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Evaluating the number of fibre orientations required in homogenization schemes to predict the elastic response of long fibre sheet moulding compound composites from X-ray computed tomography measured fibre orientation distributions

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Abstract

For predicting the mechanical response of mis aligned short fibre composite materials a two step homogenization procedure coupled with orientation averaging of the elastic material properties is often used. Orientation averaging is not valid for long fibre composites due to non-symmetric strain localization tensors. A method to homogenize the stress for mis aligned long fibre composites using the Functionally Graded Interphase (FGI) approach is presented and the results are compared to two step Mori Tanaka homogenization. The microstructure of long fibre Sheet Moulding Compound (SMC) composite is evaluated using X-ray micro computed tomography. The measured fibre orientation distributions are used to evaluate the number of representative fibre orientations required to predict the stress state of the SMC due to applied strains. It is found that 60 orientations are required to capture the stress response of the long fibre SMC composite using the FGI model and two step Mori Tanaka model.

Keywords: A. Moulding compounds, C. Micro-mechanics, C. Computational modelling, D. CT analysis

1. Introduction

Sheet Moulding Compound (SMC) composites are compression moulded thermosetting composites used in applications such as automotive body panels and secondary structural components due to their high specific strength, stiffness and low cost. SMC's are more formable than traditional laminated composite materials due to the suspension of fibres in an uncured filled matrix material, which easily flows into complex geometries. SMC's exhibit anisotropy due to material flow and fibre orientation

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