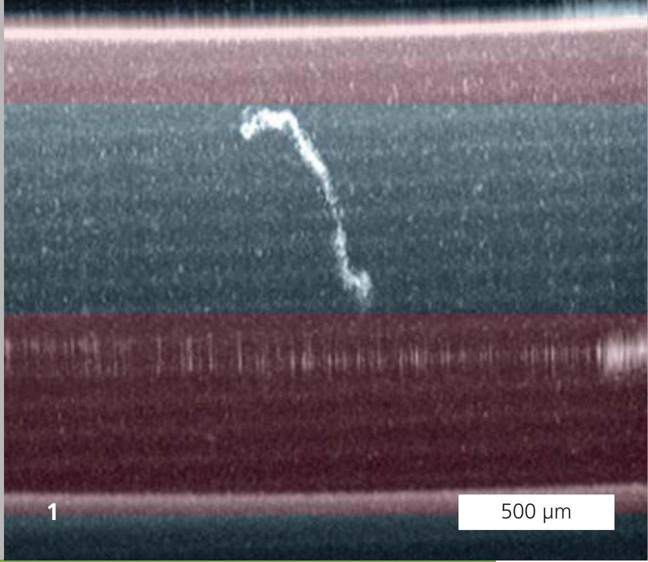

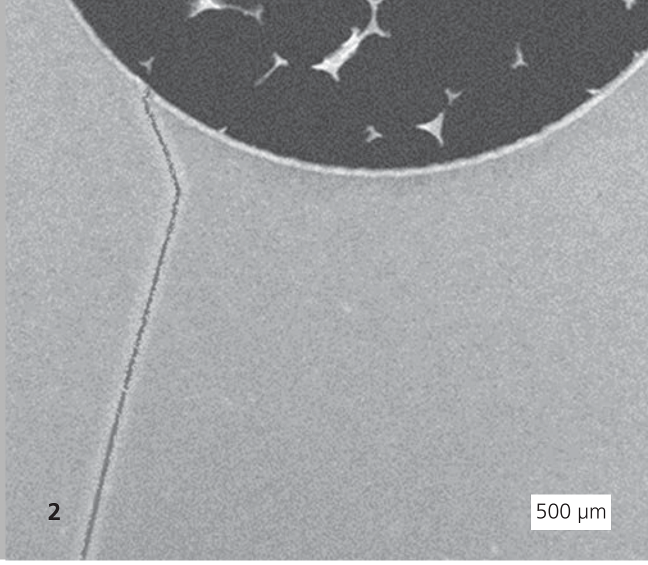

3D INSPECTION OF TRANSLUCENT CERAMIC COMPONENTS USING OCT

Dipl.-Ing. (FH) Christian Wolf, Dipl.-Ing. (FH) Christian Jürgens, Dipl.-Ing. Uta Oberbach, Dr. Thomas Härtling, Dr. Isabel Kinski

The optical coherence tomography (OCT) is well-established in medical diagnostics and life science (e.g. ophthalmology, dermatology). Current OCT developments of Fraunhofer IKTS expand the field of application to non-destructive testing of translucent ceramic components. Developing an automatic test solution for process control in the production of ceramic components is the aim in order to discard defective components before particularly costly processing steps follow.

When light penetrates ceramic components, it is strongly scattered during the passage. For this reason, the detection of defects und material inhomogeneity is normally very limited for optical imaging methods. Fraunhofer IKTS is capable of using optical coherence tomography (OCT) for structural analysis of porous and dense ceramics (such as foams and Al_2O_3 components).

By using near-infrared light, semi-transparent media can be analyzed non-destructively. Applying a special test probe, the investigated surface is irradiated with light of appropriate wavelength. For this contact-free method, no coupling medium is necessary. The backscattered light produces the desired information on scattering intensity in the medium and is processed by interferometry (A-scan). When assembling a number of A-scans, a cross-sectional image is created, also referred to as a B-scan in analogy to the term used in ultrasound imaging. By additional displacement of the test probe or the test specimen, a series of cross-sectional images (B-Scan) can be recorded. This batch of images (tomogram) provides high-resolution geometric information from the interior of the specimen.

The OCT, used for optical 3D inspection, provides high-resolution information about the scattering intensities in various ceramics. From the visualization of these signals, major quality parameters can be extracted. The versatile OCT measurement method can be used throughout the whole production chain. In this example, pore sizes and web widths of foams are determined or structural defects, such as cracks, pores or notches in dense ceramics, automatically detected.

At the Fraunhofer IKTS, a system for evaluating planar high-performance ceramics, such as electrolytes for solid oxide fuel cells (SOFC) and high-strength functional components, is currently under development. In contrast to projective methods, the defect type and spatial defect position in the material can be specified by the cross-sectional analysis of the OCT image (Figure 1). While the defects in the red area are uncritical, the central part must not contain any defects. Consequentially, the component can be declared "defect" already before progressing to the next costly process step (especially hard machining). The rejection of defective parts in advance leads to a great increase in efficiency of the ceramic industry.

In the thermally separating processing of ceramic electrolytes, crack formation might occur on the edges. In Figure 2, a thermally induced fracture is shown, starting from the cutting edge into the volume of the ceramic material. In the case of ceramic carrier substrate with such defects, the robustness of the whole SOFC stack is significantly reduced, also decreasing the service life. So far, only a time-consuming manual quality check was possible, which also required a lot of expertise. The 3D inspection with OCT enables an automated quality assurance of electrolytes increasing the robustness of SOFC stacks and gaining a higher added value in the chain of production.

1 *Cross-sectional image of inhomogeneous ceramics with a filamentous inclusion.*

2 *OCT image of a crack in laser-cut ceramics.*

Contact Christian Wolf • Phone +49 351 88815-618 • christian.wolf@ikts.fraunhofer.de