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

ABSTRACT - Maskless (including extrusion-, laser-, and inkjet-based) three-dimensional (3D) cell bioprinting is a revolutionary advance for printing arbitrary cellular patterns as well as creating heterogeneous living constructs. More importantly, bioprinting provides a promising solution to the problem of organ donor shortage by providing printed tissue/organ constructs for transplantation, resulting in what is known as organ printing. While there are various technological advances for bioprinting, cell-laden viscoelastic fluid printing and printing-induced cell injury still pose significant challenges to ensuring the scale-up of robust bioprinting. Using laser bioprinting (laser-induced forward transfer) and inkjet bioprinting as two jet-based model printing systems, we have been studying the bioink jettability and printability as well as printing-induced cell injury problems, aiming to achieve robotic bioprinting. In this talk, the perspective of ongoing bioprinting research and various bioprinting technologies are first introduced. Then the jettability and printability of cell-laden viscoelastic bioinks are discussed using the dimensionless Ohnesorge and elasto-capillary numbers to capture the influence of material properties along with the Weber number to capture the influence of printing conditions. Furthermore, the modeling of laser-induced cellular droplet formation and landing processes is presented, and the relationship between the mechanical loading information and post-transfer cell injury/viability is established using an apoptosis signaling pathway-based modeling approach. Finally, this talk shares some thoughts regarding bioprinting-related basic scientific challenges.

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SPEAKER BIO – Dr. Yong Huang is a professor of Mechanical and Aerospace Engineering, Biomedical Engineering, and Materials Science and Engineering at the University of Florida, Gainesville, Florida. His research interests are two-fold: 1) processing of biological and engineering materials for healthcare/energy applications, and 2) understanding of dynamic material behavior during manufacturing and process-induced damage or defect structures. His current research topics include three-dimensional (3D) printing of biological and engineering structures, precision engineering of medical implants and performance evaluation of machined implants, and fabrication of polymeric microspheres / microcapsules / hollow fiber membranes. 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 awards for his manufacturing research contributions including the ASME Blackall Machine Tool and Gage Award (2005), the Society of Manufacturing Engineers Outstanding Young Manufacturing Engineer Award (2006), the NSF CAREER Award (2008), and the ASME International Symposium on Flexible Automation Young Investigator Award (2008). 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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