

ICME Approaches to Innovation in Biomedical Implants Workshop

The Indian Institute of Science (Bangalore) and ICME National Hub@IIT Kanpur hosted the National workshop “ICME Approaches to Innovation in Biomedical Implants” on August 11-12, 2018 along with a Pre-Workshop Tutorial on August 10, 2018 at the Materials Research Center, Indian Institute of Science, Bangalore. This event was additionally



supported by the DBT Bioengineering and Biodesign Initiative and the DBT Center of Excellence on Biomaterials, and was organized as one of the activities of the DST-SERB funded Vajra scheme to Professor Surya R. Kalidindi from Georgia Institute of Technology and Professor Bikramjit Basu from Indian Institute of Science (Bangalore). The workshop was endorsed by the American Ceramic Society, the Biomedical Engineering Society and the Society of Biomaterials and Artificial Organs.

In the pre-workshop tutorial aimed at introducing cutting-edge research topics to young researchers (i.e., graduate students and postdoctoral students), Prof. Kalidindi delivered a series of lectures on the foundational elements of the emergent ICME (Integrated Computational Materials Engineering) and MGI (Materials Genome Initiative) whose goal is to accelerate dramatically the rate at which new and improved materials (including biomaterials) are designed, developed, and deployed in biomedical applications. Additionally, a number of experts from complementary fields of expertise of central focus to the workshop (including biomaterials, bioimplants, and bioengineering) also presented lectures in the pre-workshop tutorials. The topics covered in the pre-workshop included statistical quantification and low dimensional representation of material structure, techniques for the measurement of microstructures over multiple length scales, accelerated development of high performance materials using machine learning, formulation of Process-Structure-Property (PSP) linkages using machine learning tools, phase-field modelling in ICME, molecular dynamics simulations in modelling of bio-materials,

high throughput experimental assays for PSP linkages, quantitative biology of the cytoskeleton, immune response to biomedical implants, and tissue engineering applications in cardiovascular surgery.

The main workshop explored the cutting-edge research opportunities and potential benefits from the application of ICME-based approaches to the design and development of implantable biomaterials. In the field of Materials Science, new protocols are being developed for the extraction of reliable and robust PSP linkages from all available experimental and simulation datasets. It is anticipated that the formal application of these techniques to implantable biomaterials will lead to accelerated and rational development of biomedical implants and devices. The lectures and discussions in this workshop deliberated on topics such as clinical challenges in the successful deployment of biomedical implants, indigenous manufacture of bioimplants, and the multiscale physics-based simulations for integrated materials, product design and development. A common thread in all the discussion was the new opportunities afforded by the emergent tools in data science and informatics for circumventing many of the current challenges in the biomaterials/bioengineering fields. In particular, there was excitement that these new tools can help address the current major gaps in our fundamental understanding of how the microstructure and material composition influence cell functionality, bone remodeling, genotoxicity, and osseointegration. It was broadly understood that a physics-based understanding, capturing, and exploiting of the principles of biocompatibility in a consistent PSP framework would allow for a rational design of bioimplants. It is expected that future research at the intersection of biomaterials, bioimplants, materials science, manufacturing, data sciences, and informatics holds tremendous promise for arriving at new and improved materials at dramatically reduced cost and effort.

The workshop brought together 35 speakers, which include academicians, clinicians and industrialists. There were 5 representatives from 4 industries, 5 clinicians, 25 faculty colleagues from IITs, NITs and IISc, and 25 young researchers. There were 9 sessions chaired by different experts in the field. There was also a panel discussion with lively discussion between all of the attendees. The panelists included leaders from academia, government, and industry. The discussion concluded that there is currently a timely opportunity for a significant national investment aimed at accelerated development of biomedical implants.