

Readme – Supplementary data

Data set title: Supplementary material to publication with title: *Design Guidelines for Multi-Material Parts Manufactured in the Material Extrusion of Metals Process*

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Context: This dataset is supplementary material to the publication with the title "*Design Guidelines for Multi-Material Parts Manufactured in the Material Extrusion of Metals Process*" of the International Congress on Applications of Lasers & Electro-Optics (ICALEO) 2025, 13 – 16 October 2025, Orlando/Florida/USA.

Multi-material additive manufacturing (MMAM) enables the integration of different materials within a single component, allowing for tailored functionality and the reduction of process steps. Among available metal additive manufacturing (AM) techniques, material extrusion of metals (MEX/M) offers a cost effective and feasible approach for the production of multi-material parts using a commercial feedstock.

This study focuses on the fabrication of green parts composed of pure copper (Cu) and Inconel 718 (IN718), selected for their highly complementary properties: Cu offers excellent thermal conductivity, while IN718 provides outstanding mechanical strength, as well as high corrosion and oxidation resistance. These characteristics make the Cu-IN718 combination particularly attractive for demanding aerospace applications, such as heat exchangers and combustion chambers.

A Design of Experiments (DoE) approach using Response Surface Methodology (RSM) was employed to evaluate the influence of key printing parameters, such as nozzle temperature, printing speed, extrusion multiplier, and layer thickness on the density and dimensional accuracy of green part test specimens. Optimal process parameter

sets for each individual material were identified and a corresponding parameter set for the multi material combination was subsequently derived.

Different geometric features, various material topologies and two interlocking geometries were analyzed to assess the print quality, and geometric accuracy of multi-material prints. The results were used to derive a set of design guidelines aimed at the manufacturability, reliability, and quality of Cu-IN718 green parts using MEX/M. These guidelines contribute to future standardization efforts in multi material extrusion, thus supporting more robust and reproducible production of components via metal AM.

Content of this data set:

The content of the data set is listed below in the same order as the files are stored in the folder *Supplementary_Data.zip*. Files are highlighted with bold font and a short description is given.

- **Supplementary_Data_README.pdf**: This readme file
- Supplementary_Data.zip: ZIP-Folder containing supplementary data
 - **Table_CAF_TargetAndActualDimensions.png**: Table of the target and actual dimensions of the Cylinders with annual fins (CAF)
 - **Table_DoE_ProcessParameter.png**: Table of the Design of Experiment (DoE) showing all process parameter combinations used
 - **Table_HC_TargetAndActualDimensions.png**: Table of the target and actual dimensions of the Hollow Cylinders (HC)
 - **Table_HCO_TargetAndActualDimensions.png**: Table of the target and actual dimensions of the Hollow Cones (HCO)
 - **Table_IG_TargetAndActualDimensions.png**: Table of the target and actual dimensions of the Interlocking geometries (IG)
 - **Table_SC_TargetAndActualDimensions.png**: Table of the target and actual dimensions of the Solid Cylinders (SC)
 - **Table_TestCubes-Cu_GreenDensity-GeometricAccuracy_1.png**: Table showing all the process parameter combinations used to print the Cu test cubes as well as the measured values of green density and geometric dimensions in X, Y, and Z direction (part 1/2)
 - **Table_TestCubes-Cu_GreenDensity-GeometricAccuracy_2.png**: Table showing all the process parameter combinations used to print the Cu test cubes as well as the measured values of green density and geometric dimensions in X, Y, and Z direction (part 2/2)
 - **Table_TestCubes-IN718_GreenDensity-GeometricAccuracy_1.png**: Table showing all the process parameter combinations used to print the IN718 test cubes as well as the measured values of green density and geometric dimensions in X, Y, and Z direction (part 1/2)
 - **Table_TestCubes-IN718_GreenDensity-GeometricAccuracy_2.png**: Table showing all the process parameter combinations used to print the IN718 test cubes as well as the measured values of green density and geometric dimensions in X, Y, and Z direction (part 2/2)
 - **ToolChangeScript.png**: Screenshot of the custom tool change script

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