Fraunhofer IPM

3D CT
Material and component analysis

For additive manufacturing and other innovative manufacturing methods

A look inside: 3D computed tomography makes it possible to identify defects inside components. Such hidden defects are often the cause of complete system failures.

3D computed tomography offers new possibilities for the non-destructive analysis of components which are produced using additive or other innovative manufacturing methods. Using a 3D computer tomograph (3D CT), objects, components, or materials can be displayed two-dimensionally or three-dimensionally.

Simple and non-destructive

Manufacturing components using novel processes, such as additive manufacturing, often results in defects that can have many possible causes. Analyzing the internal structure of defective parts helps to identify typical sources of defects and thus optimize the manufacturing process. However, this often involves disassembling or cutting the parts apart or even prepare material cross sections. This sometimes leads to inadvertent changes to the original state of the sample. For 3D CT analysis, it is generally not necessary to prepare the components.

3D CT for additive manufacturing

Non-destructive material analysis using a 3D CT provides fast and reliable information and data regarding defect classes and issues typical of additive manufacturing processes:

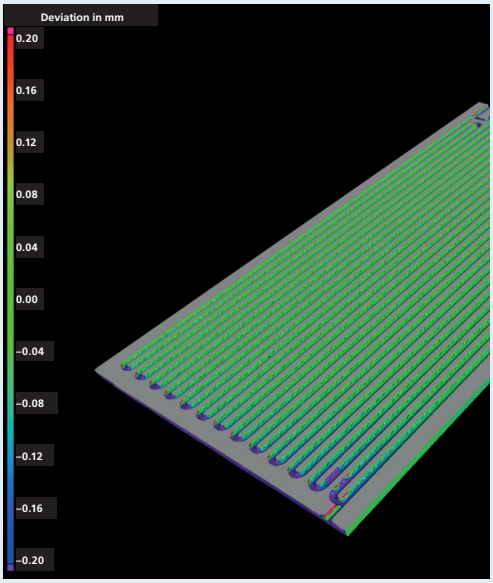
- Component defects such as blowholes, cracks, inclusions and powder residues (also areas with incompletely melted or sintered material powder)
- Analysis of material powders (determination of particle size and ratio of particle sizes, detection of impurities in the original powder, etc.)
- Detection of deviations from nominal dimensions with easy-to-read false-color display even for fine, internal structures such as microchannels or wall structures
- Wall thickness analysis with regard to wall thickness, deviations from nominal dimensions, variance of wall thicknesses etc.

Know how & Experience
Individual component and materials analysis

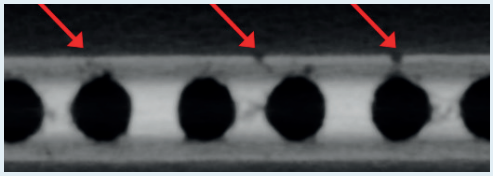
As a research institute, we have many years of experience in the analysis of components and materials. And we are well aware of the details and pitfalls involved. Based on this foundation, we carry out individual 3D CT measurement tasks on behalf of our customers.

Don't hesitate to get in touch!

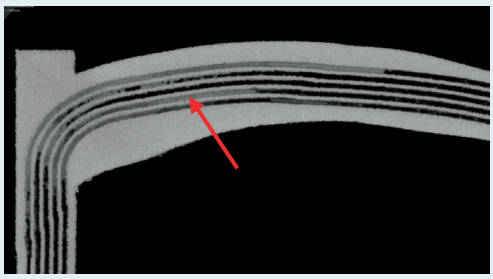
Typical examples of materials and component analyses by means of a 3D CT



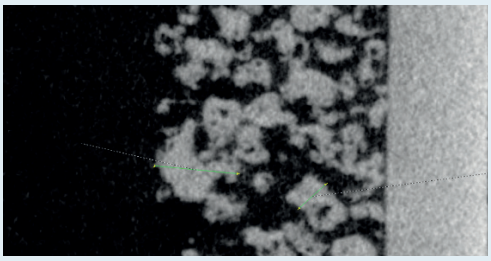
Additively manufactured water cooler: Comparison of fluid channel dimensions to nominal dimensions in false-color representation. Deviations from the nominal dimensions occur mainly at the upper and lower ends of the channels. Green: no deviation, blue and red: deviation of the dimensions downwards and upwards.



Microscopic cracks on a cold plate with fluidic channels.



S-shaped water cooler with fine channel structures manufactured in an additive process. The 3D image reveals significant amounts of residual metal powder (arrow mark).



Capillary wick structure sintered from metal powder. The image shows a high porosity and a sponge-like structure. The powder particle size varies and is between approx. 70 to 300 µm.

Apart from defect detection, 3D computed tomography can also be used for product control or in the establishment of new manufacturing processes for series production, such as 3D printing. With the aid of 3D CT, the components can be compared quickly and comprehensively with the target state.

Live and in situ analysis under operating conditions

Using two-dimensional radiography, our tomograph is able to capture live images with a frame rate of up to five images per second. This allows components to be analyzed live and "in situ" under realistic conditions, including defined pressure, tensile and torsional stress, and also defined temperatures or degrees of humidity. For this purpose, specifically adapted measurement cells can be developed, in which the components are exposed to defined operating conditions. This allows defects that only occur under certain operating conditions to be detected.

Technical data

- 300 kV tube – for imaging dense materials such as stainless steel and copper
- 180 kV nanofocus tube – for detail recognition of up to 200 nm under ideal conditions and resolutions of up to 1 µm
- 16 MP detector with high dynamic range – to capture fine structures and high contrasts
- Geometric measurements – with traceability for calibration standards according to VDI 2630 1.3
- In situ analysis of components under operational conditions including e. g. defined pressure, tension, torsion or temperature

Contact

Dr. Markus Winkler
Project Manager Component Analysis
Phone +49 761 8857-611
markus.winkler@ipm.fraunhofer.de

Andreas Mahlke
Engineering
Phone +49 761 8857-480
andreas.mahlke@ipm.fraunhofer.de

Fraunhofer Institute for Physical Measurement Techniques IPM
Georges-Köhler-Allee 301
79110 Freiburg, Germany
www.ipm.fraunhofer.de