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A novel Pseudo-Grain approach for the estimation of the elastic stress distributions within the matrix of Short Fiber-Reinforced Polymers

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Abstract

The aim of the work is to provide a new methodology for the calculation of the linear elastic stress distributions within the matrix of a short fiber-reinforced Representative Volume Element (RVE) with misaligned fibers, without relying on complex algorithms for the generation and solution of the microstructure. For this purpose, a *Pseudo-Grain* approach is adopted, the novelty of which lies in the computation of local stress distributions through the analytical combination of numerical solutions from unidirectional (UD) grains that can be easily and quickly solved through commercial codes. The new approach consists in two steps: i) the application of Voigt boundary conditions to Finite Element models (grains) with fully aligned fibers and ii) the mathematical combination of the computed Stress Cumulative Distribution Functions (S-CDF) on the basis of the second-order Fiber Orientation Tensor (FOT) of the microstructure of interest. The latter can be generally derived from process simulations or experimental analyses. The method is validated by comparing the resulting stress fields with those calculated from actual RVEs with different fiber volume fractions, fiber aspect ratios and Fiber Orientation Tensors, showing a very good agreement.

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