Particle-Based Multiscale and Multiphysics Simulation within The Framework of Material Point Method

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ABSTRACT

The need for understanding the energetic composite responses to extreme loading conditions necessitates the development of a particle-based multiscale simulation procedure, while a particle-based multiphysics simulation method is required to better control the additive manufacturing (AM) process. The material point method (MPM) has evolved over the last two decades to simulate multiphase (solid-fluid-gas) interactions involving failure evolution without invoking a master/slave nodal treatment at the contact surface, and has been applied to many areas in simulation-based engineering science, as shown in the recent comprehensive literature survey [1]. Recently, a particle-based multiscale procedure has been proposed for simulating the responses of discrete nano and sub-micron structures and assemblies in energetic composite systems to impact loading, in which a concurrent link between the dissipative particle dynamics (DPD) and the MPM is established with a hierarchical bridge from molecular dynamics (MD) to DPD [2]. On the other hand, a fully coupled thermo-mechanical formulation is being developed within the framework of generalized interpolation material point, based on the weakly coupled scheme [3]. The effects of both the thermal state on the deformation and the deformation on the thermal state are considered to better control the AM process, with a staggered solution scheme being designed to solve the coupled temperature-displacement equations. In this conference, recent advances in particle-based multiscale and multiphysics simulation within the MPM framework will be presented, and future tasks will be discussed based on the current findings.

REFERENCES