Innovative SLM Materials

Previous DMRC projects in the field of the Selective Laser Melting (SLM) process promise a lot of new properties made from conventional materials. Single-material components manufactured by this production technique have been developed by different DMRC research groups. For example, tailored mechanical properties of components as well as high strength lattice structures. Thus, the outstanding potential of this innovative Additive Manufacturing technology was demonstrated for different metals and applications. Nevertheless, all these investigations have been carried out on more or less conventional materials, such as titanium alloy TiAl6V4 or stainless steel 316L.

1. Objectives

This circumstance leaves one huge potential of the SLM process unconsidered: An in situ combination and processing of different materials in order to obtain novel materials characteristics. The innovative idea is in contrast to other conventional production-routes and offers a new degree of freedom. During the latest investigations, two different types of new materials proved to be: The easiest way to create new materials is to mix different materials to one metal matrix composite (MMC). The second way is to combine them by variating it as the dimension varies to a functionally graded material (FGM). In order to enable a systematic procedure for this project, it has been subdivided into the following work packages.

- WP01: Material-screening and definition of desired properties
- WP02: Development of exposure parameters
- WP03: Comprehensive characterization of the mechanical properties
- WP04: Concept development “locally adapted material combinations”
- WP05: Transfer analysis

Figure 30: Bronze-316L Multimaterial

The establishment of innovative materials via the combination of different materials is the main goal of this project. The two different methods, on the one hand the MMC and on the other hand the functionally graded materials, require different processing routes. The main challenge for the MMC is to find a new way to process this combination by introducing them to new exposure parameters. In order to provide new parameters it is crucial to evaluate an efficient method for detecting the optimal exposure values. The main issue on the functional graded materials is to find a way to process it in a SLM 280 machine without having to stop the process in order to change the powder or to continuously change the parameters. Finally, the exposure results of the MMC materials will be used to optimize the interface between two functionally graded materials for the purpose of improving the transition area.

2. Procedure

The first MMC material consisting of boron carbide and AlSi7Mg was designed to evaluate the exposure parameters. After some improvement loops, it shows an advantage to the mechanical properties. Due to this successful processing, the currently examined materials are 316L, H13 and bronze. The figure to the left shows a FGM made of bronze and 316L. To achieve that type of alter-

nating structure at once, a new recoater had to be designed and produced. In combination with different slicing strategies, it is possible to change the material and the exposure parameters for every layer. According to the first microstructural and mechanical investigations, it is possible to attain good performance of the transitional area.

3. Latest results

The last results of the project contain the main activities which concentrate on further material combinations, which have been examined by additional optical deformation image correlation (DIC). With regard to the probable formation have been applied to the specimens of new alloy systems. Due to the development of a new generation of SLM slide-recoaters, it was necessary to design an entirely new recoater which fits into the new system. It works reliable and will be used in the future for new material combinations. The project has been completed in the year 2016.

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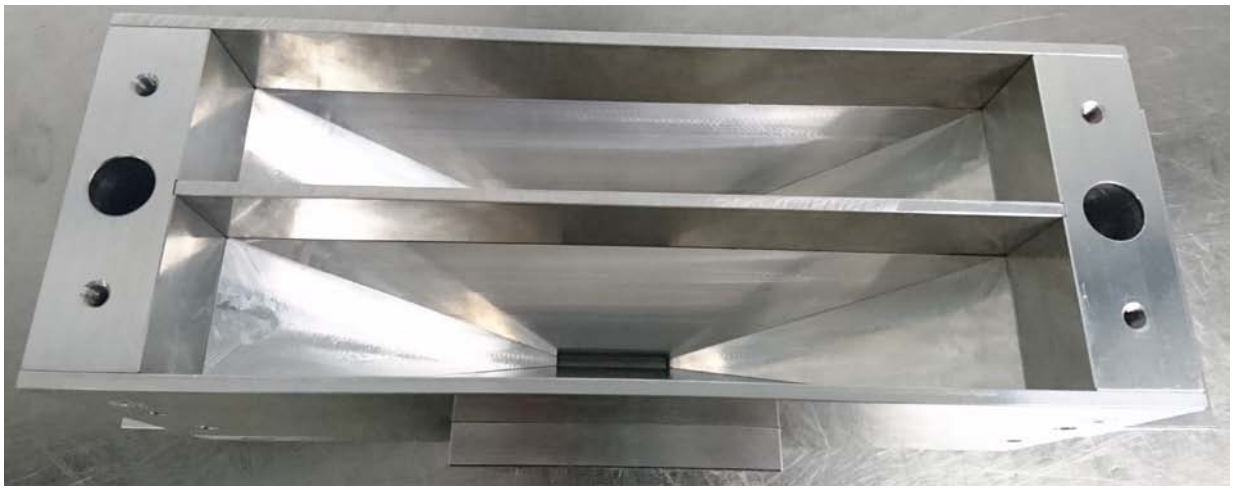

Figure 31: Multi-Material-Recoater