

Public Abstract

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Title:Elastic Property Prediction of Short Fiber Composites Using a Uniform Mesh Finite Element Method

This thesis presents a uniform mesh finite element method to determine the elastic material non-isotropic properties of fiber reinforced composite materials. This method employs a uniform array of custom 3D displacement based elements that use an increased number of Gauss points in the elemental stiffness calculation in order to define the fiber boundaries. The material properties at each Gauss point are dependent upon whether the Gauss point lies within a fiber or matrix. A correction factor is developed to account for differences in strain in the fiber and matrix and thus provide increased accuracy for "hybrid" elements. This method allows for a significant reduction in the number of degrees of freedom in the model, resulting in dramatically reduced memory requirements and computational time. The use of a uniform mesh also greatly simplifies the meshing procedure and is ideal for implementing periodic boundary conditions.

The method is compared with continuous and a short single fiber finite element models found in literature. The method is also used to provide property predictions for a model consisting of 100 misaligned short fibers randomly placed using a Monte Carlo algorithm. The predictions are compared with a constant strain orientation averaging scheme using both the Halpin-Tsai and Tandon-Weng micromechanical models. The method is shown to be in good agreement with the results from literature.