Materials Science & Engineering and Metallurgical Engineering Graduate Seminar

Wednesday, October 17 2018, 4:10-5:00PM, WEB 1230

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Multi-scale Modeling of Thermo-fluid Dynamics and Microstructure Evolution in Laser-based Manufacturing

Due to their unique properties, lasers can be used to add, remove, join, deform, and in-situ synthesize materials, and thus have been widely used as advanced tools for manufacturing. Laser-based manufacturing is usually a complex process involving multi-scale, multi-phase, and multi-physics phenomena. A modeling scheme has been developed to investigate these phenomena on three scales. On the macro-scale, numerical models have been built to simulate the laser-matter interaction, phase change, free surface motion, and multi-phase heat transfer and fluid mechanics. On the meso- and micro-scale, numerical models have also been built to simulate solid-state phase transformation and grain/dendrite growth during solidification. These multi-scale models have been applied to laser surface hardening, laser direct deposition, and laser keyhole welding processes. Simulations offer reasonable predictions for the geometry, microstructure, and mechanical properties of the processed materials, and the predicted transient dynamics of the processes have helped to reveal the formation mechanisms of certain defects such as porosity in laser keyhole welding. These models can be used not only to optimize manufacturing processes, but also to advance scientific understanding of the underlying physics.

Dr. Wenda Tan is an assistant professor of Mechanical Engineering at the University of Utah. He received his BS and MS degrees in Mechanical Engineering from Tsinghua University, China, and his Ph.D. degree in Mechanical Engineering from Purdue University. His major research interests include the computational thermo-fluid dynamics and computational materials in metal additive manufacturing and welding processes. He is the recipient of NSF-CAREER award in 2017.