Healthcare industry BW

# Orthobion GmbH: biomaterials for spinal implants

**If one takes a closer look at the mechanisms involved in bone growth, it turns out that the supposedly simple issue as to how bones grow cannot be fully answered. Konstanz-based Orthobion GmbH investigates and produces targeted biomaterials for use in implants designed for the treatment of spinal column defects. The surface structures of materials and how they affect the adhesion of bones to implant surfaces are key issues in the production of biomimetic bone replacement and implant materials.**

As a medical technology company specialising in spinal column surgery, Orthobion GmbH's research focuses specifically on the treatment of diseased spinal column segments. Back or leg problems that result from degenerated intervertebral discs or slipped vertebral bones causing the compression of the nerve roots as well as considerable pain can be treated with lumbar fusion (spondylodesis), a common procedure for surgically reinforcing the unstable and painful segment.

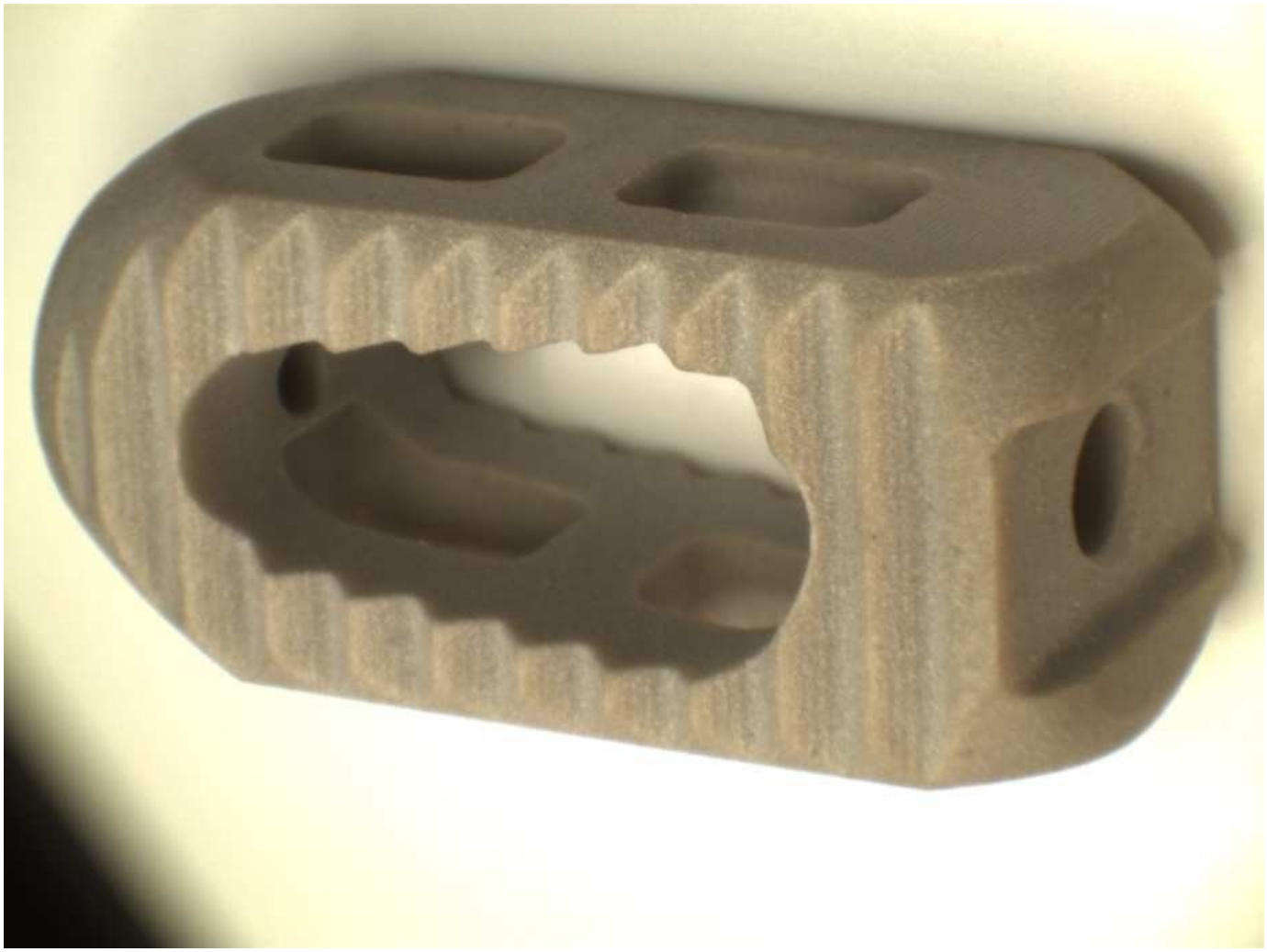
## Pain in the back and legs is the result of a defective spine position

Spondylodesis involves an operation to immobilise two or more vertebral bones by fusion of the vertebral bones with a short bone graft. The spine has several spinal levels, surrounding and in between the vertebral bones. "A one-level fusion links or fuses together two vertebral bones on either side of a diseased disc. A two-level fusion links or fuses together three vertebral bones with two intervening discs," explains Frederik Müller, managing director of Orthobion GmbH. When a diseased intervening disc is removed, artificial implants are placed between the vertebral bones in the area usually occupied by the intervening disc. The fusion of two or more vertebral bones is aimed at establishing a stable bone bridge.

## Stabilising the spine by lumbar fusion

Surgery that is carried out to fuse two or more vertebral bones can be done in several ways: incisions can be made into the skin covering the abdominal wall, the flank or the back. "Cervical discs are mainly accessed from an anterior abdominal incision (anterior lumbar interbody fusion; ALLIF); other discs are accessed from a posterior incision (posterior lumbar interbody fusion; PLIF). "In the majority of cases, the vertebral bones need to be stabilised with screws that are normally screwed into the pedicle of the vertebral arch and are subsequently connected to each other with a rod or a plate.

## Fixation systems for the fusion of intervertebral discs



SSC cage after surface treatment


Such fixation systems lead to immediate stabilisation, and a bony bridge will later lead to the complete fusion of the vertebral bones. Occasionally, so-called cages made of titanium or medical plastics are incorporated into the space usually occupied by the intervertebral disc. This procedure is known as “intercorporal fusion”. Orthobion GmbH develops, produces and sells cages made of medical plastics for the different parts of the spine and access paths as well as the fixation systems required for such interventions. The fixation systems are also made of titanium or carbon composite materials.

## Osseointegrative surface characteristics are a huge challenge

The permanent and stable positioning of implants depends on osseointegration (from Latin os: bone), which relates to the structural and functional connection between living bone and the surface of an artificial implant. “Osseointegration depends on the characteristics of the bone, the construction of the implant and the surface characteristics of the implant material.” The complex dynamic processes that occur at the interface between “inorganic implant” – “living tissue” and eventually lead to the formation of new bone, are crucial for the effective integration of the implant and have been a matter of intensive discussion for quite some time.

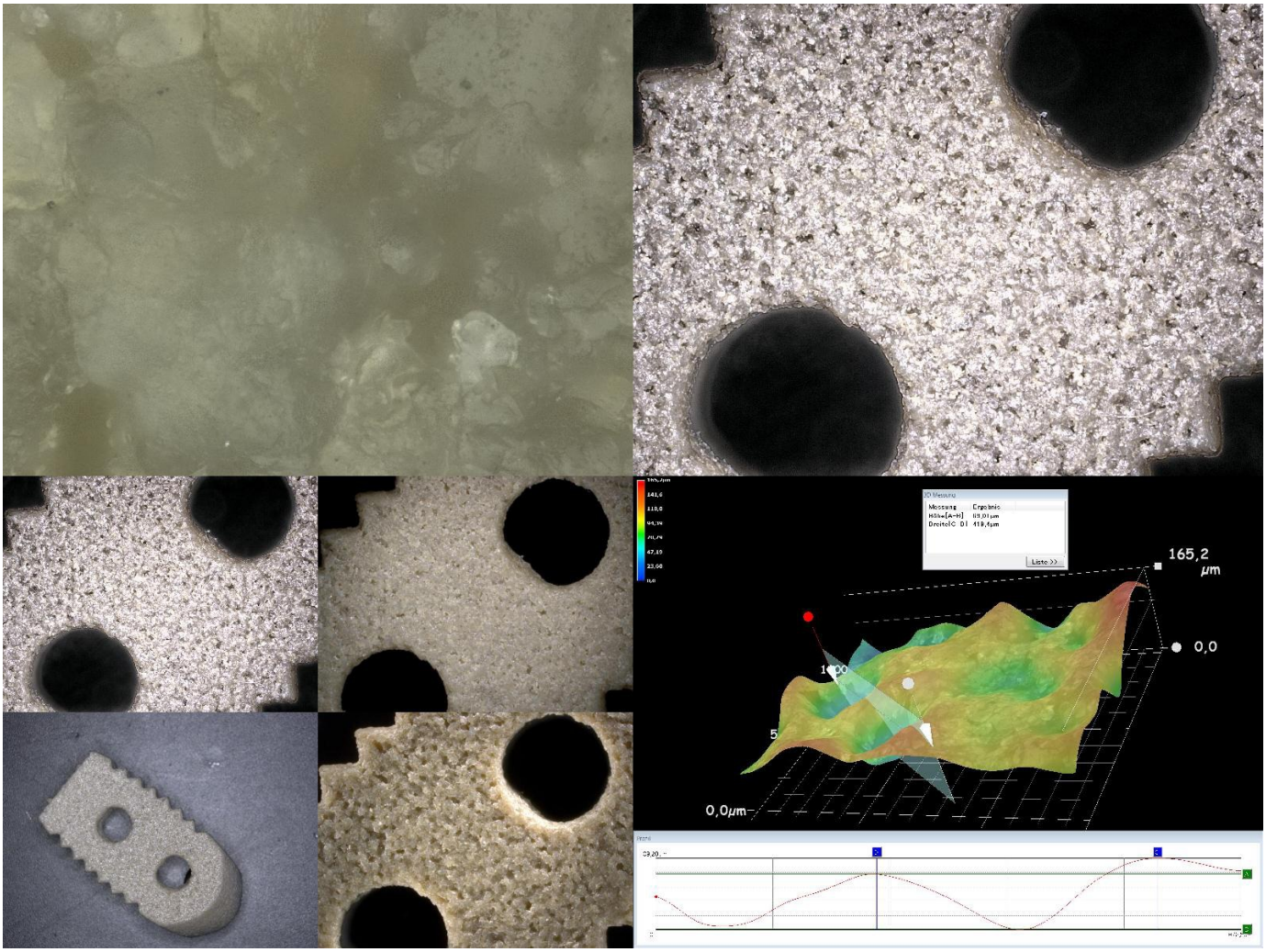
The basic questions relating to crystallography, thermodynamics and phase relationships have been solved in the field of chemistry. However, as far as the biological formation of calcium phosphates during bone growth are concerned, aspects such as speed of crystallization, control of crystal morphology and other aspects related to the integration of biomolecules need to be taken into account. However, to date, these processes are not yet fully understood, Frederik Müller pointed out. Orthobion is therefore also focused on gaining a better understanding of the structure and formation of biominerals, which will lead to improved biomaterials for the treatment of bone and potentially also tooth diseases.

## Biomimetics and biocompatibility

The term biocompatibility relates to the ability of a material to fulfil a function in the living organism and generate sought-after reactions on the cellular and molecular level. The term biomimetics relates to the examination of nature, its models and structures so that it can be emulated to create technological applications for solving human problems. In terms of implant production, the topography of a surface might play a role that is just as important as its chemical composition or properties.

X-ray examinations that are carried out after spondylodesis require implant materials to be transparent; traditional metal implants lead to disturbing artefacts. "This is why polyetheretherketone (PEEK) plays an important role as a medical plastic: due to its X-ray transparency, the material is invisible and allows the monitoring of bone growth. PEEK implants do not lead to disturbing artefacts when imaging methods are used for medical examination."

Calcium phosphate is one of the most important biomaterials: "Hard tissues such as teeth and bones are made up of hydroxyapatite, a calcium phosphate mineral that gives them stability and hardness." In order to produce an artificial bone-like composite material, researchers in the Orthobion laboratories are investigating different materials using a broad range of mechanical and chemical methods.




Surface topography after mechanical treatment: the texture is prepared and the surface measured before being chemically coated.


## Roughness and surface texture: biomimetics for bone growth

In addition to the materials used, the surface composition of the materials has a considerable influence on the effectiveness of an implant: the roughness and shape (e.g. milli- and nanometre-scale roughness) of a surface can have a considerable impact on the adhesion of bone cells to the implant; the topography of a surface is defined by its form as well as by its texture (undulations, roughness). Therefore, increasing focus is being concentrated on the creation of sought-after surface compositions. Different procedures can be used to produce thin and thick layers of hydroxyapatite: ion beam methods, sputtering, biomimetic separation from solutions, electrophoresis, dip coating in suspensions, hydrothermal methods and sol-gel synthesis. The company is also investigating the use of powder sinters, the adhesive attachment of powder to implant surfaces, as well as plasma injection techniques.

“In our laboratories, we combine different materials with each other as well as using a mix of different mechanical and chemical methods in order to produce a bone-like composite material that we will eventually be able to take from the prototype stage to serial production,” said Müller.

The broad range of research interests and tasks related to the development of biomimetic materials requires the researchers to work in close cooperation with other researchers: for example, Orthobion works in cooperation with Zwisler Laboratorium GmbH, a laboratory that

investigates cell growth on processed surfaces. These investigations have shown that the material used for the implant as well as the topology of the implant surface and its refinement make a major contribution to the effective growth and vitality of the individual cells. The results of these investigations are currently being prepared for publication.

**Further information:**

Orthobion GmbH
Gottlieb-Daimler-Str. 6
D-78467 Konstanz
Tel.: +49 (0) 7531/ 36 99 597
E-mail: info(at)orthobion-spine.com

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**Article**

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T. Warthmann
BioLAGO


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