Lecture Notes in Mechanical Engineering

K. S. Vijay Sekar · Manoj Gupta
A. Arockiarajan *Editors*

Advances in Manufacturing Processes

Select Proceedings of ICEMMM 2018

Springer

Lecture Notes in Mechanical Engineering

Lecture Notes in Mechanical Engineering (LNME) publishes the latest developments in Mechanical Engineering—quickly, informally and with high quality. Original research reported in proceedings and post-proceedings represents the core of LNME. Volumes published in LNME embrace all aspects, subfields and new challenges of mechanical engineering. Topics in the series include:

- Engineering Design
- Machinery and Machine Elements
- Mechanical Structures and Stress Analysis
- Automotive Engineering
- Engine Technology
- Aerospace Technology and Astronautics
- Nanotechnology and Microengineering
- Control, Robotics, Mechatronics
- MEMS
- Theoretical and Applied Mechanics
- Dynamical Systems, Control
- Fluid Mechanics
- Engineering Thermodynamics, Heat and Mass Transfer
- Manufacturing
- Precision Engineering, Instrumentation, Measurement
- Materials Engineering
- Tribology and Surface Technology

To submit a proposal or request further information, please contact: Dr. Leontina Di Cecco Leontina.dicecco@springer.com or Li Shen Li.shen@springer.com.

Please check the Springer Tracts in Mechanical Engineering at http://www.springer.com/series/11693 if you are interested in monographs, textbooks or edited books. To submit a proposal, please contact Leontina.dicecco@springer.com and Li.shen@springer.com.

More information about this series at http://www.springer.com/series/11236

K. S. Vijay Sekar · Manoj Gupta
A. Arockiarajan
Editors

Advances in Manufacturing Processes

Select Proceedings of ICEMMM 2018

Springer

Editors
K. S. Vijay Sekar
SSN College of Engineering
Chennai, India

A. Arockiarajan
Department of Applied Mechanics
Indian Institute of Technology Madras
Chennai, India

Manoj Gupta
Department of Mechanical Engineering
National University of Singapore
Singapore, Singapore

ISSN 2195-4356 ISSN 2195-4364 (electronic)
Lecture Notes in Mechanical Engineering
ISBN 978-981-13-1723-1 ISBN 978-981-13-1724-8 (eBook)
https://doi.org/10.1007/978-981-13-1724-8

Library of Congress Control Number: 2018948831

This Springer imprint is published by the registered company Springer Nature Singapore Pte Ltd.
The registered company address is: 152 Beach Road, #21-01/04 Gateway East, Singapore 189721, Singapore

Preface

The Two-day International Conference on "Engineering Materials, Metallurgy and Manufacturing" (ICEMMM 2018) is organized by the Department of Mechanical Engineering, SSN College of Engineering, Kalavakkam, Chennai. The advent of the digital age is seeing a robust growth of research in smart materials and technologies, while the manufacturing processes ensure in making these new age products and prototypes. The need for energy savings, environment protection, and green-rated processes are further accelerators in the right direction. We are therefore happy to organize the International Conference on Engineering Materials, Metallurgy and Manufacturing (ICEMMM 2018) on February 15–16, 2018, in our esteemed institution. The aim and scope of the conference is to provide a robust platform for academicians, researchers, scientists, and students to present their ongoing research work in cutting-edge areas of materials, metallurgy, and manufacturing. It is also the endeavor of this conference to bring to the forefront the seminal research works in these key areas by eminent scholars worldwide and provide them with an opportunity to share their success stories with an earnest audience. This conference hopes to provide enough food for thought on challenges faced by the industry and eagerly awaits the amalgamation of ideas and solutions to address the current and future requirements. We sincerely hope all the delegates will cherish the exchange of new ideas and reap considerable benefits from the face-to-face interaction and potential future networking.

Chennai, India — K. S. Vijay Sekar
Singapore — Manoj Gupta
Chennai, India — A. Arockiarajan

Acknowledgements

We express our gratitude to the management of SSN Institutions for giving us the opportunity to organize this important conference and also thank all the delegates for making this event a grand success. We thank the keynote speakers, conference chairs, advisory, program, and technical committees, reviewers, colleagues, college administration, our friends, students, and well-wishers for making this event a memorable one. We thank Springer publications for having consented to publish our papers through two book volumes. We thank one and all.

About the Institution

SSN Institutions, founded by Padma Bhushan Dr. Shiv Nadar, Chairman, HCL Technologies, stand out as a premier center for higher learning with a mission of pursuing excellence in education and research. These institutions, with their diverse and dynamic community of students, offer a distinctive combination of some of the finest graduate, undergraduate, and research programs, accomplished faculty, world-class facilities, and a residential campus set on a sprawling 250 acres of sylvan surroundings. SSN Institutions provide a variety of stimulating environments for intellectual development, freethinking, and personal growth, challenging its students with dynamic learning opportunity and equipping them with the skills, insights, attitudes, and practical experiences that are necessary to take up responsibilities in the society. While students at SSN immerse themselves in academics, the college has a lot in store for them outside the classroom. Student life includes participation in sports, recreational and cocurricular activities, and culturals. In short, at SSN, students will find an academic and social environment where everyone—from faculty members to students—help shape their future. SSN is a home to aesthetically designed buildings with the state-of-the-art computer and Internet facilities, modern workshops, seminar halls, auditoriums, well-stocked libraries, and sports and games fields in addition to an indoor stadium with gymnasium. As an exemplary institution for learning, SSN follows an admission policy that strongly favors merit, even as it enables access to education for students from all strata of society through appropriate scholarships. The institution boasts of a strong alumni network with alumni events held every year serving as a platform for the past students to get back to SSN and share their experiences with its present fellow students. With so much to offer, it is only natural that the students of SSN get a unique opportunity to carve a niche for themselves in their chosen field of study that enables them to become well-rounded and discerning citizens, fully qualified for their chosen professions in the workplace.

Smart India Hackathon 2017: SSN was selected as one of the 26 nodal centers in India for conducting the grand finale of the Smart India Hackathon 2017, world's largest hackathon event organized by the Ministry of HRD, India. Two teams from

SSN won the first prize and the third prize under the Ministry of Skill Development and Postal Services, respectively.

NIRF rankings: SSN secured the all India 27th rank in the engineering category in the NIRF ranking system constituted by the Ministry of HRD. SSN College of Engineering was also accredited by NAAC with an A+ Grade in 2017.

About the Department

The Department of Mechanical Engineering was established in the year 2007. It offers a UG program in mechanical engineering and PG programs in manufacturing engineering and energy engineering.

The department is also recognized as a nodal research center for pursuing M.S. (By Research) and Ph.D. under Anna University, Chennai, for pursuing doctoral research works. The department has got 34 well-qualified and experienced faculty members, out of which 29 are Ph.D. degree holders and the remaining 5 are on the verge of completing their Ph.D. degrees. The department has 29 recognized Ph.D. supervisors and 103 Ph.D. research scholars registered under Anna University, Chennai, out of which 19 are full-time scholars and 84 are part-time scholars.

The faculty members and students actively engage in research and constantly publish papers in reputed international journals. The department regularly organizes national and international conferences and workshops in emerging areas. The department also has Industry Institute Partnership Cell (IIPC) for enhancing the relationship between the institute and industry.

The department has well-equipped laboratories with research facilities like friction stir welding, material processing, composite machining, cryogenic machining, and vibration analysis. Faculty members are actively involved in executing a number of R&D projects for government agencies like Department of Science and Technology (DST), All India Council for Technical Education (AICTE), and Naval Research Board (NRB) to the tune of more than 2.5 crores.

The major research areas are friction stir welding, metal cutting, composites, FEA, CFD, vibration analysis, nanotechnology, robotics, heat transfer, alternate fuels, thermal energy storage, and vapor absorption refrigeration systems.

About the Conference—ICEMMM 2018

The Two-day International Conference on "Engineering Materials, Metallurgy and Manufacturing" (ICEMMM 2018) is organized by the Department of Mechanical Engineering, SSN College of Engineering, Kalavakkam, Chennai. The principal objective of ICEMMM 2018 is to provide a neutral platform for researchers, engineers, academicians, and industrial professionals from all over the world to present their research results and development activities in materials, metallurgy, and manufacturing technology. This conference provides opportunity for the delegates to exchange new ideas and application experiences face to face, to establish business or research relations, and to find global partners for future collaboration. It is proposed to have several parallel sessions with invited keynote lectures by eminent academicians and experts from various fields. The selected papers will be published in the Lecture Notes in Mechanical Engineering (Springer publications). The papers have been selected from diverse fields like composite materials, welding metallurgy, powder metallurgy, tribology, conventional and advanced machining, metal forming processes, additive manufacturing, coating, and surface engineering. The conference hopes to bring out the multi-disciplinary fields of materials, metallurgy, and manufacturing under a single roof.

President's Message

One of the perennial problems being faced by the industry today is the spiraling manufacturing costs led by higher material cost and extraction costs. It has been the endeavor of the academia to find lasting solutions to these problems.

With this background, I am happy that the Department of Mechanical Engineering is conducting an International Conference on Engineering Materials, Metallurgy and Manufacturing—ICEMMM2018, on 15 and 16 February 2018. This conference will not only encourage knowledge sharing but also prove to be a platform for brainstorming ideas that will shape the Metallurgy and Material Science industry in future.

Research is an important facet of life at SSN and SSN researchers are working on finding practical solutions to a wide range of research problems. This conference aims at promoting exchange of ideas, building mutually rewarding collaborations and providing exposure and motivation to the budding researchers. I am sure this conference will be an enriching and inspiring experience for everyone involved.

I wish the organizers of the conference the very best and also warmly welcome all the participants. I am sure all the delegates will have a comfortable stay at the SSN campus and will take back lasting memories to cherish in future.

Ms. Kala Vijayakumar
President, SSN Institutions

Principal's Message

In today's world, it has become preeminent to constantly be networked and connected to stay abreast of the technical field and in this connection, academic conferences help in promoting and sharing of research findings and provide new avenues for all stakeholders.

SSN College of Engineering values its academic as well as research knowledge as its greatest wealth. A number of national and international conferences in various domains are conducted on a regular basis to feed the changing technological environment around us. These meetings encourage new ideas to be exchanged in a multitude of engineering domains amongst contemporary researchers. The magnitude of these efforts have increased over time and resulted in a higher level of thinking and execution which helps today's engineers navigate their lives and careers.

I take immense pleasure in welcoming the delegates of the International Conference on Engineering Materials, Metallurgy and Manufacturing—ICEMMM2018, organized by the Department of Mechanical Engineering on 15 and 16 February 2018. The conference aims to promote cutting edge research in futuristic areas of material, metallurgy and manufacturing. I am sure that, this platform will be an enriching experience for the delegates and the confluence of ideas will develop solutions to the problems faced by the industry.

I express my gratitude to the advisory committee, organizing committee, keynote speakers, session chairs, review committee, contributing authors and conference participants for their efforts in making this conference a grand success. I wish all the delegates an eventful two days at the conference as well as at their stay on campus.

Dr. S. Salivahanan
Principal, SSNCE

HOD's Message

Any Engineer is associated with the task of developing solutions. Solutions come through appropriate selection of materials and processing technology. With the entire world being invited to "Make in India", manufacturing technologies play a major role. Newer applications demand newer materials. The advent of new materials necessitate corresponding developments in material processing technology. Advances in metallurgy enable better and efficient processing of materials.

Thus materials, metallurgy and manufacturing are three major aspects of importance to any mechanical engineer. I am happy to note that these are being covered by ICEMMM2018. Wishing the Conveners Dr. K. S. Vijay Sekar and Dr. A. K. Lakshminarayanan, and the Co-conveners Dr. L. Poovazhagan, Dr. M. Dhananchezian and Dr. K. Jayakumar, for a successful event.

Dr. V. E. Annamalai
Professor and Head, Mechanical Engineering, SSNCE

Conveners' Message


Dr. K. S. Vijay Sekar
Convener


Dr. A. K. Lakshminarayanan
Convener


Dr. L. Poovazhagan
Co-Convener


Dr. M. Dhananchezian
Co-Convener


Dr. K. Jayakumar
Co-Convener

The advent of the digital age is seeing a robust growth of research in smart materials and technologies while the manufacturing processes ensure in making these new age products and prototypes. The need for energy savings, environment protection, green rated processes are further accelerators in the right direction. We are therefore happy to organize the International Conference on Engineering Materials, Metallurgy and Manufacturing—ICEMMM2018, on February 15–16, 2018 in our esteemed institution.

The aim and scope of the conference is to provide a robust platform for academicians, researchers, scientists and students to present their ongoing research work in cutting edge areas of materials, metallurgy and manufacturing. It is also the endeavor of this conference to bring to the forefront, the seminal research works in these key areas by eminent scholars worldwide and provide them an opportunity to share their success stories with an earnest audience.

This conference hopes to provide enough food for thought on challenges faced by the industry and eagerly awaits the amalgamation of ideas and solutions to address the current and future requirement. We sincerely hope all the delegates will cherish the exchange of new ideas and reap considerable benefits from the face to face interaction and potential future networking. We express our gratitude to the management of SSN Institutions for giving us the opportunity to organize this important conference and also thank all the delegates for making this event a grand success. We also thank the Keynote speakers, Conference chairs, Advisory,

Program and Technical committees, Reviewers, Colleagues, the College administration, our friends, students and well-wishers for making this event a memorable one.

We thank one and all.

Keynote: I

The Promise of Magnesium (Composite) Technology for Sustainable Planet Earth

Dr. Manoj Gupta

Department of Mechanical Engineering, National University of Singapore, Singapore

Email: mpegm@nus.edu.sg

The development of technology for producing sustainable energy sources replacing fossil fuels is the vital subject imposed on researchers. A recent analysis has confirmed that the conversion of solar energy into electricity by solar cells is one of the most promising renewable energy technologies. Among the solar cells, nanoporous semiconductor based dye-sensitized solar cells (DSSCs) have gained much interest in recent years because of their low production costs and ease of fabrication. The performance of this type of solar cells depends on the semiconductor material, morphology, structure of the sensitizing molecules and redox mediator used. The interfacial recombination of the electrons injected by the sensitizer with the cations of the dye molecule or redox couple limits the efficiency of the DSSCs. It has been found that the coating of insulating layer on nanoporous semiconductor oxide material greatly suppresses the recombination in DSSCs and thereby increases the overall cell efficiency. The coating of insulating shell layer on

the core semiconductor oxide material may be an interesting approach to reduce the interfacial recombination in DSSCs. Therefore, our recent research has been focused on the development of core/shell structured nanomaterials by various solution growth techniques. In this study, we report a widely applicable and relatively simple approach for the successful preparation of core/shell structured semiconductor oxide thin films. Further, the promising applications of this core/shell structured nanomaterials will also be discussed.

Keynote: II

Design and Analysis of Structures Made of Long Fiber Reinforced Polymer Composites

Dr. Idapalapati Sridhar

School of Mechanical and Aerospace Engineering, Nanyang Technological University, Singapore

Email: MSridhar@ntu.edu.sg

Wood based natural composite materials are exploited by humans since ancient times for several load-bearing structures. Material intensive modern day aeroplanes, ships and wind-turbine blades are designed and fabricated with long glass or carbon fiber reinforced polymer composites leading to high specific strength and stiff designs. In this presentation, after a brief introduction to composite materials, design and analysis of sandwich structures comprising composite laminates as facesheets and polymeric foams as cores under static and impact loading conditions will be discussed. The competing failure modes of facesheet failure, core shear and localised core indentation failures through upper-bound analytical solutions, finite element based numerical solutions and their comparison with experimental measurements will be presented. A case study on the design and analysis of composite adhesive bonded joints under static and fatigue loading will be discussed for primary structures and as a tool for composites repair will be discussed.

Keynote: III

A-TIG Welding and Its Effect on Performance of the Stainless Steel Weld Joints

Dr. M. Vasudevan

Head, Advanced Welding Processes and Modeling Section,
Materials Development and Technology Division Professor, Homi Bhabha National Institute
Indira Gandhi Centre for Atomic Research, Kalpakkam

Email: dev@igcar.gov.in

Activated Tungsten Inert Gas (A-TIG) welding process has been developed for stainless steels which overcome the major limitations of TIG welding. Significant improvement in penetration performance over 300% has been achieved by A-TIG welding and variable weld penetration during autogenous TIG welding has been overcome. The mechanism causing the improvement in penetration in stainless steels has been identified as the reversal of marangoni flow in the weld pool caused by dissolved oxygen (surface active element) from the activated flux. The weld bead width is reduced and the weld bead profile is improved due to arc constriction caused by the activated flux. A-TIG welding process has been successfully employed for fabricating type 304 LN stainless steel, 316 LN stainless steel, Duplex stainless steel and 409 ferritic stainless steel weld joints. Significant improvement in

mechanical properties, corrosion resistance, large reductions in residual stresses and distortion and cost of fabrication have been demonstrated for the above stainless steel weld joints. A-TIG welding is already found applications in the nuclear industry for improving the performance of weld joints and reduce the cost of fabrication. A-TIG welding has greater potential for welding of structural components made of stainless steels.

Committee Members

Chief Patron
Dr. Shiv Nadar, Founder, HCL and SSN Institutions

Patrons
Ms. Kala Vijayakumar, President, SSN Institutions
Dr. S. Salivahanan, Principal, SSNCE

General Co-chairs
Dr. P. Ramasamy, Dean (Research)

Conference Chair
Dr. V. E. Annamalai, Professor and Head, Mechanical Engineering

Conveners
Dr. K. S. Vijay Sekar, Associate Professor
Dr. A. K. Lakshminarayanan, Associate Professor

Co-conveners
Dr. L. Poovazhagan, Associate Professor
Dr. M. Dhananchezian, Associate Professor
Dr. K. Jayakumar, Associate Professor

Technical Committee
Dr. S. R. Koteswara Rao, Professor
Dr. S. Vijayan, Associate Professor
Dr. B. Anand Ronald, Associate Professor
Dr. K. Babu, Associate Professor
Dr. K. Rajkumar, Associate Professor
Dr. D. Ananthapadmanaban, Associate Professor
Dr. K. L. Hari Krishna, Associate Professor
Dr. R. Damodaram, Associate Professor
Mrs. R. Rajeswari, Assistant Professor
Mr. R. Vimal Samsingh, Assistant Professor

Program Committee
Dr. N. Nallusamy, Professor
Dr. K. Subbaiah, Professor
Dr. N. Lakshmi Narasimhan, Associate Professor
Dr. M. Selvaraj, Associate Professor
Dr. K. S. Jayakumar, Associate Professor
Dr. M. Suresh, Associate Professor
Dr. M. S. Alphin, Associate Professor
Dr. S. Suresh Kumar, Associate Professor
Dr. S. Rajkumar, Associate Professor
Dr. R. Prakash, Associate Professor
Dr. A. S. Ramana, Associate Professor
Dr. M. Nalla Mohamed, Associate Professor
Dr. G. Satheesh Kumar, Associate Professor
Dr. G. Selvakumar, Associate Professor
Dr. S. Soma Sundaram, Associate Professor
Mr. D. Ebenezer, Assistant Professor
Mr. B. Jayakishan, Assistant Professor
Mr. C. Arun Prakash, Assistant Professor

International Advisory Committee
Dr. K. Prasad Rao, Research Professor, University of Utah, USA
Dr. J. Paulo Davim, Professor, University of Aveiro, Portugal
Dr. N. Krishnan, Professor, Charles Darwin University, Australia
Dr. Ramana V. Grandhi, Distinguished Professor, Wright State University, USA
Dr. Sinin Hamdan, Professor, University of Malaysia
Dr. R. Ganesan, Professor, Concordia University, Montreal, Canada
Dr. Dulce M. Rodrigue, Professor, University of Coimbra, Portugal
Dr. K. Elangovan, Professor, Ibri College of Technology, Oman
Dr. R. Mohd Amri B. Lajis, Universiti Tun Hussein Onn Malaysia (UTHM)
Dr. S. Parasuraman, Professor, Monash University, Malaysia
Dr. Mustafizur Rahman, Professor, NUS, Singapore
Dr. M. V. Venkatashamy Ready, Professor, NUS, Singapore
Dr. George Totten, Research Professor, Portland State University, Portland, Oregon
Dr. Esther Akinlabi, Professor, University of Johannesburg, South Africa
Dr. Hakeem Amuda, Associate Professor, University of Lagos, Nigeria
Dr. Sathish Jothi, Lecturer, Swansea University, UK
Dr. B. Prabhu, Coherent, Inc., Santa Clara, USA
Dr. Ramkumar Kandasamy, Volvo Construction Equipment, Sweden
Dr. Khalid Rafi, UL International Singapore Pte Ltd., Singapore
Dr. Kumar Kandasamy, R&D Manager, Oerlikon, USA

National Advisory Committee
Dr. G. Madhusudhan Reddy, Outstanding Scientist, DMRL
Dr. B.Venkataraman, Outstanding Scientist, IGCAR

Dr. V. Balasubramanian, Professor and Director,
CEMAJOR, Annamalai University
Dr. M. Vasudevan, Scientist "H", IGCAR
Dr. N. Sridhar, Scientist "F", NMRL, Mumbai
Dr. G. Rajendran, Scientist "G", CVRDE
Dr. T. Ramprabhu, Scientist, DRDO
Dr. M. Kumarasubramanian, AGM, TIII
Dr. A. Rajadurai, Professor, MIT, Anna University
Dr. M. Kamaraj, Professor, IITM
Dr. T. S. Sampath Kumar, Professor, IIT Madras
Dr. S. Aravindan, Professor, IIT Delhi
Dr. Phani Kumar, Professor, IIT Madras
Dr. S. Ganesh Sundara Raman, Professor, IIT Madras
Dr. K. C. Hari Kumar, Professor, IIT Madras
Dr. Narayan Prabhu, Professor, NIT Surathkal
Dr. K. Kalaichelvan, Professor, Anna University, Chennai
Dr. Raju, Professor, Anna University
Dr. P. Kuppan, Professor, VIT University
Dr. Vaddi Seshagiri Rao, Principal, St. Joseph's College of Engineering
Dr. V. Paramasivam, Hindustan University
Dr. T. Sornakumar, Professor, Thiagarajar College of Engineering
Dr. N. Murugan, Professor, PSG College of Technology
Dr. T. Senthilvelan, Professor, Pondicherry Engineering College
Dr. A. Noorul Haq, Professor, NIT Trichy
Dr. K. V. Sreenivas Rao, Professor, Siddaganga Institute of Technology
Dr. M. Pradeep Kumar, Associate Professor, Anna University
Dr. P. Chakravarthy, Associate Professor, IIST Trivandrum
Dr. K. Balachandar, Associate Professor, SASTRA University, Tanjore
Dr. R. V. S. Prasad, G.E., Oil & Gas—John F. Welch Technology Center (JFWTC)

Contents