Hysteretic damping optimization in carbon nanotube nanocomposites

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Abstract

Optimization of the hysteretic damping capacity of carbon nanotube (CNT) nanocomposites is carried out via a differential evolution algorithm coupled with an ad hoc finite element implementation of a nonlinear 3D mesoscale theory. Such theory describes the hysteresis due to the shear stick-slip between the nanotubes and the polymer chains of the hosting matrix. The amount of energy dissipated through the CNT-matrix stick-slip depends on the nanocomposite constitutive parameters such as the elastic mismatch, the nanofiller content/distribution, and the CNT-matrix interfacial shear strength. The optimization problem seeks to determine the set of material parameters that can give rise to the best damping capacity of the nanocomposite. The objective function is defined as the area below the damping ratio curve versus the strain amplitude over the range of strains of interest. The results confirm that the genetic-type nanocomposite damping optimization making use of a sound mechanical model of the material response can be an effective design method providing the right mix of phases overcoming a costly error and trial approach to manufacturing and testing.

Keywords: Carbon nanotube nanocomposite, Hysteretic damping optimization, Interfacial stick-slip, Differential evolution optimization, Three-dimensional model of hysteresis

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