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ADDITIVE MANUFACTURING OF DEGRADABLE MAGNESIUM IMPLANTS

Task

Among the materials used for degradable implants, magnesium alloys show great promise. For bone replacement implants, not only is the material itself essential, but also the implant's geometric functionality. When interconnecting pore structures are introduced into the implant, new autologous bone can grow into the implant and degradation products can be efficiently removed. The additive production process laser-powder bed fusion (L-PBF) is predestined for the manufacture of such complex implants since it can build components economically due to its layer-by-layer method.

Method

To process magnesium alloys with L-PBF, research faces several challenges: the reactivity of the alloy, the small process window between the melting and evaporation temperature and the powder particles themselves, which are light due to their low density. Not only do these aspects need to be controlled, the process parameters also have to be specially adapted for the production of complex components with overhanging structures, as is the case with implants having interconnecting pore structures. Geometrically adapted exposure strategies are being used for this purpose.

Results

By appropriately adjusting the process control, process parameters and the exposure strategy, Fraunhofer ILT has been able to build implant demonstrators with complex pore structure from the magnesium alloy WE43. The demonstrators have a density of more than 99.5 percent in the solid material, are biocompatible, and can be smoothed by appropriate post-processing techniques such as blasting and etching to reduce the initial degradation.

Applications

In addition to producing degradable implants for various indications, L-PBF can also be used with magnesium alloys for lightweight construction applications since these alloys are about 30 percent lighter than aluminum alloys. Since the additive manufacturing process is highly flexible, thus allowing the construction of highly complex components, it has great potential for applications in the aerospace as well as automotive industry.

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2 Demonstrator made out of magnesium alloy WE43 for a degradable bone replacement implant.