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 (Project Continuation)

Motivation

Incremental Casting, aka Liquid Metal Jetting (LMJ), is a droplet-based metal additive manufacturing process that has been studied for several years at the Chair of Metal Forming and Casting (utg) of the Technical University of Munich (TUM). In the first part of this DFG project, water-soluble salt support structures for LMJ were produced for the first time. Figure 1 shows a TUM logo – made via LMJ from aluminum – with overhangs. A monolithic salt support structure supports the overhangs.

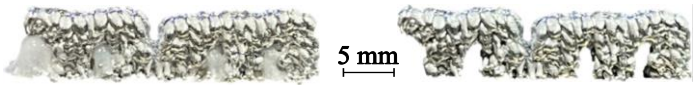

Figure 1: Left: TUM logo made from aluminum with a monolithic salt support structure. Right: Same component after removal of the support structure. (Kirchebner et al., 2023)

The low thermal conductivity of salts limits the height of monolithic salt support structures. The use of salts only as a thin release layer minimizes the influence of the thermos physical properties of the salt on the process. In the second part of the project, release layer support structures made of salt will be investigated (Figure 2, right-hand side).

Figure 2: Left: Monolithic salt support structure. Right: release layer support structure. (Kirchebner et al., 2023)

The project's first part and the project continuation are in collaboration with the Chair of Microtechnology and Medical Device Technology (MIMED) at TUM. In the first part of the project, MIMED created the basis for geometric deviation compensation by implementing a height sensor and coupling it with the printing parameters, which shall be used for a local adaptation of the droplet size in the component, e.g. for better realization of component features. Furthermore, the implementation of an inline calibration for the identification of optimal start parameters shall be implemented.

Approach

At utg, first, a process simulation to show the limits of monolithic support structures and determine reasonable release layer thicknesses shall be performed. Subsequently, the focus will be on the process development of the interface support structure. For this purpose, aluminum components are imprinted with salt at different parameters, and the adhesion is characterized mechanically. Finally, test specimens are printed on salt and subjected to tensile tests to determine their mechanical strength. MIMED will first develop the inline calibration to identify optimal starting parameters. Then, an algorithm is developed that creates G-Codes with a selectable droplet size, starting from an STL file. Finally, parts with variable droplet sizes are investigated regarding their geometry and mechanical properties.

Outlook

The implementation of this project extends the 3D capability of Incremental Casting and enables a more detailed part geometry and a more stable process.

References

Kirchebner, B., Weidner, C., Ploetz, M., Rehekampff, C., Volk, W., Lechner, P. (2023) Liquid Metal Jetting of Aluminum Parts with Salt Support Structures. In *2023 International Solid Freeform Fabrication Symposium*.

Benedikt Kirchebner, M.Sc.
Walther-Meißner-Straße 4
85748 Garching
GERMANY

Tel. +49 89 289 14 539
Fax +49 89 289 13 738
benedikt.kirchebner@tum.de
https://www.mec.ed.tum.de/en/utg/

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