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ADDITIVE MANUFACTURING WITH POWDER BEDS

THE TASK

Additive manufacturing of parts with powder bed processes offers a thus so far unknown level of geometric freedom. The technology enables to redesign existing products so that they have substantially improved properties. Highly complex shaped parts can be manufactured with integrated functions resulting in significant improvements.

The raw material is efficiently utilized due to the near net shape fabrication process. The level of resource efficiency is further increased by applying lightweight construction strategies. One example is the replacement of full density body sections with lattice structures of nearly the same strength. It is also possible to create individually optimized structures, for example to increase the relative surface area for improving the efficiency of cooling systems.

Additive manufacturing processes offer an enormous potential to save resources and energy and to increase ergonomics and efficiency. On the other hand, there are enormous challenges for novel manufacturing processes. Examples include the generation, handling and protection of part data, the reproducibility, speed and precision of the processes as well as the surface quality, detail resolution and material properties of the fabricated objects. Here we need the development of specially adapted process chains and the definition of design guidelines beginning with the creation of the CAD model and continuing with the preparation of manufacturing-ready data all the way to the post-processing of the completed parts to achieve the previously defined surface and structural properties.

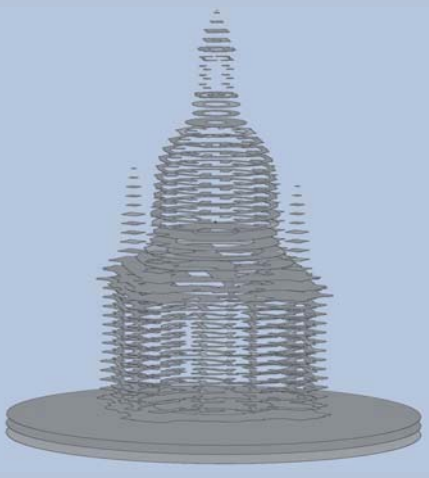
OUR SOLUTION

Selective Laser Melting (SLM) and Electron Beam Melting (EBM) are two additive processes which can produce highly complex parts from powder raw materials.

These processes are based on the iterative areal deposition of powders and selectively melting the material layer by layer. To avoid chemical reactions of the melted powder with the surrounding atmosphere, the SLM manufacturing process is performed in a shielding gas atmosphere, whereas the EBM process operates in vacuum.

Figure 2 shows individual layers of a part which are created with computers prior to processing in the machine.

A sliced layer model



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RESULTS

Beyond the commonly used materials, IWS engineers qualified highly corrosion resistant steels and highly thermally resistant nickel base alloys for the selective laser melting process. Process parameters were developed to optimize the energy deposition into the powder bed for the fabrication of parts that are nearly free of pores.

The resulting part strengths are similar to the strengths of the base materials. In the buildup direction it is possible to even further increase the strength beyond the base materials. Using these materials and processes decisively contributes to establishing the additive manufacturing processes especially for aerospace applications. Novel possibilities emerge for this high technology sector, which make the best possible use of the advantages of additive manufacturing.

A sample structure of a combustion chamber with adapted cooling channels

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The additive manufacturing of cooling channel structures for combustion chambers is one possible application. For these systems cooling ribs were generated with wall thicknesses in the submillimeter range. Subsequently their surface properties were optimized so that flow behavior and thermal transport improved for the generated cooling channels.

Due to the deposited heat, such thin wall thicknesses often suffer distortions. Support structures were added as a measure to counteract this effect. These structures also contribute to the heat conduction from the inner region of the part toward its mounting point.

Optimizing the creating of the support structure and increasing the building chamber temperature improved the building process. This yielded reduced thermal distortions, which significantly increased the reproducibility.

1 SLM produced model of Dresden's Church of Our Lady
3 Planet gears produced in one step (without joining)

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