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ABSTRACT

Several stress-based failure criteria (von Mises, dilatational strain energy density, parabolic stress and Drucker-Prager) are implemented in a numerical model of a 3D woven composite to predict initiation of damage due to cooling after curing. It is assumed that the composite is completely cured at elevated temperature and the residual stresses arise due to difference in the thermal expansion coefficients of fibers and matrix. The stresses are found by finite element analysis on the mesoscale while the effective thermoelastic properties of fiber tows are determined by micromechanical modeling. The matrix is modeled as an isotropic material with temperature dependent elastic properties and thermal expansion coefficient.

Comparison of numerical simulation results with the microcomputed tomography data obtained for a one-by-one orthogonally reinforced carbon/epoxy composite shows that the parabolic stress and the dilatational strain energy criteria provide the most accurate predictions of cure-induced damage. However, the accuracy of the parabolic failure criterion is dependent on the choice of the mechanical tests used to determine the values of its two material parameters.