MECHANICAL & MATERIAL COLLOQUIUM

Bioprinting: Implementation, Process Dynamics, and Process-Induced Cell Injury

by Yong Huang (Department of Mechanical and Aerospace Engineering, University of Florida)

Maskless three-dimensional (3D) bioprinting, including modalities such as extrusion, laser, and inkjet printing, represents a revolutionary advance in the ability to print arbitrary cellular patterns and create heterogeneous living constructs. More importantly, bioprinting offers a promising solution to the organ donor shortage by enabling the on-demand production of tissue and organ constructs for transplantation, a process known as organ printing. Despite various technological advances in bioprinting, challenges such as the printing of cell-laden viscoelastic bioinks and printing-induced cell injury continue to hinder the robust implementation of bioprinting. Using laser bioprinting (specifically, laser-induced forward transfer) and inkjet bioprinting as two jet-based model printing systems, we have been investigating the bioink jettability and printability as well as the printing-induced cell injury, with the goal of achieving resilient bioprinting. In this presentation, I will first introduce the current state of bioprinting research and the various bioprinting technologies involved. Next, I will analyze the jettability and printability of cell-laden viscoelastic bioinks by using the dimensionless Ohnesorge and elasto-capillary numbers to understand the influence of material properties and the Weber number to assess the impact of printing conditions. Additionally, I will discuss the modeling of jetting-induced cellular droplet formation and landing processes and further establish the relationship between the resultant mechanical loading information and post-transfer cell viability using a modeling approach based on the apoptosis signaling pathway. Finally, I will share insights into the scientific challenges related to bioprinting.

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Dr. Yong Huang is a UF Research Foundation professor of Mechanical and Aerospace Engineering and an affiliate professor of Biomedical Engineering, Materials Science and Engineering, Chemical Engineering, and Electrical and Computer Engineering at the University of Florida, Gainesville, Florida. His research interests are two-fold: 1) understanding of dynamic material behavior (solids and liquids) and process-induced damage or defect structures using and during manufacturing, and 2) printing and machining of biological and engineering materials for healthcare, energy, environmental, infrastructure, and space applications. His current research topics include three-dimensional (3D) printing of biological and engineering materials from difficult-to-print ink materials using inkjetting, extrusion, and laser-induced forward transfer, design and fabrication of microphysiological and engineered living systems, and study of dynamic material behavior using jetting and machining. He served as the Technical Program Chair for the 2010 American Society of Mechanical Engineers International Manufacturing Science and Engineering Conference (ASME MSEC 2010) and the 2012 International Symposium on Flexible Automation (ISFA 2012). He received various honors and awards for his manufacturing research contributions including the ASME Blackall Machine Tool and Gage Award (2005), the Society of Manufacturing Engineers (SME) Outstanding Young Manufacturing Engineer Award (2006), the NSF CAREER Award (2008), the ASME International Symposium on Flexible Automation Young Investigator Award (2008), the SME Albert M. Sargent Progress Award (2024), and the ASME Shaw Manufacturing Research Medal (2025). He received his Ph.D. in Mechanical Engineering from the Georgia Institute of Technology in 2002 and is a Fellow of ASME.

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For questions or suggestions, contact Colloquium Organizers Dr. Jiuhua Chen (chenj@fiu.edu) or Dr. Pezhman Mardanpour (pmardanp@fiu.edu)