# Effect of gas flow on the melting and solidification of IN718 powder in a LPBF process

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## ABSTRACT

Laser Powder Bed Fusion (LPBF) is the most widely used metal additive manufacturing (AM) process. A laser beam melts the metal powder and temperatures up to the boiling temperature are reached resulting in a violent gas stream which affects the solidification process. Due to the small size of the melting zone, a detailed experimental analysis of the process is very difficult and simulation is an important tool to understand the manufacturing process and the influence on the quality of components.

In this work a three-phase melting and solidification simulation methodology has been used to investigate the melting, evaporation and solidification in a LPBF process. The approach uses the finite-volume method and arbitrary polyhedral control volumes to solve the governing equations. A High-Resolution Interface-Capturing (HRIC) scheme has been established as state-of-the-art for modelling multiphase flows with sharp interfaces between gas, melt and solid (three-phase approach) using the so called Volume-of-Fluid (VOF) model. Details of the approach are given in [1]. The methodology was extended by a model to calculate the heating of the metal powder by the laser beam, which combines a participation media approach with a volume heat source. The metal evaporation model extends the work of Klassen et al. [2] to include the effect of the evaporated metal gas on the total gas flow.

The methodology was applied to analyse the melting, evaporation and solidification of single track experiments with IN718 powder using an EOS M290 machine. The simulation revealed, that evaporation leads to a violent gas flow with velocities up to 100 m/s (see fig. 1 left). The simulation results were validated by comparing the calculated melt pool depth with the experimental findings. A good agreement for a wide range of line energies (=laser power/laser speed ratio) could be found (see fig. 1 right).

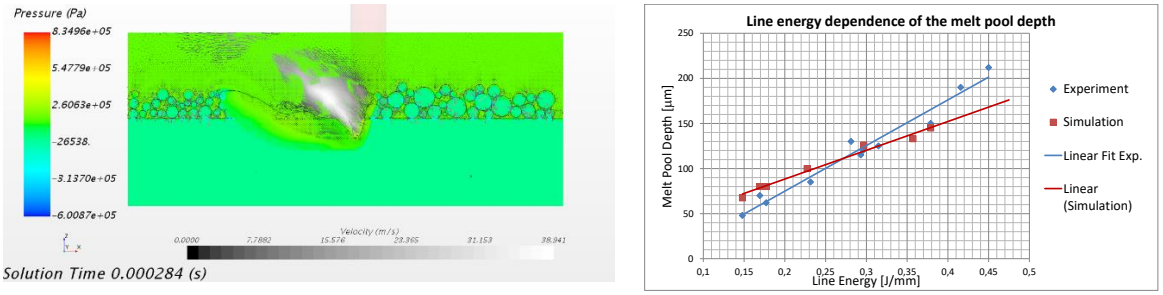


Fig. 1: Pressure and velocity distribution during the melting of IN718 powder in an LPBF-process (left) and comparison of the calculated melt pool depth with experimental findings at DAP (right)

## REFERENCES

[1] Jana, S. (2012). *A Three-Phase Fully Coupled Model to Predict Misruns.* Ph.D. dissertation, RWTH Aachen University

[2] Klassen, A., Forster, V. E., Juechter, V., & Koerner, C. *Numerical simulation of multi-component evaporation during selective electron beam melting of TiAl*. Journal of Materials Processing Tech. 247 (2017) 280–288. doi:10.1016/j.jmatprotec.2017.04.016