

# Boundary conditions for simulation of powder bed fusion for metallic glass formation: measurements and calibrations

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## ABSTRACT

This work aims at simulation of the powder bed fusion process with an alloy that have the capability to become amorphous. The powder bed fusion process enables rapid solidification such that crystallization can be bypassed. This enables formation of bulk metallic glass. However, elevated temperatures and thermal cycling of solidified material may be destructive to the metallic glass by formation of nuclei. Thermal simulation of the process combined with a phase model can reveal if and where a crystalline structure may form during the printing process.

The work includes temperature measurements on the base plate during printing for calibration of boundary conditions for heat losses for the PBF process, Figure 1. The measurements are performed with thermocouples located at three positions: at the center, half radius and at the edge of the circular base plate, five millimeters from the top surface. The temperature of the protective gas is also measured during the printing process. This measurement is performed with thermocouples located in the gas flow, both at the inlet and outlet.

An axisymmetric two dimensional thermal model was used to simulate the printing of a 60 mm tall cylinder with a diameter of 10 mm and a layer thickness of 20  $\mu\text{m}$  using the layer-by-layer approach [1]. Boundary conditions for heat losses was calibrated to match the temperature measurements on the base plate. A phase model was calibration based on DSC measurements on amorphous samples (so far at low temperatures and low heating rates) and the crystalline phase fraction is predicted with a JMAK expression.

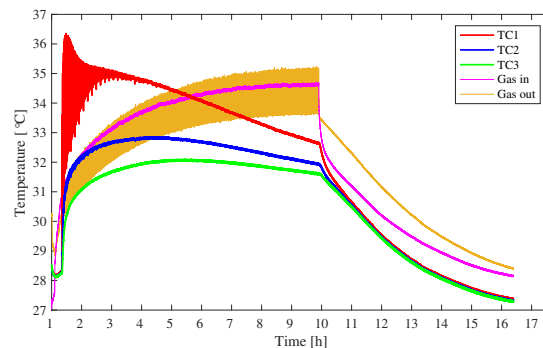


Figure 1: Temperature measurements at the base plate and the protective gas during the PBF process.

## REFERENCES

- [1] Lindwall J., Pacheco V., Sahlberg M., Lundbäck, A. and Lindgren, L-E., Thermal simulation and phase modeling of bulk metallic glass in the powder bed fusion process, *Additive Manufacturing* (2019) 27:345–352.