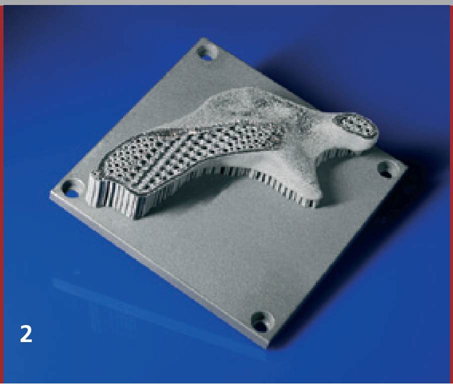
FRAUNHOFER-INSTITUTE FOR MANUFACTURING TECHNOLOGY AND ADVANCED MATERIALS IFAM



1 *Partial replica of a human jaw bone – laser sintered (with support structure on a building platform).*
2 *Partial replica of a human jaw bone with complex inner structure – laser sintered (with support structure on a building platform).*

ADDITIVE MANUFACTURING USING LASER MELTING (LASER SINTERING)

Through the use of a generative process, „laser melting" components can be created using metallic powders, in almost any shape and also allowing for complex shapes, directly from 3D CAD data. Here, the custom-made components are prepared and receive their final properties during the production process. Common to all current process variants is the principle of the component 's tool-free, layered structure, on the basis of a three-dimensional CAD model.

Laser melting or laser sintering, as the process is still sometimes called, is now no longer a sintering process. During manufacturing, the material is melted to 100% using laser exposure, and solidified immediately. Without subsequent sintering, process components with an almost 100% density can be taken. Laser melting is therefore the more appropriate term.

In today's market, laser melting is the most widely used method in generative metal powder processing. The following processes and systems from different manufacturers are well-known:

- »Direct Metal Laser Sintering (DMLS)« of EOS GmbH, Krailing
- »Selective Laser Melting (SLM)« of SLM Solutions GmbH, Lübeck and MTT Technologies Ltd., Stone, UK and Realizer GmbH, Borchen
- »Laser Cusing« of CONCEPT Laser GmbH, Lichtenfels

All of the aforementioned processes use variants of the laser melting procedure.

Laser melting has applications in the rapid product development of prototypes, individual and small-scale production and rapid tool manufacture for plastic

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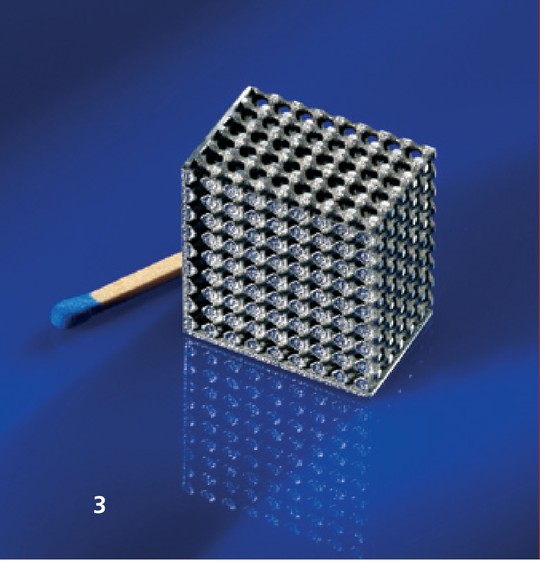

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injection molding and die-casting use. The production of customized products for the end user (rapid manufacturing) has become an economically viable option.

Customer-oriented and application-specific material and process development for laser melting are at the center of the Fraunhofer IFAM's development projects. The material palette ranges from light metals such as aluminum and titanium, to tungsten carbide and high-melting alloys.

The development process includes the entire chain, from creation of the 3D data models, to generative production to the physical and geometric final inspection of the components.

Example: Implant Study

The partial replica of a human jaw bone shown here (Figs 1 and 2) was made by Fraunhofer IFAM using an existing EOS laser sintering system.

The component generated by titanium-based alloy Ti6Al4V is typical of products with complex internal structures. In the implant study shown, the internal geometry is used to reduce weight while still maintaining mechanical strength. On the other hand, the introduction of internal geometries that mimic the human bone structure, or the creation of reservoirs for long-term medication, is also possible.

Complex Internal Structures

The unique potential of this generative manufacturing process, in conjunction with new design philosophies and simulation techniques, makes possible the development of new approaches and products.

The production of components with form-fitting cooling channels such as injection molding tools are possible, as is the manufacture of honeycomb-like structures with a flow guide. The use of internal, repetitive geometries (Figure 3) to increase the inner surface area – for example, for better energy and mass transfer in apparatuses for heat recovery or filtration – are also feasible with this method.

An impression of the potential of so-called topology-optimized structures in particular, not just for use in calculation but also in production, is shown in Figure 4. Topology optimization refers here to the design, simulation and fabrication of graded cellular structures for mechanically stressed components with a high stiffness and low weight. These methods are based on an optimized distribution of different material properties in the component.

Machine data

The metal laser sintering plant (manufactured by EOS) used at Fraunhofer IFAM processes a wide range of standard powder materials at an overall installation size of 250 x 250 x 215 mm. This ranges from steel-based powder for series injection molds, to light metals such as aluminum and titanium, to stainless steels – particularly on a CoCr-basis – for functional prototypes and production parts in mechanical engineering and medical technology. In future the plant will be used for the development and creation of materials, processes and products.

Our offer

- Development of materials for laser melting with simultaneous process adjustment – material palette of light metals such as aluminum and titanium to tungsten carbide and high-melting alloys
- Extensive process development for rapid manufacturing – from the generation of 3D data models to generative production up to the final inspection of the physical and geometrical components
- Support for process integration – implementation of technology studies, market analyses, workshops.

3 *Complex laser-sintered structures.*

4 *Study of a »topology-optimized jaw structure«.*