

GENERATION OF SOLID BODIES ON THIN-WALLED PARTS

THE TASK

The automotive, energy and aerospace industries have similar requirements with respect to reducing the required resources to process hard-to-machine high performance materials while simultaneously performing such processes at lesser costs. Alternatives are explored by moving away from pure subtractive processes. Hybrid processes such as the combination of additive generative laser processing with milling offer the potential to substantially improve material utilization.

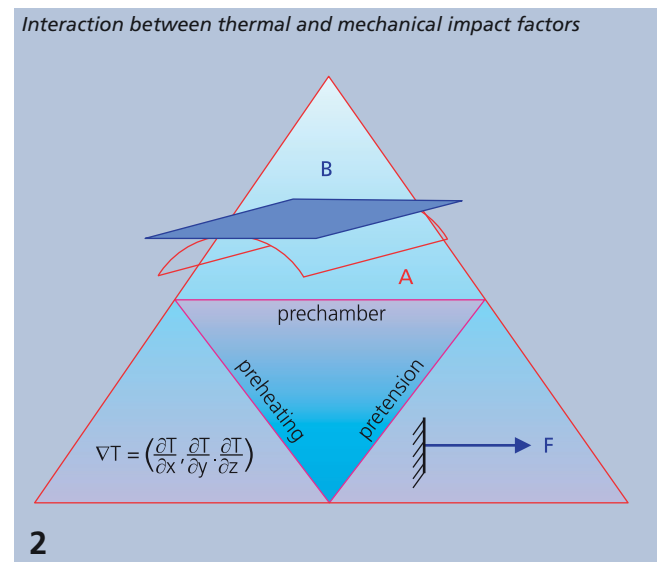
A special requirement is the deposition of large volumes of material on thin-walled parts. A key requirement is the control of thermally introduced stresses. These lead to warpage of low stiffness structures that are not fitted with any special countermeasures. To avoid this issue many industrial parts are machined from bulk material. If the material is hard to machine this approach quickly leads to the need for time consuming, technologically challenging and expensive efforts.

Of special interest are thin-walled structural components, which often have local thickness variations for increased stiffness requirements due to assembly reasons. Depending on the shape of these transition regions or their maximum thickness, these parts may require substantial machining efforts. Machining exerts mechanical forces which may have to be considered during part design, especially for very thin-walled cross sections.

Addressing these challenges involves the development of special processing strategies, which allow for the generative buildup of large material volumes on thin-walled parts with minimum change of the part's shape.

OUR SOLUTION

Laser powder buildup welding is an additive process that, under special processing conditions, is capable of depositing material directly onto thin-walled components. This can be achieved if the part is thermally precambered in combination with precisely aligned laser energy deposition and precamber temperature as well as suppression of any plastic deformation due to the pretension (Fig. 2). This approach enables the buildup of large material volumes at low structural stiffness.



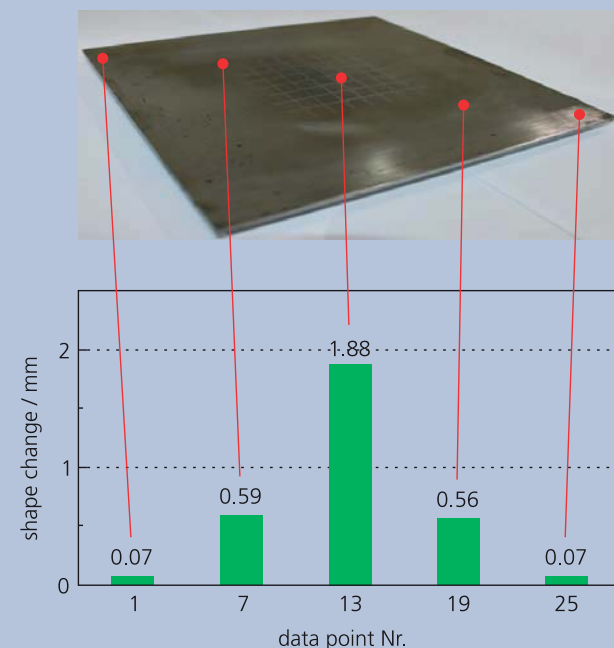


RESULTS

A solid cuboid with a height exceeding 40 mm was generatively fabricated on top of a 2.4 mm thick substrate using a laser powder buildup welding process. The thickness ratio of the deposited shape to the substrate was about 1:17 (Fig. 1). The lateral dimensions of the part were 200 mm for the quadratic substrate and 60 or 40 mm for the deposited volume. The material was a high temperature stable nickel base alloy.

The tailored process minimized the changes to the original shape to less than 2 mm (Fig. 4). Outside of the area of material deposit the shape change remained below 0.56 mm.

Changes of the substrate geometry compared to original shape



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Figure 3 shows the measurement setup to detect local shape changes as it was used during the process to perform tactile measurements.

This method substantially reduces the traditionally required milling effort, which is in particular true for difficult to machine materials. It is also possible to build complex shapes while enormously reducing the required material. This promises economic advantages, especially when costly materials are required.

- 1 Volume deposition on thin-walled substrate (isometric)
- 3 Tactile measurement of shape changes

CONTACT

Dipl.-Ing. André Seidel (SFI)

+49 351 83391-3854

andre.seidel@iws.fraunhofer.de

