Viscoelastic mechanical characterization of a short-fiber reinforced polyethylene tube: Experiments and modelling

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Abstract

It is presented in this paper a characterization of the viscoelastic mechanical response of short-fiber reinforced thermoplastic tubes. The tubes are manufactured by helical winding of a composite made of high-density polyethylene with short glass-fibers as reinforcement. The mechanical behavior of the composite lamina is characterized by means of monotonic and loading/unloading tensile tests at different deformation rates for specimens extracted in the axial and circumferential directions of the tube. Based on the experimental results, a three-dimensional Maxwell model with eight parameters, five to describe the elastic anisotropy response and three to describe the incompressible-isotropic viscoplastic response, is proposed. The comparison of the model results with the experimental data shows that the model properly captures the material non-linear anisotropic behavior. The only exception is the unloading of the specimens in the circumferential direction, for which the final deformation after the complete unloading is largely overestimated. The model is implemented as part of a finite element code and validated by comparison to experimental measurements of a full-scale test that combines the bending and punching of a tube. The proposed non-linear model for the reinforced polyethylene constitutes a step forward with respect to the classical linear-elastic analysis used for tubes.