IOWA STATE UNIVERSITY
Department of Mechanical Engineering

Advances in Numerical Modeling of Dendritic Solidification

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Seminar host: Baskar Ganapathysubramanian

Abstract

Solidification is a crucial step for many manufacturing processes such as casting, welding, and additive manufacturing. The importance comes from the fact that the solidification microstructure has a significant influence on the properties of the solidified materials. The numerical modeling of solidification microstructures involves a complex combination of physical phenomena at different scales, which makes the simulations computationally expensive or impractical, particularly for 3D simulations. The recent advance of supercomputing power is driving the development of algorithms that can efficiently utilize the high number of processors of massively parallel machines. In this presentation, we show some of our recent work in simulating the solidification of dendritic structures utilizing two local-type methods amenable to parallelization, the lattice Boltzmann and cellular automaton methods. We show how these two methods combined lead to a better scalability under a large number of processors, which allows us to model computationally challenging problems like arrays of several dendrites under convection in three dimensions or dendritic microstructures of thousands of dendrites in macroscale domains. We also explore a new lattice Boltzmann technique based on multiple lattices and time steps to address the numerical difficulties associated with the widely different diffusion scales of the physical quantities involved in solidification.

Dr. **Sergio Felicelli** is Professor and Chair of the Department of Mechanical Engineering at The University of Akron, in Akron, OH. As leader of the largest department in the College of Engineering, he manages an annual budget of $5M, 40 faculty members, and over 1,400 students. Before joining the University of Akron, Dr. Felicelli served as the Coleman and Whiteside Professor of Mechanical Engineering and Associate Director of the Center for Advanced Vehicular Systems at Mississippi State University (MSU), where he worked for 9 years. Previously to MSU, he worked 17 years for the Argentine Atomic Energy Commission, where he was head of the Computational Mechanics Division, and 2.5 years for the Crystals Division of Saint-Gobain High Performance Materials in Northborough, Massachusetts. Dr. Felicelli's expertise is in the area of computational modeling of solidification processes, with particular application to casting, welding, and additive manufacturing. He has published 120 peer-review articles and received over $15M in research funding during his career. Dr. Felicelli earned his Ph.D. degree in mechanical engineering from the University of Arizona and his B.S./M.S. degree in nuclear engineering from Instituto Balseiro, Argentina

This seminar is part of the Pletcher Lecture Series and counts towards the ME 600 seminar requirement for Mechanical Engineering graduate students.

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