Winter 2025 Joint Colloquium

Materials Department & Materials Research Laboratory

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Professor of Materials Science

and Engineering

Friday, February 28th, 2025

11:00 am | MRL 1001

Is Grain Growth in Materials Predictable?

Many materials are composed of small crystallites, or grains, that have lattices of different orientations. The boundaries between the grains can move to reduce the total grain boundary energy of the ensemble. Since many mechanical and physical properties of materials are functions of the local grain morphology, grain growth can be used to design materials to yield a desired set of properties. The predictive power of models for grain growth is critically dependent on understanding the mechanisms governing grain boundary movement. The mobility of grain boundaries is thought to be determined by the crystallography of the adjacent crystals. However, using a rapid-throughput experiment, measurements of the reduced mobilities of over 1600 grain boundaries shows that the mobilities vary by three orders of magnitude and are largely independent of the grain boundary crystallography, implying that grain growth is not solely governed by a reduction in grain boundary energy. To further analyze the experimental dataset, a phase field model has been developed for grain growth that allows the grain boundary energy and mobility to vary with all five macroscopic crystallographic degrees of freedom of the grain boundary. A continuous orientation field model for the local orientation of the crystal lattice is employed, and thus the computational effort is independent of the number of grains in the system. The results of the experiments and phase field simulations will be given.

Bio

Peter Voorhees is the Frank C. Engelhart Professor of Materials Science and Engineering at Northwestern University, and Professor of Engineering Sciences and Applied Mathematics (by courtesy). He received his Ph.D. in Materials Engineering from Rensselaer Polytechnic Institute and was a member of the Metallurgy Division at the National Institute for Standards and Technology until joining the Department of Materials Science and Engineering at Northwestern University. He has received numerous awards including the ASM International Materials Science Division Research Award (Silver Medal), the TMS Bruce Chalmers Award, the ASM J. Willard Gibbs Phase Equilibria Award, and the McCormick School of Engineering and Applied Science Award for Teaching Excellence. Professor Voorhees is a fellow of ASM International, the Minerals, Metals and Materials Society, and the American Physical Society. He is a member of the American Academy of Arts and Sciences. He has published over 350 papers in the area of the thermodynamics and kinetics of phase transformations.

Hosted by Ananya Renuka Balakrishna.