

A Multiscale Material Point Method for Impact Simulation

*Zhen Chen^{1,2}, Shan Jiang^{1,2}, and Yong Gan³

¹Department of Engineering Mechanics, Dalian University of Technology, Dalian 116024, China

²Department of Civil and Environmental Engineering, University of Missouri, Columbia, MO 65211-2200, USA

³Department of Engineering Mechanics, Zhejiang University, Zhejiang 310027, China

*Corresponding author: chenzh@missouri.edu

Key Words: *MPM, Multiscale, Impact Mechanics, Simulation-Based Engineering Science*

The Material Point Method (MPM, http://en.wikipedia.org/wiki/Material_Point_Method), which is a spatial discretization extension from Computational Fluid Dynamics to Computational Solid Dynamics, has evolved over the last twenty years with applications to different areas in Simulation-Based Engineering Science. To better simulate multiphase and multiscale interactions involved in the structural responses to extreme loading conditions, a particle-based multiscale simulation procedure is being developed within the framework of the MPM, with the use of molecular dynamics (MD) and cluster dynamics (CD) potentials. As an immediate application of the proposed procedure, the detonation process of energetic nano-composites from molecular to continuum level is considered to formulate a multiscale equation of state. In the proposed multiscale material point method (MMPM), MD at nanoscale is linked with cluster dynamics (CD) at sub-micron scale via a hierarchical approach while CD is embedded into the MPM via a concurrent approach. Preliminary results are presented to illustrate that a transition region is not required between different spatial scales with the proposed approach, due to the nonlocal shape functions in the MMPM. Future research tasks will also be discussed in the conference.