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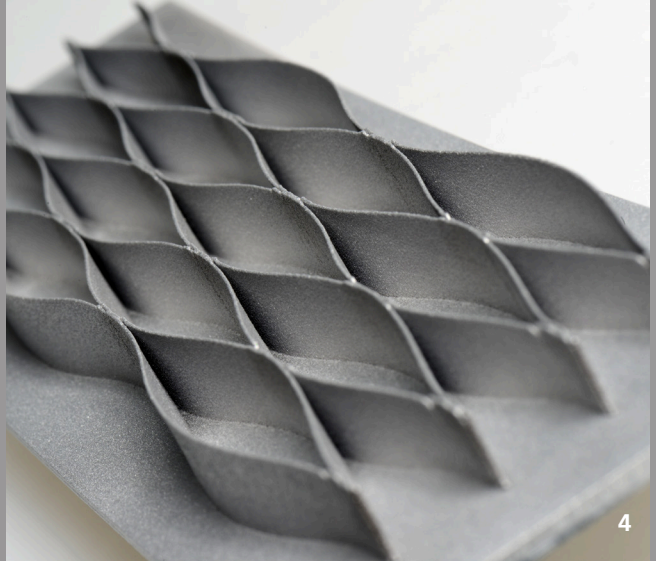

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EHLA 3D FOR THE ADDITIVE MANUFACTURING OF LIGHTWEIGHT ALUMINUM COMPONENTS

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Additive manufacturing with extreme high-speed laser material deposition (EHLA 3D) has numerous unique technological features and advantages over conventional laser material deposition processes: significantly greater precision and resolution of the manufactured structures combined with high build-up rates. Such advantages can unlock great potential in innovative lightweight applications with aluminum materials. Processing aluminum alloys with laser-based methods is challenging, however, since they have a low absorption coefficient and high thermal conductivity. Thus, the process control needs to be adapted to these specific material properties.

Method

To implement the required high feed rates in all spatial directions for the production of complex structures, Fraunhofer ILT cooperated with Ponticon GmbH to develop and set up a highly dynamic tripod kinematic system for feed rates of up to 200 m/min and high accelerations of up to 50 m/s². Based on investigations and findings on EHLA 3D for iron- and nickel-based materials, Fraunhofer ILT identified process parameters for the materials AlSi12 and AlSi7Mg0.6 experimentally. In addition to a metallographic evaluation, it determined the mechanical properties of additively manufactured three-dimensional structures.

Results

Additive manufacturing of aluminum structures succeeds at process powder efficiencies of over 95 percent and reaches a relative component density of over 99 percent. Tensile tests show that the mechanical properties are on a par with non-additive material samples. In addition, thin-walled structures with web widths of less than 1 mm for lightweight aluminum components, e.g. for ribbing structures of sandwich components, can be applied additively to aluminum components. It is also possible to produce overhangs of up to approx. 40° without having to line up the component laterally with the powder nozzle.

Applications

By identifying suitable process parameters and build-up strategies for basic geometric elements, the project partners are ready to transfer the results to complex, industrially applicable aluminum components. Since it can be used to combine materials that are difficult to weld, EHLA 3D opens up a wide range of new possibilities. The first industrial applications are expected for high-strength, corrosion-resistant component coatings, such as in toolmaking or aerospace. The work was partially financially supported by the Fraunhofer-Gesellschaft as part of the "HIGHLIGHT – Light Materials 4 Mobility" project.

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3 EHLA 3D process with stationary powder feed nozzle and moving component.

4 Lightweight honeycomb structure manufactured using EHLA 3D for the production of aluminum sandwich components.