# LBM Simulation and Visualization of Free Surface Flows in 3D

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The free surface model developed in the course of the *FreeWiHR* project is able to simulate a fluid with a free surface, treating the gas liquid interaction with respect to the gas pressure. This mitigates problems which can be caused by the differences in the viscosity of the two phases, and reduces the required computations, as the huge gas volumes occurring in metal foams dont require additional calculations.

This model was used to successfully simulate 2D metal foams in [1]. Here we will present the extension of the model for the simulation of the liquid metal phase to 3D. While the basic algorithm dealing with the mass exchange across interface and fluid cells directly transfers to 3D, further problems are introduced for handling the different types of cells and the calculation of the surface tension. The curvature is calculated with the geometrical surface data generated by the *marching cubes* algorithm. Using an approximated normal, points in the neighborhood of all interface cells can be used to calculate two 2D curvatures, that are averaged to add an additional force during the boundary condition calculations at the free surface.

Improvements of this algorithm, however, also increase the computational complexity of the curvature calculation. Thus, our current work on tracking the fluid surface with *level set* methods will be presented [2]. These allow a more accurate and very efficient calculation of surface normals and curvatures, but on the other hand increase the complexity of the surface tracking. Visualizations to illustrate the results of the 3D implementation will be shown.

# References

[1] M. Arnold, M. Thies, C. Körner, and R.F. Singer. Experimental and Numerical Investigation of the Formation of Metal Foam. *Materialsweek*, 2000.

[2] S. Osher and R. Fedkiw. *Level Set Methods and Dynamic Implicit Surfaces.* Springer, 2003.