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Abstract

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3D image analysis in material science with particular focus on fiber reinforced composites

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The development of modern high-performance materials requires a deeper understanding of the complex relations between a material's micro-structure geometry and its macroscopic properties. Quantitative image analysis combined with stochastic micro-structure modelling is a promising approach to study these relations. A key ingredient for this is a reliable geometric description provided by the quantitative analysis of 3D images of the materials micro-structures. This talk gives an overview over methods for characterizing structures based on spatial image data as obtained e. g. by micro computed tomography. Particular attention is paid to algorithms that rely on segmentation of the component to be analyzed but do not require to further separate it into individual image objects.

Fiber reinforced composites are a class of materials gaining more and more attraction due to their potential in lightweight design. This potential is nevertheless often not fully exploited since fiber distribution and orientation are on the one hand crucial for the reinforcement to serve its purpose and on the other hand hard to monitor non-destructively throughout the processing chain. Here, we review the state of the art for estimating the spatial local fiber orientation. The fiber orientation distribution is defined on the unit sphere and is therefore preferably estimated based on fully three-dimensional images of the microstructure.

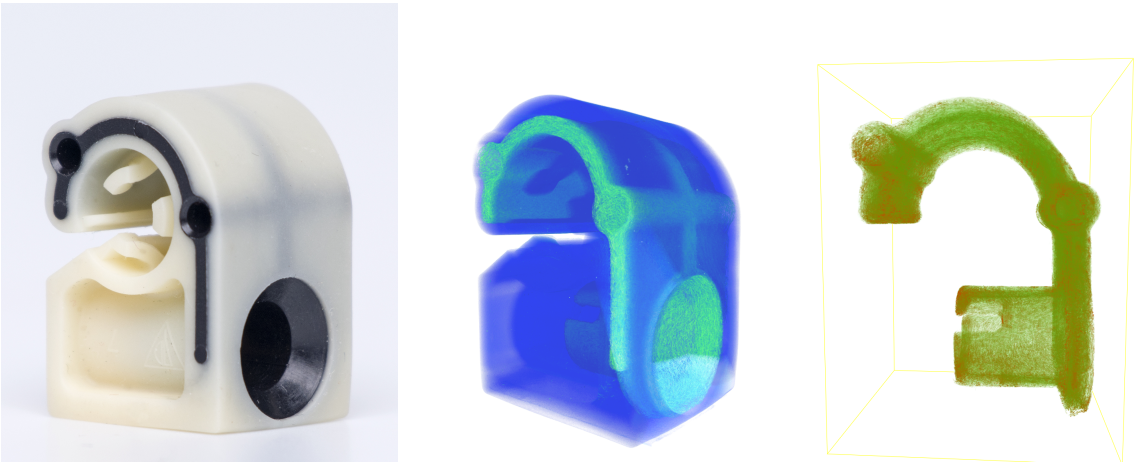

Figure 1: Brake pipe clip made from glass fibre reinforced polymer, imaged by micro computed tomography at 12.5 µm voxel size. Picture (left), volume rendering with fiber component in green (center), and volume rendering of xx-component of the 2nd order orientation tensor estimated in cubic subvolumes of edge length 250 µm (right, green – low xx-component, red – high xx-component).