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Nonlinear viscoelasticity of pre-compressed layered polymeric composite under oscillatory compression

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Abstract

Describing nonlinear viscoelastic properties of polymeric composites when subjected to dynamic loading is essential for development of practical applications of such materials. An efficient and easy method to analyze nonlinear viscoelasticity remains elusive because the dynamic moduli (storage modulus and loss modulus) are not very convenient when the material falls into nonlinear viscoelastic range. In this study, we utilize two methods, Fourier transform and geometrical nonlinear analysis, to quantitatively characterize the nonlinear viscoelasticity of a pre-compressed layered polymeric composite under oscillatory compression. We discuss the influences of pre-compression, dynamic loading, and the inner structure of polymeric composite on the nonlinear viscoelasticity. Furthermore, we reveal the nonlinear viscoelastic mechanism by combining with other experimental results from quasi-static compressive tests and microstructural analysis. From a methodology standpoint, it is proved that both Fourier transform and geometrical nonlinear analysis are efficient tools for analyzing the nonlinear viscoelasticity of a layered polymeric composite. From a material standpoint, we consequently posit that the dynamic nonlinear viscoelasticity of polymeric composites with complicated inner structures can also be well characterized using these methods.

Keywords

Nonlinear viscoelasticity; Layered polymeric composite; Fourier transform; Geometrical