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Generation of Micro-scale Finite Element Models from Synchrotron X-ray CT Images for Multidirectional Carbon Fibre Reinforced Composites

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ABSTRACT

This paper develops a new fibre tracking algorithm to efficiently locate fibre centrelines (skeletons), from X-ray Computed Tomography (X-ray CT) images of carbon fibre reinforced polymer (CFRP), which are then used to generate micro-scale finite element models. Three-dimensional images with 330nm voxel resolution of multidirectional [+45/90/-45/0] CFRP specimens were obtained by fast synchrotron X-ray CT scanning. Conventional image processing techniques, such as a combination of filters, delineation of plies, binarisation of images, and fibre identification by local maxima and ultimate eroding points, were tried first but found insufficient to produce continuous fibre centrelines for segmentation, especially in regions with highly congested fibres. The new algorithm uses a global overlapping stack filtering step followed by a local fibre tracking step. Both steps are based on the Bayesian inference theory. The new algorithm is found capable of efficiently define fibre centrelines for the generation of micro-scale finite element models with high fidelity.

Keywords: A. Carbon fibres; B. Microstructures; C. Finite element analysis (FEA); D. CT analysis

1. INTRODUCTION

X-ray computed tomography (X-ray CT) is a technique being increasingly used to understand the relationship between the fibre architecture and the mechanical performance of fibre reinforced composites, owing to its non-destructive nature, and the capability of producing high-resolution

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