan project, sponsored by CSIR to the tune of Rs. 68.54 Crore] with CSIR-CECRI as the Nodal lab and 6 CSIR Institutes as participating labs during 2012-2017. She is currently involved in the development of practically viable Sodium-ion/Lithium-sulfur batteries and Supercapacitors.

Dr Kalaiselvi has more than 130 research papers and 6 patents to her credit. Under her guidance, 9 research scholars have received Ph.D. Degree and 6 researchers are currently pursuing their Ph.D. She is a recipient of many prestigious awards including MRSI medal, CSIR Raman Research Fellowship, INSA-NRF Exchange award, Brain Pool Fellowship of Korea and the Most Inspiring Women Scientist award.