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Compact CT unit for accredited test laboratory

Non-destructive analysis of 3D printed titanium implants with computed tomography

Werth Messtechnik GmbH

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In addition to dental implants, the CPM Group from Hirschberg also develops and manufactures 3D-printed spinal implants made of titanium. For this purpose, the accredited test laboratory CPM Diagnostics, which belongs to this group of companies, inspects the structure of the workpieces with a compact computed tomography coordinate measuring machine.

Every year, more and more dental implants are being used worldwide. In Germany alone, this figure is well over one million annually, a development that Claus-Peter Maier probably foresaw when he founded his company, then called CPM Claus-Peter Maier Präzisionsdrehtechnik. In 20 years, the master craftsman, who is experienced in the manufacture of such implants, expanded his original one-

man company into the CPM group of companies with over 100 employees. Today, the CPM Group supplies a wide variety of medical products (with a major focus on dental implantology) to major companies worldwide. The success is essentially based on the correct assessment of market developments, a corresponding diversification of the product range, and qualified employees, who have access to consistently high-quality equipment.

Under the umbrella company CPM Global GmbH there are now four independent companies dedicated to the development, manufacture, and distribution of precision turned and milled parts for dentistry and orthopedics, surface finishing, and measuring and testing technology. The manufacturing sister companies operate in close cooperation, enabling CPM to supply its customers with "ready-to-install" implants and complementary components.

The newest CPM company is an accredited testing laboratory for material testing, material analysis, and surface quality testing. Managing Director Christoph Stoll (Fig. 1) explains: "Today, the CPM Group supplies high-precision and surface-finished implants – tested and sterile-packaged. As an important building block for this complete range, we founded CPM Diagnostics GmbH in 2010, which also offers its metrological services freely on the market."

To meet the high requirements of the medical industry, the company initially invested in a scanning electron microscope, a white light microscope, and strength testing equipment. Equally important was the accreditation according to DIN EN ISO/IEC 17025 by the German Accreditation Body (DAkkS), emphasizes Stoll: "This documents our independence and guarantees that all tests are carried out in compliance with the standards."

3D printing – new manufacturing process for titanium implants

Up till now, CPM Diagnostics has focused on SEM/EDX analyses, non-contact roughness examinations, and the strength tests required for the market approval of dental implants in accordance with DIN EN ISO 14801, for which the company is listed in the DAkkS database.

But the range of tasks has expanded in 2020. The reason for this is the diversification of the CPM program to include spinal implants, which have also been 3D printed for some time. A process for which Christoph Stoll and his team are also responsible in addition to testing tasks. He explains: "After very positive trials with a small printer for laser melting titanium powder, this year we invested in a larger, high-quality Trumpf TruPrint 2000 system that ensures economic output of spinal and dental implants. However, such workpieces require a microstructure analysis that confirms that no voids, cracks, or other flaws are hidden inside. With our new TruPrint, such defects are very rare, but a verification requirement applies to workpieces that are used in the body and to safety-relevant products."

Computed tomography – ideal for testing and measuring

According to Stoll, there is no alternative to X-ray computed tomography (CT) for non-destructive testing in the volume of 3D-printed workpieces. In this process, which is increasingly used in industry, the respective workpiece is moved around its own axis on a rotary table and irradiated. From thousands of 2D images created in this way, a measurement software calculates a three-dimensional workpiece volume in the form of a dense point cloud that maps all the geometric information of the measured object 1:1.

CPM decided to purchase a TomoScope XS (Fig. 2) from Werth Messtechnik GmbH, Giessen. Christoph Stoll was already familiar with the manufacturer, as the sister company CPM Precision had already invested in a Werth ScopeCheck S multi-sensor coordinate measuring machine with the patented fiber probe and image processing several years ago. This reliably records the difficult internal geometry of the dental implants. "We had also thought of a coordinate measuring machine with computer tomography for this task," Stoll recalls. "But at that time, there were only very large and expensive CT machines on the market. Fortunately, that has changed – at least at Werth."

In 2017, the Giessen-based measuring machine manufacturer introduced the compact TomoScope XS, which opens up a wide field of metrological applications for computed tomography. The core element is the transmission tube, which achieves a small focal spot at high tube power and thus enables fast tomography with ›››

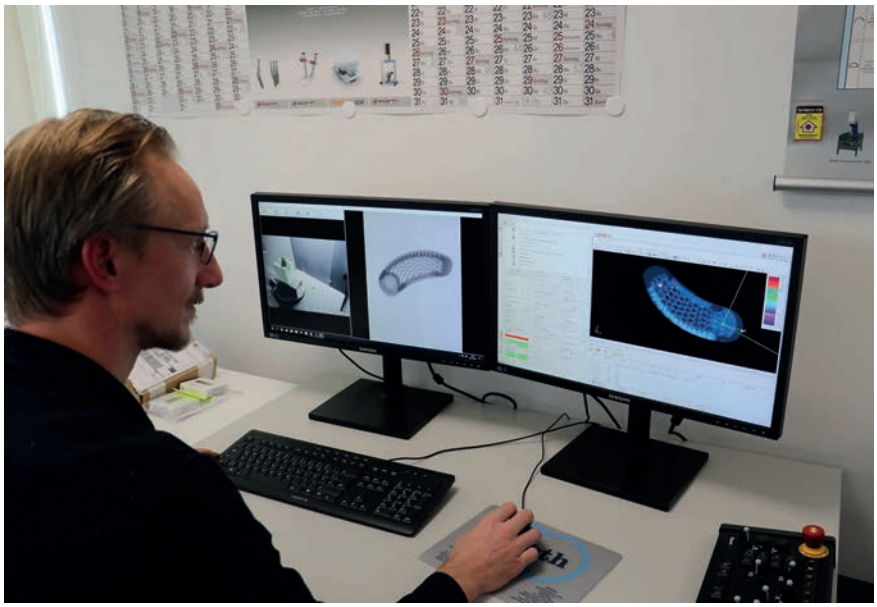

Figure 2. Laboratory assistant Thore Bienas appreciates the user-friendly measuring software, which enables him to program the measuring process quickly and evaluate it easily. © Werth

high resolution. Its open monoblock design ensures low operating costs and – due to long maintenance intervals – minimal downtime. The maximum tube voltage is 160 kV, the maximum power 80 W. This allows denser materials to be irradiated and longer irradiation lengths to be realized. A high-precision rotary axis with air bearings ensures low measurement uncertainties.

Figure 1. Christoph Stoll, Managing Director of CPM Diagnostics: "We are currently using the CT compact machine for void analysis of our 3D-printed implants. In the medium term, we will additionally use it for measuring geometrical properties." © Werth

"We had also looked around for alternatives," mentions Stoll, "but couldn't find anything that came close to meeting our requirements in a comparable way. The TomoScope XS is ideal for us in terms of its performance, compact design, and light weight of less than a ton. This allowed us to easily integrate it into our lab environment." The device also scored points for its low acquisition costs, which ensure a quick return on investment.

Laboratory assistant Thore Bienas is responsible for operation (Fig. 2) and is enthusiastic about how easy it is to use the measuring device and the WinWerth measuring software: "Only a few entries are required for programming the measurements, which are supported interactively by the software. During the evaluation, I then usually only need a few mouse clicks to obtain the desired results."

Easy application – fast result

The measurement technicians are positively surprised by the speed with which a scan is performed on the TomoScope XS. Despite the high resolution of the scans required, the measurement time is only a little more than 20 minutes, even for the titanium lumbar implants, which are several centimeters wide (Fig. 3). In addition to the transmission tube co-developed by Werth, the OnTheFly CT operating mode is also responsible for this. Here, continuous rotation of the device axis avoids the dead times that otherwise occur when positioning the

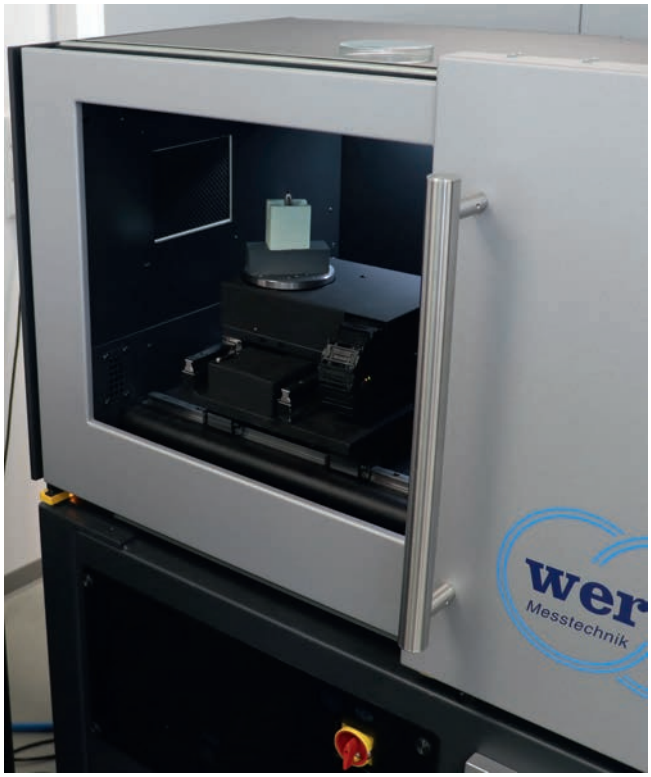

Figure 3. Extremely time-saving: the CT coordinate measuring machine is set up in just a few minutes, scans the components in record time and makes the measurement data available for evaluation immediately after the scan.

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workpiece. An extremely time-saving feature is the real-time reconstruction of the workpiece volume in parallel with image acquisition, so that the highly accurate measurement data is then immediately available for evaluation.

CPM Diagnostics is currently using the CT machine for void analysis in 3D-printed titanium implants. Each part is inspected individually before it goes into mechanical processing. "We do consider whether a random inspection per print job might be sufficient. But the high level of automation of the Werth TomoScope means we'll probably maintain 100 percent inspection even as production numbers increase."

WinWerth's dual output strategy allows metrologists to detect any voids at a glance and read off the calculated volume content. The voids, color-coded according to volume content, are displayed graphically in different perspectives on the semi-transparent point cloud, while the numerical values are displayed in tabular form.

Managing Director Stoll points out that the CT device "will also be used for measuring geometrical properties in the medium term. Among our customers, the extended offer has already triggered a very positive reaction."

In spring 2021, CT analysis will also be included in the scope of accreditation. In this respect, the testing laboratory benefits from the standard-compliant specification of the Werth TomoScope, which stands for reliable and traceable measurement results. Werth was able to supply the CT device with a DAkkS certificate because the Werth DAkkS laboratory is the first facility of its kind to have been accredited for the calibration of coordinate measuring machines with computed tomography since 2011. ■

Translated by Werth Messtechnik GmbH

INFORMATION & SERVICE

THE APPLICANT

Founded in 2010, CPM Diagnostics GmbH is part of the CPM Group, which develops, produces, and distributes dental and spinal implants, prosthetics, and laboratory components. As a DIN EN ISO/IEC 17025 DAkkS-accredited testing laboratory, CPM Diagnostics provides various measurement and testing services both for external clients and within the group of companies.

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