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Viscoelastically prestressed polymeric matrix composites: An investigation into fibre deformation and prestress mechanisms

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Abstract

A viscoelastically prestressed polymeric matrix composite (VPPMC) is produced by subjecting polymeric fibres to a creep load, which is removed before moulding the fibres into a polymeric matrix. The resulting fibre viscoelastic recovery creates compressive stresses within the cured matrix. Although mechanical properties can be improved by up to 50%, the effect of fibre creep stress magnitude on VPPMC performance is unknown. In this paper, viscoelastic effects were investigated for 24 h creep stress values of 330-590 MPa. This involved recovery force measurement and wide-angle X-ray diffraction (WAXD) on nylon 6,6 fibres and Charpy impact testing of nylon fibre-polyester resin VPPMCs. Greatest performance was achieved with an intermediate value (460 MPa), suggesting an optimum creep stress condition. Moreover, with increasing creep stress, WAXD demonstrated a progressive reduction in regions with viscoelastic energy storage capability. By considering polymeric three-phase microstructural and latch-based mechanical models, a viscoelastic fibre-generated prestress mechanism is proposed.

Keywords: A. Polymer-matrix composites (PMCs); B. Impact behaviour;
B. Residual/internal stress; Viscoelasticity.

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