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Addressing the Numerical Challenges Associated With Laser-Induced Melt Convection BRIAN WESTON, Univ of California - Davis, ROBERT NOURGALIEV, Lawrence Livermore National Laboratory, JEAN PIERRE DELPLANQUE, Univ of California - Davis, ANDY ANDERSON, Lawrence Livermore National Laboratory — We present a new robust and efficient numerical framework for simulating multi-material flows with phase change. The work is motivated by laser-induced phase change applications, particularly the selective laser melting (SLM) process in additive manufacturing. Physics-based simulations of the laser melt dynamics requires a fully compressible framework, since incompressible flow solvers are inefficient for stiff systems, arising from laser-induced rapid phase change. In this study, the liquid and solid phases are both modeled with the compressible Navier-Stokes equations. The solid phase has an additional combined variable viscosity and drag force model to suppress the velocity in the solid. Our all-speed Navier-Stokes solver is based on a fully-implicit, high-order reconstructed Discontinuous Galerkin method. A Newton-Krylov based framework is used to solve the resulting set of non-linear equations, enabling robust simulations of the highly stiff compressible Navier-Stokes equations. We demonstrate the method's capabilities for phase change on several different melting and freezing configurations, including a three-dimensional laser-induced melt convection problem. Future model enhancements will incorporate material evaporation and rapid solidification.

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