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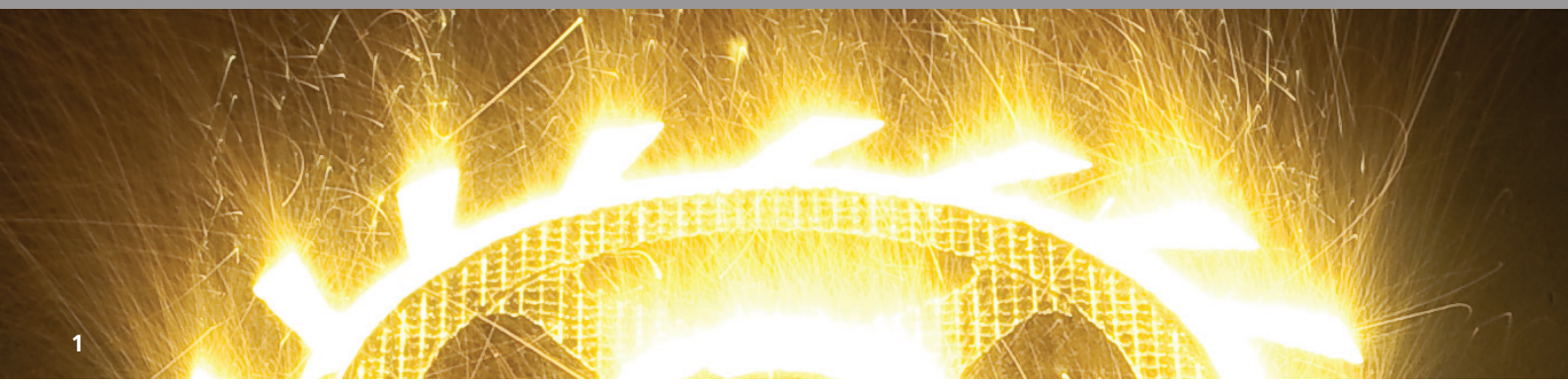

1 *Ultralight and highly complex implant made of titanium*

GENERATIVE MANUFACTURING METHODS: SELECTIVE LASER MELTING

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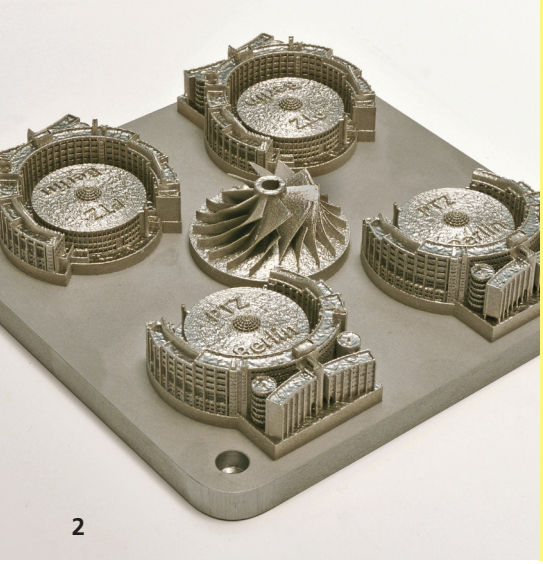
Since the late eighties generative manufacturing methods have been established as manufacturing systems for the product development in various sectors of industries. After only used for the production of demonstration models (Rapid Prototyping) is the rapid tooling and manufacturing now able to service a steady increasing range of applications. In order to achieve this status the range of usable materials has been extended. Today it is possible to process next to the in the RP area omnipresent plastics also metallic standard materials and ceramics. For the processing of metallic materials with the selective laser melting method are no binders or additives necessary.

Method

The selective laser melting (SLM) is an additive manufacturing process. Complex components can be generated directly out of powdered metal on the base of CAD-Files. This manufacturing method is used for the manufacturing of tools for the plastic injection molding and the die casting. It is also possible to produce very filigree structures for dental and human implants. Today you can find diverse applications in the area of rapid prototyping, rapid tooling and rapid manufacturing. Currently there are ten materials qualified for this manufacturing method. These are high quality steels, titanium-, aluminum- and nickel-based alloys with powder grain sizes between 10 µm and 60 µm. The producible layer thickness is between 20 µm and 50 µm. It is possible to achieve a component accuracy of ±50 µm.



The processing speed is 5-20 cm³/h depending on the space utilization. The generated parts have a homogeneous structure and a density of almost 100 %. Not only the physical but also the mechanical properties of the produced components comply with cast structures. The laser of the selective laser melting machine which is placed at the Fraunhofer IPK has a power of 400 W.

Process

The manufacturing process of the SLM can be subdivided into three phases which recur periodically. During the first phase the substrate plate is lowered by one layer thickness. In the second phase a new layer is applied on the substrate plate with the help of a coater. In the last step the powder is scanned by the laser. Due to the absorbed energy the powder fused at the scanned areas. This procedure will be repeated until the component is completed.

Advantages of SLM

As a result of the layered build-up the selective laser melting allows the manufacturing of components with hollows and undercuts. The developer gets a huge degree of freedom concerning the part geometry without being limited by restrictions of conventional manufacturing methods. In addition to that is it possible to integrate multiple functions in the component. Thanks to this great freedom in design is it also possible to individualize the products and to enlarge the number of variations arbitrary.

In comparison to the indirect laser sintering processes several process steps can be omitted like infiltration of the part with other materials. Since the introduction of the SLM process time-consuming and cost-intensive thermally after-treatments can be also substituted. The whole process chain and thereby the manufacturing time of the product can be reduced thanks to this change. In branches with very short product life cycles is the generated saving of time a big competitive advantage. Especially in areas in which small lots of little components are required is the SLM process already today a competitive alternative to the conventional manufacturing methods. The metallic substructure of dental crowns can be manufactured with the help of the SLM process within 48 hours.

In the SLM the complexity of a component has only a low effect on the unit costs, because the costs of this process are more volume- than geometrical-based. Particularly suitable for the SLM are parts with a high degree of complexity, because its manufacturing with conventional processes is either very cost intensive or not possible.

Targets

The current main-targets of the Fraunhofer IPK concerning the generative production methods are the increase of the process safety, the profitability and the quality improvement. An improved control, supervision and diagnostic up to Condition Monitoring should increase the process capability and the process controllability. Other targets are:

- Increasing of the economic efficiency,
- Improvement of the geometrical and dimensional stability, minimizing warping and residual stress which should lead to cost reduction for downstream processes,
- Selective setting of material- and part properties,
- Qualification of new materials for the SLM process,
- Opening up new markets for SLM,
- Transfer of the results of re-search to the industry, univer-sities and vocational schools

2 *Komplex geometries of metal powder*

3 *Propellers, nozzles and injection seeds - produced in one construction process*