Chair of Metal Forming and Casting
TUM School of Engineering and Design
Technical University of Munich

Incremental Casting

Support Material and Close-Loop Control of Layer Height for Direct Metal Printing with Aluminium

Motivation

"Incremental casting" is the name of an additive manufacturing process that is investigated at the Technical University of Munich (TUM). According to DIN EN ISO 17296-2 the process is categorized under material jetting (MJT). Compared to established additive processes (especially selective laser sintering and selective laser melting), MJT offers potential advantages in terms of building time as well as cost of device and semi-finished product. In MJT, the building material (e.g. aluminum) is melted in a print head and applied droplet by droplet to a building platform. Figure 1 shows a part made from aluminum using MJT.

Figure 1: TUM logo made additively using MJT

In order to exploit the full potential of MJT, it is necessary to be able to print overhanging structures (full 3D capability). According to the current state of the art, this is possible with support structures or by using 5-axis systems. Support structures usually have to be removed mechanically after the process, thus causing expenses. The disadvantage of 5-axis systems is the complex production planning.

Furthermore, inaccuracies in droplet size inevitably lead to deviations between the target height of a printed layer and its actual height. If these deviations are not compensated for, they accumulate to inadmissible deviations in the component geometry.

Both aspects – the implementation of the full 3D capability of the process and the compensation of the geometry deviation – are to be tackled in this project.

Approach

As part of this research project, water-soluble support structures shall be realized out of salt using MJT. For this purpose, a suitable salt is selected as a support material and the compatibility with the aluminum melt is analyzed.

A suitable print head is set up and integrated into the existing test facility. Thus, the effects of the process parameters on the salt-aluminum interface can be examined and suitable settings can be determined.

The thermal simulation of the process is also part of the research project. An existing model is to be expanded so that the printing of both build and support material can be simulated. The heat transfer between the two materials and to the construction platform is of interest in particular.

The research project is being carried out in collaboration with the Chair of Micro Technology and Medical Device Technology (MIMED). At MIMED, the layer height control is implemented by an optical measuring system. Further, a continuous feed of the support material is realized.

Outlook

Due to the possibility of manufacturing support structures from water-soluble salt, components can be processed additively fast and inexpensively without time-consuming rework. The layer height control ensures the quality of the printed components regarding their geometry and the process simulation enables an optimization of the printing process.

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Funding: