

X-ray scattering tensor tomography based finite element modelling of recycled carbon fibre reinforced polypropylene

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INTRODUCTION: In contrast to conventional absorption-based micro computed tomography, X-ray scattering tensor tomography (XSTT) facilitates the analysis of complex 3D microstructures over an extended volumetric field of view. XSTT with a circular grating array between scanned object and detector allows for a rapid acquisition [1]. Coupling the measured 3D microstructure with numerical models takes full advantage of recent progress in imaging technologies. It is now possible to move from qualitative image results to quantitative simulated prediction of the mechanical properties of the microstructures [2].

METHODS: Recycled carbon fibre reinforced polypropylene with a fibre volume fraction of 40 % was studied. Cylindrical samples with a diameter of 13 mm and a thickness of 4 mm were cut out of a plate. The samples were scanned at the TOMCAT beamline. The tomographically reconstructed scattering tensor data of the sample (Fig. 1 a) served as basis for finite element modelling, including automated model generation and a local fibre orientation (Fig. 1 b). Additionally, the scattering intensity was used to define a local fibre volume fraction and the degree of fibre alignment which directly influences the stiffness properties. Based on the framework by Oddy et al. [3] the mapped scattering information was implemented in a material model.

RESULTS: The finite element modelling simulations allow for a detailed stress analysis for different load cases. The novel application of the scattering data as a measure of fibre volume fraction and preferential fibre orientation showed that scattering tensor tomography enables direct material modelling without the need to segment single fibres, over a large field of view. This improves the efficiency of data-

driven finite element modelling, which in turn expands the range of applicable samples.

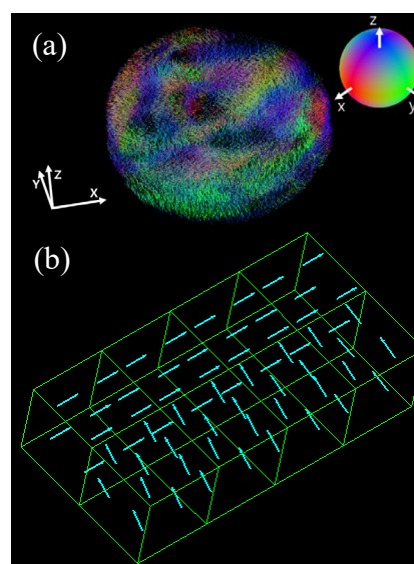


Figure 1. (a) 3D rendering of XSTT reconstruction. The colour represents the fibre orientation. Scale bar: 1cm. (b) Mapped fibre orientation for a small part of the model.

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