Success Story
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ZERSTÖRUNGSFREIE
PRÜFUNG UND
TOMOGRAFIE

ZPT+
K-Project for non-destructive testing and tomography Plus - Quantitative and in-situ methods for inspection and materials characterization
Programme: COMET – Competence Centers for Excellent Technologies
Programme line: K-Projects
COMET subproject, duration and type of project:
ZPT+, [09/2014 – 08/2018], multi-firm

Phase contrast CT for non-destructive materials testing

In the beginning of 2015 a new computed tomography (CT) system has been installed at the University of Applied Sciences Upper Austria in Wels for materials testing. After more than one year of operation and optimization of soft- and hardware the new CT is already delivering impressive results. It is the first commercially available desktop phase contrast CT for materials testing. This system has been developed in collaboration with the Belgian company Bruker microCT. The system is capable of simultaneously extracting information on absorption, refraction and scattering of X-rays, leading to additional imaging modalities. These image modalities (phase and dark-field contrast) enable new and versatile insights into different material systems.

Phase contrast CT

X-ray computed tomography is an essential imaging technique for various applications in the field of materials testing in order to reveal inner structures and material inhomogeneities in a non-destructive way. An innovative approach concerning X-ray inspection in terms of a Talbot-Lau grating interferometer CT ("phase contrast CT") has already been demonstrated 2006 for a laboratory setup, but in 2015 this technology has become accessible to a much broader research community by the introduction of the first commercially available desktop system for materials characterization (see Fig. 1). The phase contrast CT has been first installed at the University of Applied Sciences in Wels in the beginning of 2015. This new CT is especially designed for the analysis of plastic materials such as carbon fibre reinforced polymers (CFRP) or foams, but it is also possible to analyze biological samples.

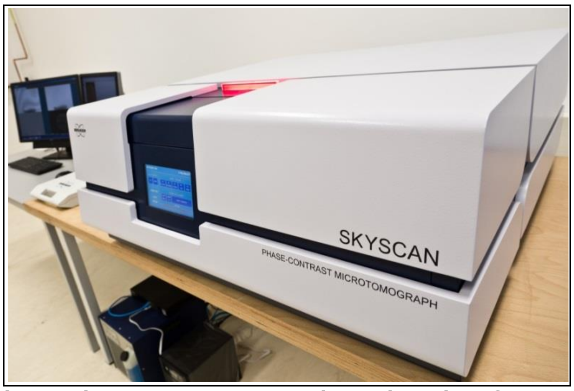

Fig. 1: Phase contrast CT at the University of Applied Sciences Upper Austria in Wels (Copyright FH Wels)

The phase contrast CT enables in addition to conventional absorption contrast (AC) imaging also new imaging modalities such as phase (PC) and dark-field contrast (DFC). These imaging modalities rely on different physical effects.

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AC is formed due to the absorption mechanism of X-ray photons interacting with matter as they pass through the object. DPC is related to the index of refraction and image contrast is thus achieved through the local deflection of the X-ray beam. DFC contains the total amount of radiation scattered at small angles, mainly caused by small structures such as micro-pores or cracks. X-rays interact with various material systems due to the different physical effects (absorption, refraction and scattering) depending on material composition, structure and geometry. The phase contrast CT is capable of extracting material specific properties (e.g. porosity, fibre orientation) on the basis of these physical effects with unprecedented resolution.

Optimization of phase contrast CT

The phase contrast CT has been optimized and characterized within the first project period by varying different system parameters (spectra of X-rays) and by characterizing typical image quality measures (image noise, contrast, image sharpness) of e.g. 2D projection images of various test phantoms (see Fig. 2) as well as of real specimens (e.g. damaged CFRP samples). Due to these preliminary studies the best possible image quality could be derived. Further improvements of soft- (correction of projection images, different data fusion approaches) and hardware (focusing and cooling of X-ray source, new gratings) have resulted in a fully operational and optimized phase contrast CT.

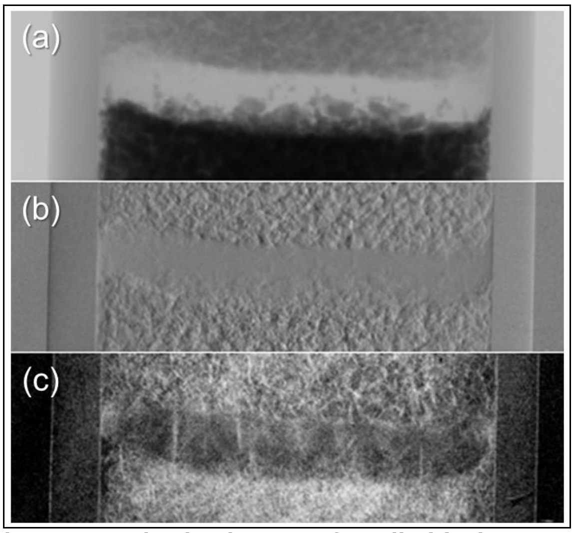

Fig. 2: 2D projection images of a cylindrical phantom filled with salt and sugar crystals showing (a) AC, (b) PC und (c) DFC (Copyright FH Wels)

Impact and effects

Researchers at the University of Applied Sciences in Wels have already successfully published first results concerning optimization and materials characterization in national and international conferences as well as in scientific articles.

In future new material systems will be investigated to further explore the potential of this innovative technology. The research activities in combination with giving the involved company and scientific partners access to these new and exciting technologies as well as imaging modalities is the basis for gaining deep material knowledge. This is necessary to be able to further develop and optimize different kind of material systems.

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