Micromechanical analysis of nanocomposites using 3D voxel based material model

A computational study on the effect of nanocomposite structures on the elastic properties is carried out with the use of the 3D voxel based model of materials and the combined Voigt–Reuss method. A hierarchical voxel based model of a material reinforced by an array of exfoliated and intercalated nanoclay platelets surrounded by interphase layers is developed. With this model, the elastic properties of the interphase layer are estimated using the inverse analysis. The effects of aspect ratio, intercalation and orientation of nanoparticles on the elastic properties of the nanocomposites are analyzed. For modeling the damage in nanocomposites with intercalated structures, “four phase” model is suggested, in which the strength of “intrastack interphase” is lower than that of “outer” interphase around the nanoplatelets. Analyzing the effect of nanoreinforcement in the matrix on the failure probability of glass fibers in hybrid (hierarchical) composites, using the micromechanical voxel-based model of nanocomposites, it was observed that the nanoreinforcement in the matrix leads to slightly lower fiber failure probability.

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