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EDITORIAL

Guest Editorial: Materials for a Sustainable Future

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Innovations in materials have driven the evolution of human society over many millennia. The rapid developments in the science and engineering of materials in the last two centuries have catalyzed changes in human society and enabled us to afford our modern lifestyles. However, these developments are associated with many global and societal challenges that necessitate continued innovations in materials. A sustainable future for humankind depends on easy and affordable access to water, food, security, education, healthcare, etc., and increasingly digital access while containing the widespread ecological damage to our planet.

The Department of Materials Engineering (originally the Department of Metallurgy) of the Indian Institute of Science (IISc) has been an active participant and contributor to the development of materials technology over several decades. The faculty members of the department are recognized as leading experts in the field. Its wide network of alumni/alumnae have established themselves as distinguished leaders based in academia, national labs, and industry worldwide, while the young graduates emerge as experts.

As the department celebrates its 75 glorious years of its activities, this special issue of the journal celebrates the contributions of its graduates in various fields now spread over several continents. A select group of alumni and alumnae have reviewed various facets of materials technologies and their impact on the different societal needs.

The design of materials has traditionally been a major activity in the field of materials science and engineering. Increasingly computational and theoretical approaches are being adopted for the rapid and rational development of materials. Maheshwari et al. describe emerging computational techniques and Lahiri reviews the use of phase-field modeling for multicomponent alloys. In the context of experimental approaches of alloy design, Mukhopadhyay and Yadav review the field of quasicrystals, highlighting the important contributions of the Department of Materials Engineering, IISc. Sabban et al. describe the advancements in high entropy alloys.

Extraction of metal and alloy preparation are energy-intensive processes. The environmental damage due to these industrial processes has motivated research in sustainable processes. Sambandam et al. review the eco-friendly innovations emerging in the steel industry, whereas Lahiri and Jha describe innovations in the extraction of titanium.

Testing of materials is critical for characterizing their properties and qualifying them for use in various applications. There have been many innovations in approaches used for testing. Jaya et al. review the recent developments in non-conventional mechanical testing at small length scales and emerging in situ testing techniques are reviewed by Sahu et al. Kumar et al. focus on the unique challenges of testing shape memory alloys.

Enormous efforts in materials development are needed to meet the growing energy needs while minimizing adverse environmental impact. Legesa and Femi present recent innovations in thermoelectric materials, and Yanamandra et al. describe the emerging trends in the recycling of batteries. Innovations in the choice of materials and processing by additive manufacturing for maximizing the performance of gas turbines are compiled in two articles by Biswas et al. and Srinivasan and Ananth. In another article, Ghule et al. review the challenges of using Ni-based superalloys with supercritical water technology. The choice of materials in nuclear reactors is critical for their safe functioning and structural integrity, which is the theme of the article by Srivastava et al. Light-weighting can offer significant benefits in energy efficiency in several sectors of the economy, especially transport. The potential of magnesium and alloys for light-weighting is presented in two articles by Emadi et al. and Seetharaman et al. Another emerging alternative for light-weighting is the use of fiber-reinforced composites, which is reviewed by Chandran.

With the widespread adoption of electronics in every aspect of our modern lives, continued innovations in materials are key for the improved performance of these devices. Pulugurtha et al. describe the current limitations and

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opportunities in the field of packaging of electronic devices. Ramesh highlights the role of multiferroics in the field of electronics in his review article.

The fast-growing interest in space technology continues to motivate developments of materials for this sector. Murty and Sharma review the emerging trends in this field.

Medtech tools are revolutionizing modern medicine, and materials also play important roles in these innovations. The advantages and opportunities of utilizing additive manufacturing for the fabrication of implants are highlighted by Bandyopadhyay et al. Senthilkumar and Gupta review the growing interest in engineering resorbable metallic implants using magnesium, iron, and zinc. Kumar et al. describe how eggshells offer a unique and inexpensive source for preparing bioceramics with attractive properties for biomedical applications. Nanomaterials are now widely recognized for their unique attributes and their potential as biomaterials. Chakraborty et al. describe the interactions of biomolecules with nanomaterials to yield the corona. In another article, Tewari et al. review the understanding underlying the interactions between graphene and amino acids that determine the cellular response to the nanomaterials.

This issue, a compilation of articles from a select group of alumni/alumnae, showcases the broad impact the Department of Materials Engineering at IISc has had in training leaders who are leaders in the world of materials engineering. More broadly, this collection of articles highlights the widespread impact of the field of materials technology in our modern lives and underscores the need for continued innovation for a sustainable future of the human race.

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Dr. Kaushik Chatterjee received his B.E. in Metallurgy from Bengal Engineering College, M.S. in Materials Science and Engineering from the University of Virginia, and Ph.D. in Bioengineering from the Pennsylvania State University. He worked as a postdoctoral fellow jointly at the National Institute of Standards and Technology and the National Institutes of Health. He joined the Indian Institute of Science, Bangalore, in 2011, where he is currently an Associate Professor in the Department of Materials Engineering and associated with the Centre for BioSystems Science and Engineering. His research group focuses on materials for biomedical applications.

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