

Artificial Intelligence-Enhanced Nanomanufacturing

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Abstract: As a research discipline, nanomanufacturing involves the design, characterization, and fabrication of nanostructures that exploit the physical and chemical phenomena at nanoscale. It is critical to various industrial and commercial applications such as energy storage, flexible electronics, and health care. However, manipulation of materials at nanoscale faces multiple challenges. At the design stage, tailoring the structure topology and composition to produce the desired functional properties has long been relying on expert knowledge. At the manufacturing stage, nanomanufacturing processes involve multiple factors that affect the reproducibility, reliability, and quality of the final products. In recent years, artificial intelligence (AI) has been increasingly considered as having the potential in complementing physical domain knowledge and better resolving the aforementioned challenges. By leveraging data from process sensors and advanced computational infrastructure, AI enables optimization in material design, high-fidelity process-structure-property modeling and effective product quality assurance.

This talk presents an overview of the basic building blocks of AI and highlights AI's applications to material design, manufacturing process modeling, and quality assurance. It demonstrates the potential of AI in enhancing physical science with data science to facilitate the design, monitoring and optimization in nanomanufacturing.

Bio: Robert Gao is the Cady Staley Professor of Engineering and Department Chair of Mechanical and Aerospace Engineering at Case Western Reserve University in Cleveland, Ohio. Since receiving his Ph.D. degree from the Technical University of Berlin, Germany in 1991, he has been working on physics-based sensing, multi-resolution analysis, stochastic modeling, and machine learning for improving the observability of cyber physical systems, with the goal to improve process and product quality control. The outcome of his work has been reflected in over 180 journal articles, three books, and 13 awarded patents.

Dr. Gao is a Fellow of the ASME, IEEE, SME, and CIRP (International Academy for Production Engineering). He has received several society awards from ASME, SME, and IEEE, Best Paper awards, and NSF CAREER award. He has served as an Associate Editor for multiple international journals, and is currently a Senior Editor for the IEEE/ASME Transactions on Mechatronics.