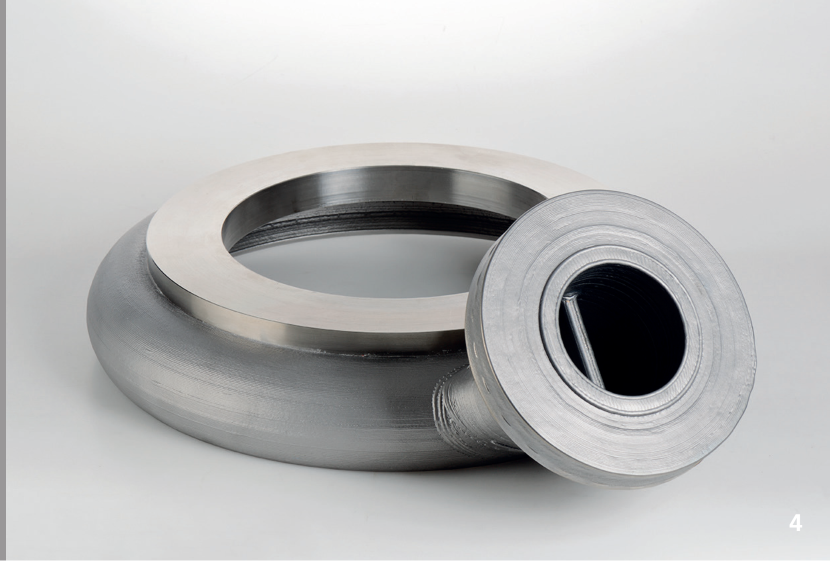

ADDITIVE PRODUCTION OF A DEMONSTRATOR FOR A ROCKET COMBUSTION CHAMBER WITH LMD

Task

As the number of innovative space companies grows, competition between them increases, which in turn requires them to reduce costs when manufacturing special components. Additive processes such as laser material deposition (LMD) are, therefore, being investigated as alternatives to conventional manufacturing, e.g. forging, machining. The reason for this is, among other things, the considerable costs of forging blanks and electron beam welding for components made of nickel-based superalloys. Here, additive manufacturing offers significant advantages: Forging blanks are no longer needed and, at the same time, the amount of raw material needed is reduced. In addition, AM's flexible, integral approach can be used to combine individual parts and, thus, reduce the number of welding seams. The project presented here aims to manufacture a rotationally symmetrical shell structure with a connecting flange as a monolithic component made of Inconel 625 by LMD for a rocket combustion chamber of the Ariane Group (Fig. 3).

Method

The component to be manufactured is the upper shell (US) including its connecting flange of the distributor ring for a demonstrator rocket combustion chamber. Based on the development of suitable process parameters and build-up strategies, the upper shell is manufactured using a CAD model as a continuous toroidal shell without a flange. In the following step, the connecting flange is built directly on the shell, which is conducted by a jointed-arm robot with turn-tilt module, a 4 kW disk laser and a coaxial Fraunhofer ILT powder feed nozzle. The component is scanned and digitized with an optical system so that the assembly result, the distortion and the allowance for mechanical post-processing can be checked.

Results

The upper-shell demonstrator (D_a 400 mm) with integrated connecting flange was completely and successfully built from Inconel 625 (Figure 4). The weight of the LMD volume is 12.5 kg with a process time of approx. 24 h. Thanks to digitalization of the part's geometry, a sufficient allowance for post-processing could be proven.

Applications

The findings of the LMD space demonstrator can also be transferred to other industries. These findings have great promise, in particular, for components that require costly blanks and/or have a high machining volume, such as integral and engine components for the aviation sector or turbines made of high-performance materials for energy generation. Moreover, the tool and mold making industry, e.g. for component modification, can make effective and flexible use of these findings.

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3 CAD model of the upper shell including flange.

4 Demonstrator component according to LMD design.