To Advance Manufacturing
— One Pivotal Thruster: Precision Additive Manufacturing

Ph.D. Candidate, School of Mechanical Engineering
Georgia Institute of Technology

Abstract

As one of the pivotal advanced manufacturing technologies, additive manufacturing (AM) or 3D Printing, a process for fabricating parts directly from a 3D digital model, has tremendous potential for producing high-value, complex, and customized parts. While AM is poised for growth and innovations, it has been plagued by a plateau of low productivity, poor quality and limited accuracy. Real-time inspection and material property determination during the manufacturing process can improve production of qualified parts directly from an AM machine. The lack of in situ sensors and measurement methods, and the lack of online control technologies, have been identified as critical barriers in large-scale deployment of AM.

Towards the next-generation precision AM, in this talk, I will exemplify how a real-time closed-loop measurement and control system can automate a photopolymer additive manufacturing process with good accuracy, repeatability and robustness. Particularly, I will present part of my PhD research that is centered on the development of a real-time metrology for an in-house exposure controlled projection lithography (ECPL) process. It includes a sensor model, data-driven algorithms, and experimental validations. The outcome of this research not only improves the particular ECPL process but also inspires the general AM community. Several impacts are perceived in multiple areas of AM process metrology, control and modeling. (1) It pioneers to address the gap of lacking traceable in-process measurement methods for polymer additive manufacturing. (2) It enables a real-time feedback control which has been envisioned for years by the AM industry but just got some emerging materialization. (3) It unveils photopolymerization dynamics from a unique perspective that can bridge the molecular reactions and the microscale forming, and the enabled modeling advance could facilitate precision polymer additive manufacturing by upscaling molecules and nanoscale materials for real-world applications.

Bio Sketch

Ms. Xiayun Zhao is a Ph.D. candidate in the School of Mechanical Engineering at Georgia Institute of Technology. She studied Precision Instrument Science and Measurement & Control Technology at Tsinghua University in Beijing (China), where she received her B.S. in 2006. She earned her M.S. in Mechanical Engineering from Georgia Institute of Technology in 2009. Then she worked as an engineer in Houston, Texas, designing instrumentation & control systems as well as performing piping stress analysis for an upstream offshore drilling platform and a downstream petrochemical refinery complex with oil & gas industry clients, respectively, Exxon Mobil and Petrobras (Brazil). In 2014, she went back to Georgia Institute of Technology and continued to pursue her Ph.D. degree. During both her master’s and doctoral programs, she worked with Professor David Rosen, and conducted research on additive manufacturing of micro parts for health and medical applications. She is currently focusing on the development of a novel real-time process metrology and control system to improve the in-house photopolymer additive manufacturing process.

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