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NANOMORPHOLOGY OF GRAPHENE AND CNT REINFORCED POLYMER AND ITS EFFECT ON DAMAGE: micromechanical numerical study

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Abstract

The effect of morphology, shapes and distribution of nanoscale carbon reinforcement in polymers on their strength and damage resistance is studied using computational micromechanical modelling. A new software and approach were developed for the automatic generation of finite element unit cell models of nanocomposites with inclusions of arbitrary and complex shapes. The effect of curved, zigzagged, snake-like shapes of real carbon nanotubes, as well as re-stacking of graphene on the damage evolution was studied in the computational experiments based on the developed code. The potential of hybrid (carbon nanotubes and graphene) nanoscale reinforcement was studied with view on its effect of damage resistance. It was demonstrated that idealized, cylinder like models of carbon nanotubes in polymers lead to an underestimation of the stress concentration and damage likelihood in the nanocomposites. The main damage mechanisms in CNT reinforced polymers are debonding and pull-out/fiber bridging, while in graphene reinforced polymers the main role is played by crack deviation and stack splitting, with following micro-crack merging. The potential of hybrid (carbon nanotubes and graphene) nanoscale reinforcement was studied with view on its effect of damage resistance.

Keywords:

A. Polymer-matrix composites (PMCs); B. Fracture toughness; C. Finite element analysis (FEA); D. Nanocomposite

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