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FRAUNHOFER INSTITUTE FOR MACHINE TOOLS AND FORMING TECHNOLOGY IWU

# ADDITIVE MANUFACTURING TECHNOLOGIES

# CREATING NEW STRUCTURES BY LASER BEAM MELTING TECHNOLOGY

The Fraunhofer Institute for Machine Tools and Forming Technology IWU is a competent partner for application-oriented research in the fields of automotive and mechanical engineering. Furthermore, it helps to ensure a competitive advantage to its industrial partners in production engineering by offering innovative solutions.

The Institute's core competencies in machine tool development, forming and machining technology as well as mechatronics, lightweight design and system technology are complemented and supported by the use of additive manufacturing processes. The production of metallic components by using laser beam melting technology enables the Fraunhofer IWU to show their industrial partners new ways to develop and manufacture innovative components.

## Laser beam melting

The laser beam melting technology belongs to the additive manufacturing processes. The components are constructed layer by layer, directly based on 3D CAD data made of powdered standard material such as stainless or hot-working steel, aluminum, titanium, cobalt-chrome or nickel-based alloys. The powder is therefore locally completely melted by a laser beam to receive a microstructure of 99.5 to 100 percent density after solidification.

This procedure ensures almost unlimited freedom of design due to the tool less layer-by-layer construction of the component and therefore enables the manufacturing of geometries and structures in metallic materials of nearly unlimited complexity. The application of laser beam melting ranges from the production of molds and forming tools with conformal cooling channels to the manufacturing of highly complex and highly loaded components produced in low volumes or as prototypes all the way to the production of patient-specific implants.

## Advantages of laser beam melting

### Time to product

– direct, single-stage and tool-less manufacturing process
– no expensive operations planning/no NC programming
– rapid prototyping and direct digital manufacturing

### Creative freedom

– almost arbitrarily complex geometries, undercuts, inner geometries, cavities, delicate structures
– geometries which are not producible by machining, forming, casting

### Lightweight construction/bionics

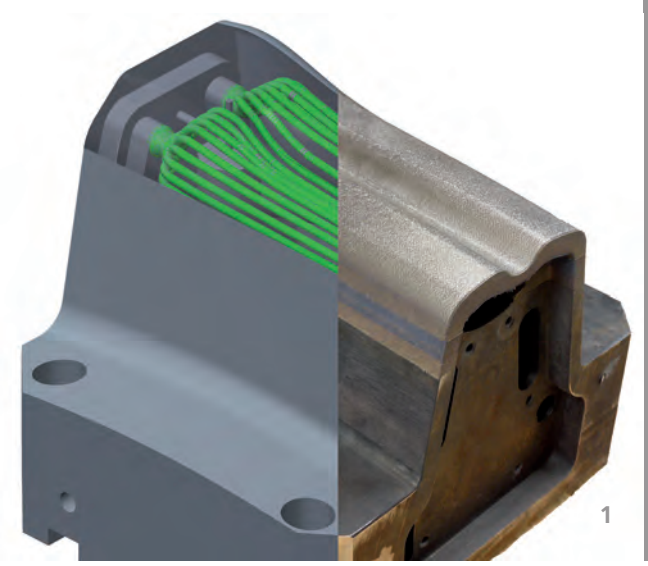
– hollow and framework structures
– direct implementation of topologically optimized component structures
– bionic structures without producibility compromises
– grated porous and scaffold structures

### Material diversity

– tool steel (1.2709, 1.2083) and stainless steel (1.4404)
– titanium (TiAl6V4), pure titanium (Grade 2)
– aluminum (AlSi10Mg, AlSi12)
– nickel-base alloy (Inconel 718)
– cobalt-chrome
– development of further material systems upon customer's request

## Tool making – active components for forming tools

The scientists of Fraunhofer IWU have extensive experience and competences when it comes to tooling. On this basis, innovative tool concepts for molds and forming processes are developed from the concept stage to readiness for series production using the laser beam melting technology. Additively manufactured tool inserts enable the integration of new functions into molds and forming tools for an optimized process control with a unique approach; for example the conformal cooling or tempering in order to reduce cycle times and improve component quality. The durability of laser beam melted tool inserts could be demonstrated with a highly stressed forging die under series like conditions.



Our range of services
– development and design of innovative, conformal mold and tool temperature control systems (plastic injection molding, die casting, forging, sheet metal forming)
– integration of additional functions in tools and dies to increase the efficiency of the tools
– support with the complete tool design, distinctive design of active components for laser beam melting
– additive manufacturing of mold and tool inserts by laser beam melting
– implementation of laser beam melted tool inserts into the tool
– support of production start-up, monitoring of relevant production data for comparison with conventionally manufactured tools
– evaluation of cycle time, tool life as well as quality and accuracy of manufactured components compared to conventionally manufactured tool

## Component manufacturing – production beyond technological limits

The laser beam melting technology is also suited for manufacturing highly complex and delicate components and systems which break the limits of conventional manufacturing technologies. The geometrical freedom of this technology combined with the rapid and tool-less manufacturing of high-tech components enable the production of complex components within a few hours.

Our range of services
– rapid prototypes in standard metallic material with series like properties
– direct rapid manufacturing of components for series production (motorsports, medical technology etc.)
– development, design and production of new lightweight components with lattice or bionic structure for applications in mechanical and aerospace engineering etc.

## Medical technology and implant production

Laser beam melting provides a variety of solutions for biomedical engineering. The production of tailored implants and prostheses with the most complex inner and outer structures become possible. Computer tomography data can be used as a design base. Totally new implants and other bone replacement structures can be manufactured by using laser beam melting. Additively manufactured products do not need to respect geometrical and manufacturing limits of common serial production, and as far as form and structure are concerned, they can perfectly adapt to the patient's need.

Today, the use of additive manufacturing within medical technology is no longer limited to the area of prototyping and model-making. The production of medical implants, instruments and tools made of bio-compatible material such as titanium, cobalt chromium and stainless steel is possible on a large scale. Besides artificial joints for hip and knee as well shoulder and spine, laser beam melting allows manufacturing of patient-specific skull and other bone plates as well as dental implants or bone replacement structures.

Our range of services
– development, design and manufacturing of patient-specific implants
– feasibility studies for medical applications
– integration of innovative functions into implants (active anchoring, functional channels and cavities and other functional structures within the implant)

1 *Hot forming tool with conformal cooling (InnoCaT®)*
2 *Implant with functional channels and cavities (MUGETO®)*

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