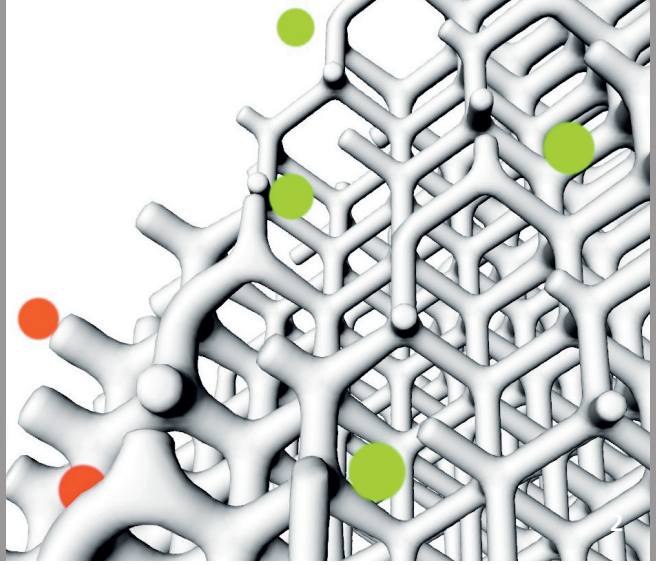

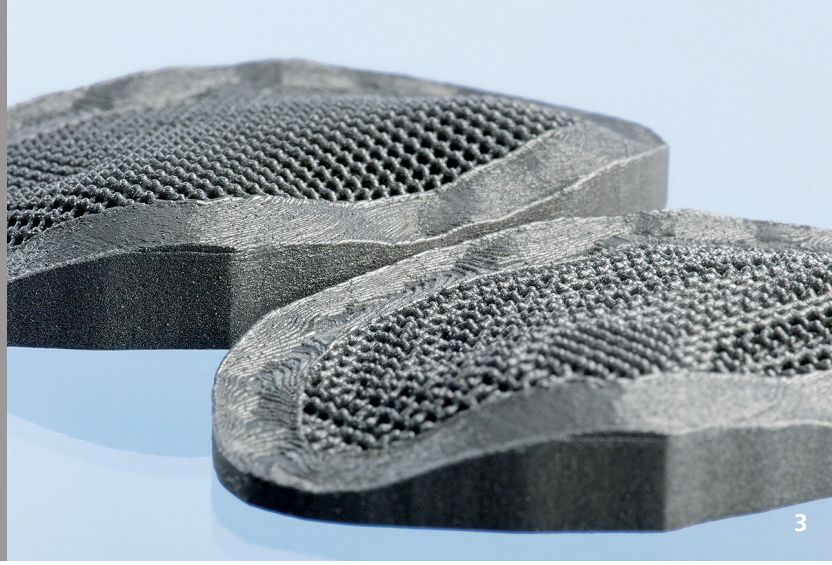

DESIGN AND ADDITIVE MANUFACTURE OF LOCALLY LOAD-ADAPTED VERTEBRAE IMPLANTS

Task

Degenerative instabilities in the spine can make it necessary to surgically remove spinal discs. So that the bones can fuse together, intervertebral cages are used in the resulting intervertebral space. The use of current cages may result in implant-related failure patterns such as non-union or migration due to a non-optimal press fit to the vertebral body. As part of the project »EITPSI«, a novel cage design is being pursued in order to determine geometry as well as rigidity and structure tailored to the patient – i.e. to individually adapt it to significantly reduce implant failure.

Method

In cooperation with the Chair for Digital Additive Production DAP of the RWTH Aachen University, Fraunhofer ILT has anatomically adapted the implant to the surface topography of the bone to produce a positive press-fit anchorage. The central fusion zone provides improved bony ingrowth. Moreover, by integrating a locally adapted lattice structure, the project partners have adapted the zone to the individual stiffness of the adjacent vertebrae and their individual bone density. At the same time, the ingrowth behavior of the bone tissue and, thus, the fusion can be significantly improved.

Results

An algorithm has been developed to locally adapt the lattice structure stiffness to the density of the adjacent bone. Based on a bone density point cloud determined by CT, local scaling factors (green = low, red = high stiffness) were derived (Fig. 2). These affect the initial and final diameters of each strut of the grid. A homogenous 3D mesh structure was generated by a subsequent smoothing process, and the general assembly ability was verified by means of selective laser melting (SLM), also known as laser beam melting or laser powder bed fusion (LPBF) (Fig. 2 and 3).

Applications

Due to the patient-specific adaptation, the production of locally load-adapted, additively produced vertebral body implants has great potential for improvement and can replace the implants that have become standardized in everyday clinical practice. The scope of applications can be extended to all implants to be fused with bone in the body.

Parts of the work have been carried out on behalf of the Federal Ministry of Education and Research BMBF within the framework of the »EITPSI« project under grant number 13GW0116.

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2 Scaling points with graded lattice structure.

3 Additively made cage out of Ti6Al4V.