Prediction of effective properties of multifunctional composites with CNTs "fuzzy" fibers across the length scales

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We estimate the effective storage and loss moduli of bristled fiber composite materials, where the surface of the fibers is coated with nanostructures such as carbon nanotubes (fuzzy fiber). We investigate the effects of nanofiber length, density of nanostructure near surface of fibers and changing of density of nanostructure near surface of fibers on the effective mechanical and dynamic properties of a multifunctional fiber composites by employing a self-consistent Eshelby method of a multi-phase model using a viscoelastic correspondence principle.

We develop the methods of modeling, allowing to take into account more fully the properties of multifunctional composites structures at various scale levels.

The applied correct gradient theories of elasticity [1] are used for the simulation, at micro/nano-level of physical and mechanical properties, of whiskerized interfacial layers formed by carbon nanofibers (nanotube forests) grown on the surface of the cylindrical fibers along the normal direction with respect to the surface. The fundamental Christensen-Eshelby of the definition of effective mechanical characteristics of fiber composites for the gradient theory of elasticity is studied [2].

Proposed approach enables us to analyze various length-scale effects, e.g., cohesive interactions; surface effects in both volume and surface. Analytical solution to the generalized Eshelby problem for cylindrical inclusions is defined as a function of the elastic constants and additional scale parameters which determine the zone of the local scale effect along the normal direction with respect to interphase, where the solution varies exponentially. This solution corresponds to the property of natural cylindrical "transverse isotropy" and can be effective for predicting of the mechanical properties of micro- and nanocomposites with wiskerized or bristled fibres. To receive solution we develop the method of radial multilayers [3] for layered cylindrical inclusions.

We give an assessment not only of the effective mechanical characteristics but also we study also the stress field on the micromechanical level.

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