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SELECTIVE LASER MELTING OF MAGNESIUM ALLOYS

Task

Thanks to their low density, magnesium alloys are commonly used today, especially in lightweight construction. These alloys are finding their way, however, into new, innovative applications in medical technology as well. For the latter, resorbable implants have been made of magnesium alloys and dissolve in the body, replaced by natural bone. Additive manufacturing processes such as Selective Laser Melting (SLM) can process such magnesium alloys with significant benefits for both applications. SLM can economically manufacture such components in small quantities (prototypes, patient-specific implants) or with unique functional properties (topology-optimized, defined porosity).

Method

When SLM is used to process magnesium alloys, a major challenge arises: Smoke is generated by the evaporation in the process because of the small temperature difference between the melting and evaporation temperature. In order to effectively remove smoke during the process, Fraunhofer ILT has developed a process chamber in cooperation with Aconity3D GmbH. The chamber allows the inert gas supply (e.g. flow profile and volume flow) to be adapted to process and material.

Result

Fraunhofer ILT has optimized the protective gas circulation for the processing of magnesium alloys and correspondingly adjusted the essential SLM process parameters such as scanning speed, laser power and exposure strategy to create a robust process. Thanks to this, components have been produced out of the magnesium alloys AZ91 and WE43 with component densities greater than 99.5 percent. The mechanical properties of the components fulfill the requirements of cast components in accordance with DIN EN 1753. The process can also be used to manufacture complex structures such as implants with interconnecting pore structures out of WE43 and structural resolutions smaller than 400 µm.

Applications

On the one hand, SLM can be used to manufacture lightweight components out of magnesium alloys. The process makes it possible to functionally optimize components with almost no restriction in design. On the other hand, it can be deployed to prepare resorbable implants in medical technology, which can be adjusted to a patient's individual needs and, at the same time, have an interconnective pore structure in which new bone tissue can grow better.

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2 Biodegradable scaffold from WE43.

3 Demonstrator for a topology-optimized triple clamp AZ91 (scale 1:4).