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Effect of nanofiller geometry on the energy absorption capability of coiled carbon nanotube composite material

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Abstract

Experimental evidence shows that coiled carbon nanotube (CCNT) simultaneously improves stiffness, fracture toughness, impact energy absorption and vibration damping properties of polymers. This makes a multifunctional composite, which is a good candidate for automobile or airplane structures. In this paper, a multi-scale model has been developed to study the damage initiation in polyethylene reinforced by CNTs and CCNTs. The cohesive zone model has been utilized to model the fiber-matrix debonding. The cohesive zone parameters have been obtained from atomistic simulation. Representative volume element (RVE) is constructed to obtain stress-strain curve. The effects of bonding strength, volume fraction (VF), CNT direction and effective geometric parameters of CCNTs and CNTs on mechanical properties and stress-strain curves of designed nanocomposites has been investigated using finite element method. Results show nanocomposites reinforced by CCNT have higher toughness than nanocomposites reinforced by CNT. We can relate this properties improvement to the shape of the coiled carbon nanotube which induces mechanical interlocking when the composites are subjected to loading. In fact, the coiled configuration of the nanotubes enhance the fracture toughness as well as mechanical strength of the composites even there is no direct chemical bonding between the nanotubes and matrix.

1. Introduction

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