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NONLINEAR VISCOELASTIC BEHAVIOR AND MODELING OF FIBER-REINFORCED POLYMER-MATRIX COMPOSITES

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The nonlinear viscoelastic response of fiber-reinforced polymer-matrix laminated composites is examined experimentally and computationally. Experimental results that indicate the range of phenomena to be captured are presented. A three-dimensional orthotropic nonlinear viscoelastic model is developed using a Rational Mechanics approach. A consistent set of constitutive equations for stress, entropy, energy, and energy dissipation are derived from a single postulated Helmholtz free energy. A key feature of the model is a unique material clock based upon internal potential energy. This clock is able to capture the effects of temperature, stress, and entropy upon the rate of viscoelastic relaxations. The nonlinear Hencky logarithmic strain measure is employed, but is approximated using the rate-of-deformation tensor for computational efficiency. Several numerical examples demonstrating the viability of the chosen modeling approach are shown.