Particle Finite Element Method for simulations of Selective Laser Melting with vaporization

S. Février [1*], R. Boman [1], and J.-P. Ponthot [1]
[1] A&M department, University of Liege, Belgium
E-mail: simon.fevrier@uliege.be

The purpose of this work is the simulation of selective laser melting processes. Such processes involve multiple physical phenomena that need to be taken into account altogether such as thermo-mechanical coupling, solid-liquid-solid phase change, surface tension and vaporization. The variety of different physical phenomena, as well as the presence of a highly deformed fluid free surface, implies multiple constraints on the required numerical procedure. Notably, the need to compute the free surface position and curvature leads to complex interface tracking algorithms in the widely-used Eulerian-based models.

The Particle Finite Element Method (PFEM), a Lagrangian method with fast triangulation and boundary identification algorithms, has been chosen to overcome some of the difficulties mentioned previously. A new version of the 2D/3D PFEM code presented in (S. Février, **"**Development of a 3D Compressible Flow Solver for PFEM Fluid Simulations**",** ULiège Master Thesis, 2020) has been developed to take into account the aforementioned physical phenomena, notably Marangoni forces and recoil pressure, and the interactions with a laser.

Alongside the presentation of the mathematical formulation and the description of its numerical implementation, some simulations involving a moving laser melting a block of material are presented and discussed.