X-RAY CT SCANNING

X-ray computed tomography takes over from coordinate measuring in dental implant manufacture

Automated CT system from Nikon Metrology works 24/7 virtually unattended

The Nikon Metrology XT H 225 ST X-ray CT system scanning zirconium dioxide implants at Dentalpoint, Zürich.

Based near Zürich, Dentalpoint launched a more aesthetic and healthier alternative to the conventional titanium dental implant, after four years of intensive research led to the invention in 2009 of a biocompatible, metal-free alternative made from ceramic. The ZERAMEX zirconium dioxide, two-part implant system includes small, complex features such as internal threads that must undergo extensive inspection to provide the evidence of meeting dimensional specifications as well as product traceability in compliance with medical device regulations.

Quality control was proving difficult and time-consuming on a coordinate measuring machine (CMM), so in 2018 the company invested in an alternative process based on a X-ray computer tomography (CT) system from Nikon Metrology and an own inbuilt robotic loading system. The benefits have been enormous, not only in the speed of operation and the high degree of automation for supporting volume production, but right back to the research and development phase of new products.

Dentalpoint is considered to have a three to four year lead in the development of ceramic implants that fully match the attributes of top-end titanium varieties. It manufactures ZERAMEX implants and related ceramic parts in its production centre in Zürich using special technology to process the extremely hard zirconium dioxide.

Benjamin Bernet, the firm's R&D Project Manager said, "As a certified medical device manufacturer, we are responsible for the quality control of all implants and must make sure that the stringent regulations and standards in this field of medical devices are met."

"Dimensional control of all the products we manufacture is crucial. Our previous production partners mainly used a CMM with a touch probe to take various point measurements of the outer implant geometry as well as of the whole inner connection which acts as a counterpart for the screw and the abutment.

"In contrast, our new in-house production line relies on an automated Nikon Metrology XT H 225 ST CT system to control quality more comprehensively through 100 percent inspection of almost every feature and dimension, despite their small size."

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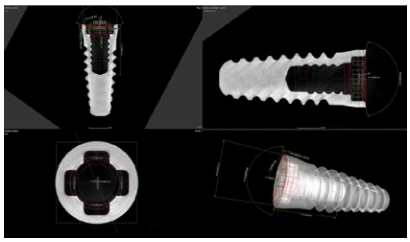
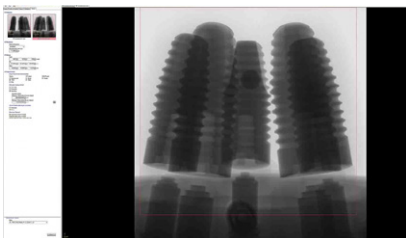
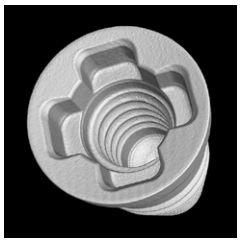


Three orthogonal views and one perspective view of an inspected dental implant, showing measured dimensions and angles.



A CT radiograph of a group of five implants that have been X-rayed.



Close-up of a single implant, showing the high level of internal detail visible from the reconstructed voxel data.

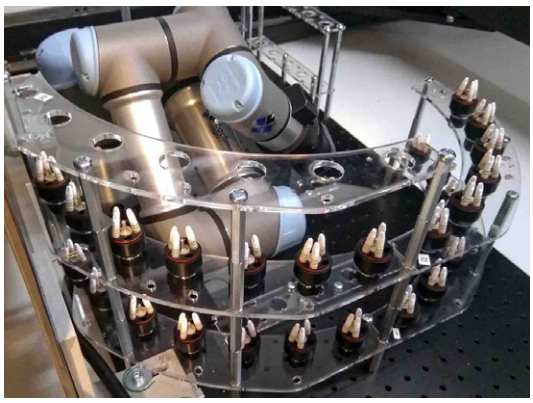
One of the main issues with the previous metrology method was the lower accuracy with which features could be measured, especially small inner geometries such as deep holes and internal threads. Moreover, measurements were often limited to points and 2D paths, as more detailed measurements were very time consuming. Additionally, there was no possibility over a long period to reanalyse measured parts after delivery or use by a patient, as only some datapoints were stored and no point clouds were available for checking 3D surfaces.

The latter restriction was one of the most important reasons for investment in the new CT equipment, according to Mr Bernet, as well as the ability to set up an automated workflow to achieve high inspection productivity, including loading by cobot (collaborative robot) of a full batch of parts into the CT cabinet.

The measuring cycle involves the cobot sequentially picking up multiple implants mounted in a plastic (PEEK) holder, transferring it onto the manipulator and, after scanning is complete, returning the components to the rack from whence they came. The CT machine runs almost 24/7, typically measuring up to 500 implants in a 24-hour period, with full traceability of results.

"We opted to invest in the CT inspection solution from Nikon Metrology because the supplier was able to demonstrate the feasibility of its system for fast, effective scanning of our products, coupled with comprehensive reporting of results."

Benjamin Bernet, R&D Project Manager



The cobot that automates the transfer of holders containing implants to the Nikon Metrology CT system.

Only one clamping is required for CT scanning, unlike with the previous CMM inspection, and all parts are held in identical fixtures that are repeatedly reused. During subsequent analysis of the scan data, the PEEK vanishes due to the large difference between its density and hence linear attenuation coefficient compared with those of ceramic.

A further advantage of the CT measuring cell is its low operating cost due to automated loading using the cobot and the concurrent, fully independent reconstruction of the previous X-ray data, registration, fitting, and reporting. Since the process is stable and the CT runs as expected, there is no need for service, maintenance or support. The cell and its software can be configured with scan profiles for simplicity of use by operators. Final reports are easy to interpret and the data can be handled with little effort, with part-to-CAD comparison available for detecting tolerance errors and geometric anomalies. Single result files can be generated for a complete batch within the measurement protocol.

The acquired metrology data is used not only to support the mandatory requirements with regards to lot traceability of measurements but also by production line operators to set up machinery and manufacturing parameters to maintain high production quality. The ability of CT to investigate the interior volume of parts non-destructively means that further analysis could be carried out in the future using the data, such as checking for internal defects or cracks.

Mr Bernet is also of the opinion that another huge and often underestimated benefit of X-ray CT is that it can be used in research and development, including for material research and analysis, failure analysis and functional relationship analysis of assemblies. He believes there exists a wide range of applications where such a powerful device can be employed, in addition to quality assurance. Furthermore, CT could assist in the development of new implants and tools, open up new horizons and overcome limitations of new designs.

He concluded, "We opted to invest in the CT inspection solution from Nikon Metrology because the supplier was able to demonstrate the feasibility of its system for fast, effective scanning of our products, coupled with comprehensive reporting of results.

The final implementation of the process workflow is highly stable and functional. The full 3D data is used to measure features in detail and is stored for traceability. High accuracy is achieved by calibrating the device to a specific scan position, leading to very small measurement errors below one micron when tested on a reference sphere.

The installation was efficient and the training, service and helpline are very professional and helpful. In particular, we received great support from Nikon Metrology's application engineers in developing the process."

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