Particle-Based Multiscale Simulation of Fluid-Structure Interactions Under Impact Loading

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Abstract

To better simulate multiphase interactions involving failure evolution at different scales, a particle-based multiscale material point method (Multi-MPM) is being developed, in which molecular dynamics (MD) at nano scale, dissipative particle dynamics (DPD) at meso scale, solid dynamics and fluid dynamics at micro scale are concurrently treated in a single computational domain within the framework of the original material point method (MPM). Preliminary results have demonstrated the potential of the proposed interfacial scheme that links the information at different scales, and the coarse-graining feature of the mapping-remapping procedure in the MPM [1, 2]. To reduce the cell-crossing error in the original MPM, the local mapping process could be replaced by various nonlocal operations with additional computational expenses. Due to the limitation of the DPD forcing functions in predicting impact responses, an attempt is being made to replace the DPD with MD via the MPM mapping procedure so that a staggered MD/MPM scheme could be designed. The smoothed molecular dynamics method improved by alternating with molecular dynamics (AltSMD) [3] might be combined with the staggered MD/MPM procedure to speed up the MD part, although the AltSMD need be further developed for impact problems. Recent research results on simulating multiscale fluid-structure interactions under impact loading, and future tasks will be presented in this international conference.

Keywords: Material Point Method, Particle Method, Multiscale Simulaiton, Solid-Fluid Interaction

References

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