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Micromechanical modeling of thermal expansion coefficients for unidirectional glass fiber-reinforced polyimide composites containing silica nanoparticles

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Abstract. The coefficients of thermal expansion (CTEs) of unidirectional glass fiber-reinforced polyimide composites containing silica nanoparticles are investigated. To this end, a three-dimensional unit cell-based micromechanical model together with an individual representative volume element (RVE) with $c \times r \times h$ sub-cells is proposed. The interphase region between silica nanoparticle and polyimide matrix is considered as an equivalent solid continuum. Comparisons are made between the results of present model with those of available cylinder model and experiment. The results reveal that with adding silica nanoparticles to glass fiber-reinforced polyimide composites, the transverse CTE of composite decreases, while its longitudinal CTE increases. The effects of fiber volume fraction and aspect ratio, interphase thickness and material properties, silica nanoparticle volume fraction and diameter on the thermal expansion behavior of silica nanoparticle-glass fiber-reinforced polyimide composites are studied. The obtained results could be useful to guide the design of composites with optimal CTEs.

Keywords: A. Nanoparticles; A. Polymer-matrix composites (PMCs); B. Thermal properties; C. Micro-mechanics.

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