Phase-Field Modeling of Microstructure Evolution

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Phase-field modeling is a versatile and powerful tool widely used to describe the formation and evolution of microstructures in interfacial problems across a broad range of materials and processes. Applications include solidification problems, phase transformation phenomena (e.g. phase separation and precipitation), as well as grain growth and coarsening. The key advantage of the phase-field approach lies in its ability to represent interfaces as smooth, diffuse regions, without the need for explicit tracking of their location, thereby facilitating the simulation of complex interfacial dynamics. In fact, the evolution of these interfaces results naturally from solving a set of partial differential equations integrated over the system's domain, adhering to the thermodynamic principle of free energy minimization.

The resulting complex microstructures are often closely linked to the macroscopic properties and behavior of materials. Through the analysis of structural features and key parameters, phase-field modeling can be used to control the formation process, allowing for the development of tailored microstructures with specific mechanical properties. This ability to tune the microstructural evolution facilitates the optimization of material design and manufacturing to meet application-specific requirements.

This minisymposium is dedicated to presenting and discussing recent advancements in modeling microstructure evolution using the phase-field method, focusing on computational, theoretical, and/or experimental aspects across diverse fields. Topics of interest include, but are not limited to: innovative phase-field modeling approaches and constitutive models, coupled problems and multiphysics approaches, novel computational methods, optimization techniques, integration within multiscale approaches, experimental calibration and validation of models, and applications in manufacturing and production processes.