Simulation of a Downsized FDM Nozzle

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Abstract

The research project faces the problem of surface accuracy in the fused deposition modelling (FDM) process by performing simulations on a downsized E3D nozzle. This kind of simulations is facing multiple problems respectively connected to the description of material properties with temperature and pressure dependencies.

Simulations on the problem are performed using COMSOL Multiphysics® including a.o. heat transfer and CFD packages. The model is fed with data from the material database included in COMSOL as well as individually generated data. The model contains the entire nozzle design including heating and cooling elements simulating the entire process from electric heating over thermal conduction until the ejection of material at the tip of the nozzle. The model contains a 25W heat source feeding the temperature to the other domains including the fluid within the nozzle tip. This is performed via heat transfer in solids and fluids as well as boundary and matching conditions.

The model includes the main physical problem of heating and melting of a solid filament. After the melting process, the fluid flows through the nozzle during continuous heating by the 25W heat source processed through the heat transfer through the other domains. At the tip of the nozzle, the fluid leaves the nozzle in a drop formation process which can be used for material deposition on external surfaces.

The study will show heat distribution within the nozzle as well as heat, velocity and pressure distribution within the fluid in the nozzle. There will be a note on turbulence within the fluid as well as after the exit of the nozzle. This would especially influence the drop formation and deposition of material on a surface.

Given the lack of similar simulations in literature, the study is facing multiple tasks performed by Comsol Multiphysics reaching from material science over heat transfer until fluid flow simulation.

Reference

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