Dataset Description

Title: Micro-CT Dataset of Carbon-Fiber Composite Microstructures: UD Tape, Recycled Staple-Fiber Yarn, and Artificial Reference Structures
Metadata creation date: 2026-09-11
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ROR: https://ror.org/03ep3q589
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This data publication contains eight X-ray computed tomography (CT) datasets representing three different classes of fiber-reinforced polymer structures: synthetic fiber-reinforced structures, recycled carbon-fiber staple-fiber yarn (SFY) structures, and unidirectional (UD) tape material.

Dataset Overview

The publication comprises the following datasets:

Dataset	Category	Description
`Artificial_FRP`	Synthetic	Artificial short-fiber-reinforced structure generated numerically.
`Artificial_UD`	Synthetic	Artificial unidirectional fiber structure generated numerically.
`RC_SFY_V20`	Experimental	CT dataset of recycled carbon-fiber staple-fiber yarn at a low draw/stretching level.
`RC_SFY_V35`	Experimental	CT dataset of recycled carbon-fiber staple-fiber yarn at an intermediate draw/stretching level.
`RC_SFY_V50`	Experimental	CT dataset of recycled carbon-fiber staple-fiber yarn at a high draw/stretching level.
`UD_TAPE_08`	Experimental	CT dataset of the UD tape acquired with one scan configuration and spatial resolution.
`UD_TAPE_16`	Experimental	CT dataset of the same UD tape acquired with a second scan configuration and spatial resolution.
`UD_TAPE_32`	Experimental	CT dataset of the same UD tape acquired with a third scan configuration and spatial resolution.

Metadata and Dataset Authorship

The metadata record for this publication was prepared by Christoph Queck.

The synthetic datasets (`Artificial_FRP` , `Artificial_UD`) and the experimental UD tape datasets (`UD_TAPE_08` , `UD_TAPE_16` , `UD_TAPE_32`) were created by Christoph Queck and Benedikt Boos.

The recycled carbon-fiber staple-fiber yarn datasets (`RC_SFY_V20` , `RC_SFY_V35` , `RC_SFY_V50`) were created by Benedikt Boos. As each dataset comprises two separate scans stitched using identical scanning and reconstruction parameters, all data were extracted from a single .txm and .txrm file pair (e.g., 'rCF_Verstreckung2x1_0').

Author identifiers and affiliation information are provided in the accompanying metadata files.

Institutional Affiliation

The datasets are associated with the:

Leibniz Institute for Composite Materials
Materials Science
ROR: `https://ror.org/03ep3q589`

Synthetic Datasets

The two synthetic datasets, `Artificial_FRP` and `Artificial_UD` , represent numerically generated fiber-reinforced structures.

`Artificial_FRP` contains a short-fiber-reinforced structure, whereas `Artificial_UD` represents a unidirectional fiber arrangement. For both datasets, the corresponding ground-truth data and the GeoDict structure data used for generating the artificial microstructures are included. These files provide the reference geometry and additional information required to trace the generation of the synthetic structures.

Recycled Carbon-Fiber Staple-Fiber Yarn Datasets

The datasets `RC_SFY_V20` , `RC_SFY_V35` , and `RC_SFY_V50` contain CT data of recycled carbon-fiber staple-fiber yarn structures recorded at three different stretching/draw levels.

Each SFY dataset was reconstructed from two overlapping CT scans. The individual volumes were stitched and subsequently cropped to obtain the final published volume. The processing information required to document these operations is provided in the corresponding processing-information subfolder of each dataset. This includes the information describing the stitching and cropping operations applied to the original reconstructed volumes.

UD Tape Datasets

The datasets `UD_TAPE_08`, `UD_TAPE_16`, and `UD_TAPE_32` contain scans of the same unidirectional tape specimen acquired using different scan settings and spatial resolutions.

The three datasets therefore represent the same underlying material structure but provide different imaging conditions. This enables direct comparison of the influence of scan configuration and spatial resolution on the representation of the fiber architecture and image quality.
The detailed manufacturing of the taple-fiber yarn (SFY) specimens is described by Detzel et al. [10.3390/polym15234575]. This includes the processing of the rCF/PA6 staple-fiber yarns and their subsequent stretching and consolidation into unidirectionally reinforced staple-fiber tapes.

Data Processing and Provenance

Where image-processing operations were applied to obtain the published volumes, the corresponding processing metadata are included with the dataset. These records document the processing history and provide traceability from the original reconstructed data to the published data.

For the SFY datasets, this processing comprises:

1. stitching of two overlapping CT volumes, and
2. cropping of the stitched volume to the final region of interest.

The corresponding processing information is stored in the associated processing metadata/provenance subfolder of each SFY dataset.

The artificial microstructures were generated using GeoDict and subsequently converted into synthetic CT data using the GeoApp Generate Artificial CT tool, initially without the addition of image noise. To approximate phase-contrast-induced edge enhancement, a two-dimensional Laplace operator was applied to the reconstructed image data using Python. Quasi-Poisson noise was then simulated by converting the reconstructed image intensities into virtual transmission values and applying Poisson-distributed photon-counting statistics. The resulting noise component was spatially correlated using Gaussian filtering and normalized to a predefined target standard deviation before being added to the original image.

Ground Truth and Structure Data

For the synthetic datasets, additional ground-truth and structure-generation data are provided alongside the CT data. The ground truth represents the known digital structure underlying the synthetic CT dataset, while the GeoDict structure files document the generated microstructure from which the synthetic data were derived.

These files enable quantitative validation of image-processing, segmentation, reconstruction, and machine-learning methods against a known reference structure.

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Intended Use

The datasets are intended for research on X-ray CT of fiber-reinforced polymer structures, including the evaluation of spatial resolution, image quality, microstructural characterization, segmentation, quantitative analysis, and the validation of image-processing or machine-learning methods.

The combination of experimental scans, repeated imaging of the same UD tape at different resolutions, SFY structures at different stretching levels, and synthetic datasets with known ground truth provides a basis for comparative and validation studies.