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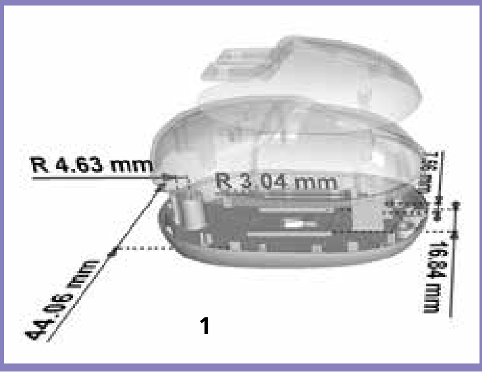

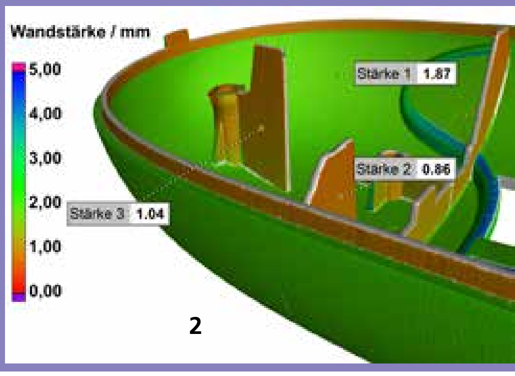

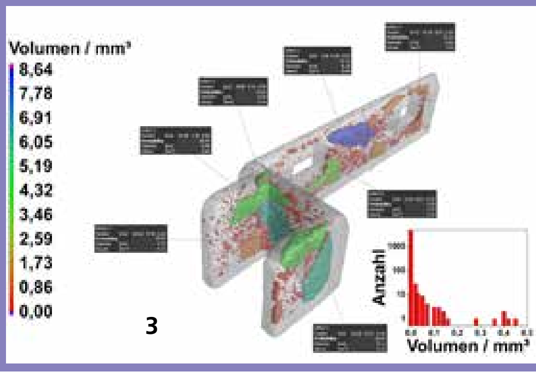

1 Dimensional measurements on a plastic injection-molded component.

2 Wall thickness analysis of a plastic injection-molded component.

3 Porosity analysis of a partially-foamed, glass fiber-reinforced PP-injection-molded component.

COMPUTED TOMOGRAPHY FOR MATERIAL AND COMPONENT EXAMINATION

Computed tomography (CT) is a fast and non-destructive method for material and component examination. It enables a three-dimensional representation of the internal and external structure of objects with a detail detectability which goes down into the micrometer range. CT evaluation enables a large number of qualitative and quantitative analyzes such as, for example, the characterization of materials regarding defects such as cracks, cavities and pores as well as dimensional investigations.

It must be emphasized that the method is principally suitable for any material or any combination of materials, including e.g. plastic-metal composites.

Measuring principle

CT uses the X-ray characteristic of penetrating objects and thereby being weakened in dependence on the material and the path length. From a series of 2D X-ray images of the examined object from different camera angles, generally by gradual rotation of the test object, the 3D volumetric representation of the object is reconstructed with the assistance of a computer.

The 3D volume is comprised of a large quantity of so-called voxels – the 3-dimensional analogs of pixels – with absorption-specific gray values. The edge length of the voxel thereby determines the detail detectability of the CT scan.

The measurement duration is task-dependent and lasts between a half-hour and two hours.

Fraunhofer Institute for Wood Research, Wilhelm-Klauditz-Institut WKI
Application Center for
Wood Fiber Research HOFZET
Heisterbergallee 10A
30453 Hannover
Germany

Contact

Christina Haxter M.Eng.
Phone +49 511 9296-2288
christina.haxter@wki.fraunhofer.de

www.wki.fraunhofer.de

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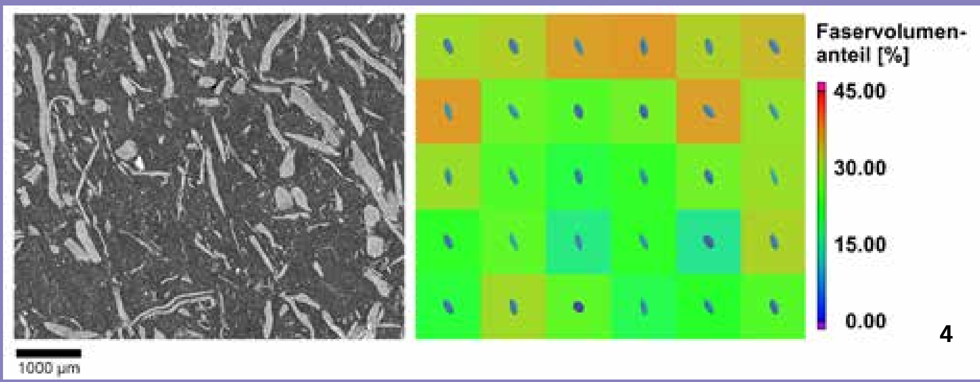

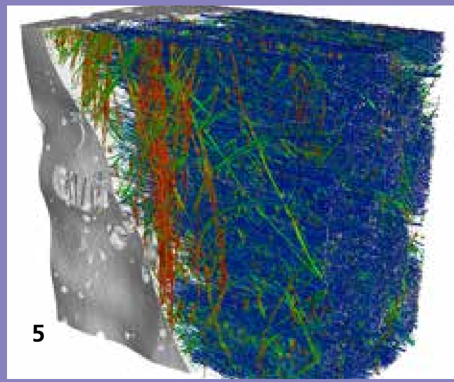

Geometry ascertainment

Through a CT measurement, the geometry of molded parts can be accurately ascertained. This enables widely-varying dimensional measurements to be precisely performed, for example of:

- distances
- diameters
- radii
- angles

Internal structures such as cavities are also hereby detected.
Furthermore, the wall thicknesses of a component can be automatically determined, color-coded and compared with nominal wall thicknesses. The nominal/actual comparison enables the comprehensive adjustment of the CT volume data of the measurement object with a reference object. This can be, for example, a CAD model or a reference measurement. In the reverse direction, a 3D model can be exported from a CT measurement, for example for reverse engineering.

Pore, cavity and inclusion analytics

The CT characteristic of showing the internal structure of the material enables defects such as cracks, cavities or pores to be detected and quantified. This includes the determination of:

- defect volume
- positions of the defects in the sample
- geometric properties (diameter, volume, sphericity) of the individual defects

Analog to this, these evaluation possibilities can be applied to inclusions such as foreign particles or filling materials.
A further application example is the characterization of the structure of foams.

Fiber analytics

In fiber composites, the individual reinforcing fibers can be resolved by means of CT. This opens up a comprehensive characterization of the materials as regards, for example:

- fiber length and diameter, ratio length/diameter (aspect ratio)
- fiber distribution
- fiber volume proportion
- fiber orientation

Furthermore, morphological features, e.g. the surface structure of fibers, fiber undulations or the vascular structure in wood fibers, can also be detected.

In situ CT

In contrast to conventional CT applications, for in situ CT examinations not only the steady state of an examination object is detected; several successive CT scans dynamically follow the object's behavior whilst it is subjected to an external load. This can be, for example, a mechanical, thermal or corrosive loading.

Equipment

CT system Procon X-Ray CT-AlphaDuo:

- 240 kV micro-focus and 225 kV high-power x-ray tube
- 4MP detectors
- Samples: Diameter max. 500 mm, height max. 400 mm, weight max. 25 kg
- In situ stage for 4-point bending tests
- Z-shaft for further in situ structures (e.g. fluids, pressure, etc.)

Max. scan volume dependent on recording mode:

- 500 mm diameter, 250 mm height
- 250 mm diameter, 400 mm height

Minimum voxel size: < 1 µm

4 *Analysis of fiber volume proportion and average orientation in a short-fiber-reinforced plastic.*
5 *Orientation analysis of a long-fiber-reinforced plastic.*