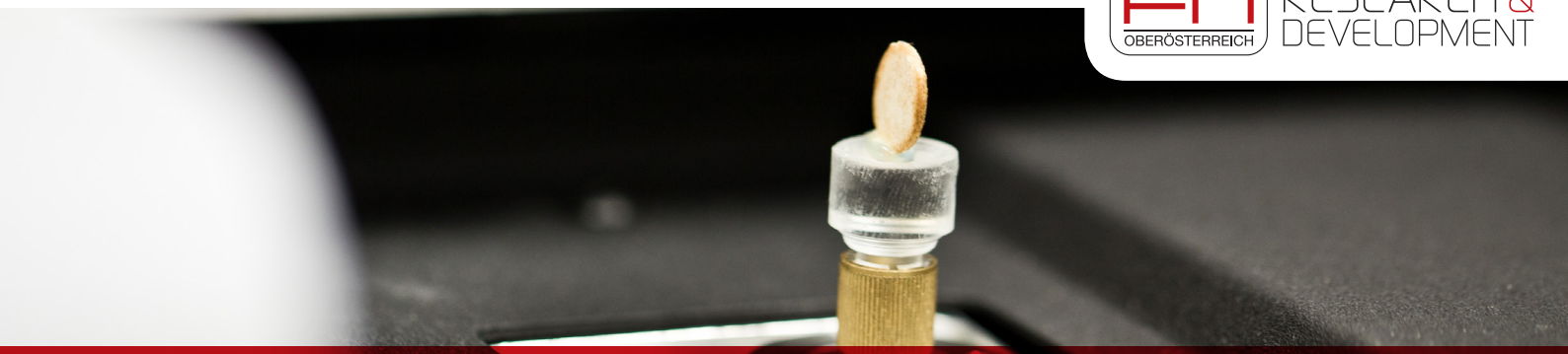


Advanced Multimodal Data Analysis and Visualization of Composites based on Grating Interferometer Micro-CT Data

Research & Development at FH OÖ

Motivation

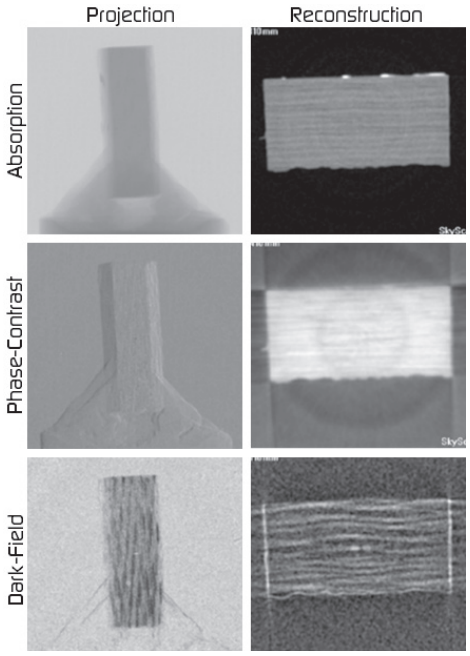
Recent advances in 3D X-ray computed tomography (XCT) apply the principles of Talbot–Lau grating interferometry (TLGI) in the first commercial laboratory XCT devices for industrial applications (TLGI XCT). TLGI XCT possesses great potential especially in non-destructive testing of fiber-reinforced polymer (FRP) materials, as it provides three complementary modalities, which open new possibilities for the characterization of material features:

» Absorption contrast (AC) results from attenuation of X-rays through a specimen and generates commonly known CT images

» Differential phase contrast (DPC) contains information about the refraction of X-rays and is highly sensitive regarding changes or interfaces in the material, e.g., delamination or fractures;

» Dark-field contrast (DFC) provides information about X-ray scattering and thus shows high responses, e.g., for micro pores or fiber bundles

Investigating, understanding and combining all three modalities will therefore enable a much more detailed material analysis compared to conventional XCT.



A fiber-reinforced polymer sample scanned with a SkyScan 1294 laboratory grating interferometry XCT system at the University of Applied Sciences Upper Austria – Campus Wels. Left: Projection images. Right: Reconstruction images.

Goals

ADAM will exploit the complementary nature of the three TLGI XCT modalities and targets:

» to develop advanced tomographic reconstruction methods for TLGI XCT data, generating high quality reconstructions even from a limited number of projections and for directly estimating the material parameters.

» to develop data fusion techniques, combinational and comparative visualization techniques enabling overviews and detailed inspections, as well as visual analysis techniques for AC, DPC, and DFC-data of fiber-reinforced composites, including bi- and multidirectional TLGI XCT data.

» to evaluate the research results and demonstrate the developed methods in a software prototype.

» to disseminate the research results and the acquired knowledge in order to foster the adoption of TLGI XCT inspection in industry as well as to provide commercialization possibilities to the industrial partners and beyond.

ADAM at a Glance

Total Budget:
€ 494.400

Funding:
FFG Bridge Early Stage

Project Duration:
36 Months - from March 2016 until February 2019

Coordinated by:
University of Applied Sciences Upper Austria

Reconstruction

Regarding reconstruction, TLGI XCT currently suffers from two major disadvantages, which prevent the exploitation its full potential:

» TLGI XCT requires the acquisition of significantly more projections compared to conventional XCT. For a fixed projection angle, multiple X-ray images are acquired (due to multiple grating shifts), increasing X-ray dose and acquisition time.

» The different contrasts AC, DPC, and DFC are reconstructed independently from each other. If combined in data fusion, reconstruction artefacts in one of the contrasts will automatically propagate through the processing chain, affecting any quantification of the resulting combined image.

Hence, there is a need to develop advanced reconstruction methods for TLGI XCT that 1) generate high quality reconstructions even from a limited number of projection angles and 2) directly estimate the material parameters of interest, avoiding error-propagation in the current two-step approach.

Analysis

In addition, advanced analysis techniques are required, which cover the complete range of preprocessing, characterization, and visualization of TLGI XCT data. The main issues are found in the following points:

» While conventional characterization of fiber-reinforced polymers relies on commercial software using simple segmentation techniques and comparison of slice images, novel workflows as well as smart and intuitive visual analysis techniques are required in order to handle, analyze and integrate the information of each modality AC, DPC, and DFC.

» TLGI XCT provides information on three different contrasts AC, DPC, and DFC, resulting in three times the data of conventional XCT. Analysis techniques are thus required to intelligently fuse and combine relevant information in meaningful visualizations in order to provide the users with the level-of-detail required by their analysis tasks.

Hence, there is a strong need for the development of a smart visual analysis system, which is able to handle and evaluate the generated TLGI XCT data. It is necessary to provide users with the methods required for their data analysis. The overviews on the data need to be provided and detailed visualization and analysis for the features-of-interest as well as detailed characterization results need to be provided on demand.

Partners

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