Feb 22, 2018

Multiscale Modeling and Simulation of Selective Laser Sintering

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ABSTRACT:

Selective laser sintering (SLS) is a rapid prototyping and manufacturing technology that fabricates 3-D objects from powdered material via layer-by-layer sintering or via melting induced by a directed laser beam. One of the most attractive advantages of SLS is its ability to process a wide range of materials that include polymers, metals, and ceramics. A sequential addition packing algorithm is employed to generate 3-D random packing of opaque, diffusively or specularly reflecting spherical particles with the same or different sizes. A temperature transforming model is employed to simulate the melting and resolidification of the powder bed with the consideration of shrinkage and convection driven by capillary and gravity forces in the melting liquid pool. Solid-liquid-vapor phase change of a metal particle subjected to nanosecond pulse laser heating is investigated analytically. Ultrafast melting and resolidification of a submicron gold particle subject to pico- to femtosecond laser pulse are studied. The nonequilibrium heat transfer in electrons and lattice is described using a two-temperature model, and the locations of the solid-liquid interface are determined using an interfacial tracking method. The neck growth in the laser sintering of different-sized gold nanoparticles under different heating rates is investigated by a molecular dynamics method. The Embedded Atoms Method (EAM) potential was employed to describe the interatomic interaction between gold atoms.

BIOGRAPHY:

Dr. Yuwen Zhang is a James C. Dowell Professor of the Department of Mechanical and Aerospace Engineering at University of Missouri. His research interests are in the areas of thermal-fluids science and engineering, including ultrafast and high-energy laser materials interaction, multiscale transport phenomena in multiphase systems, inverse problems and optimization under uncertainty, micro- and nanoscale heat transfer, and sustainable and renewable energy. He has published five books, over 285 journal articles, and more than 160 conference papers/presentations. He is recipients of the Young Investigator Award from the US Office of Naval Research, Senior Faculty Research Award from the College of Engineering in University of Missouri, as well as the Chancellor's Award for Outstanding Research and Creative Activity from the University of Missouri (2010). He is a fellow of the American Association for the Advancement of Science (AAAS), and a fellow of the American Society of Mechanical Engineers (ASME). He is the Co-Editor-in-Chief for two international journals, as well as editorial board members of other 10 international journals.