Accurate Modelling of Free Surface Tension using Smoothed Particle Hydrodynamics

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ABSTRACT

Surface tension is a crucial phenomenon in everyday life. It is responsible for the droplet formation of water or for the cleaning behaviour. And most importantly, it is the dominant effect within Additive Manufacturing. For the simulation of such processes, like Selective Laser Melting for instance, particle methods, like Smoothed Particle Hydrodynamics (SPH), are advantageous, since the modelling of the fusion is intrinsic to the formulation. The melt, which occurs during laser treatment, can be viewed like most fluids as incompressible. For this type of material behaviour the pressure distribution can be predicted more accurately using the Incompressible Smoothed Particle Hydrodynamics (ISPH) [1].

However, one huge challenge of particle methods is the treatment of surface effects, since no explicit surface information is available. In order to reduce the computational effort the surrounding medium of a fluid is often not modelled, like within the simulations of Additive Manufacturing processes [2].

Hence, for an accurate imposition of free surface tension using ISPH a new approach is developed [3]. The surface tension is now considered directly as a Dirichlet boundary condition in the Pressure Poisson Equation rendering the algorithm more robust. The curvature is computed by means of a local coordinate system. In contrast to the standard formulation using weakly compressible SPH, like in [4], this proposed formulation leads to a more accurate modelling which is exemplary demonstrated by the 3D bubble collision test. The outcome of the new approach is now very close to the experimental measurements. Additionally, the new approach is applied to simulate the remelting within powder bed fusion Additive Manufacturing processes.

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