Speaker Introduction:

Prof. Wentao Yan - Professor, Department of Mechanical Engineering, National University of Singapore (NUS). He received his B.Eng. from Tsinghua University in 2012, and his Ph.D. in 2017 from Tsinghua University and Northwestern University (joint program). He then conducted postdoctoral research at Northwestern University and served as a visiting researcher at the National Institute of Standards and Technology (NIST), USA. In 2018, he joined NUS and established his independent research group, which now includes over 20 Ph.D. students and postdoctoral researchers. His research focuses on multi-scale, multi-physics modeling of metal additive manufacturing (3D printing), data-driven modeling, and experimental studies. He has published over 110 papers in top journals such as Nature Communications, Acta Materialia, Journal of Mechanics and Physics of Solids, International Journal of Machine Tools and Manufacture (IJMTM), and Additive Manufacturing. He has won 9 awards in the NIST AM Bench additive manufacturing simulation challenge. He currently serves as Associate Editor for Smart Manufacturing and on the editorial boards of IJMTM and other journals. Research expertise: Modeling and simulation of additive manufacturing technologies.

Talk Summary:

The widespread application of additive manufacturing is limited by a lack of systematic understanding of the process-structure-property relationship. Our team has developed a series of high-fidelity multi-physics models. Using a multi-phase flow model coupling computational fluid dynamics and discrete element method, we successfully simulate the powder spreading process as well as spattering and denudation phenomena during powder melting. The powder melting model incorporates composition-dependent evaporation effects and a physics-informed heat source model, enabling accurate reproduction of melt pool flow and associated defects such as lack-of-fusion pores and keyhole pores. Using phase-field and cellular automaton methods, we have established microstructural evolution models at both grain scale and dendrite scale. By integrating actual geometric features (rough surfaces and pores), temperature field distribution, and microstructure, we employ crystal plasticity finite element models to accurately simulate mechanical properties and thermal stresses. These models demonstrate strong capabilities in revealing physical mechanisms and optimizing manufacturing processes, and have been extensively validated through experiments, particularly in-situ observations.