A Micromechanics Analysis of Nanoscale Graphite Platelet-reinforced Composites Using Defect Green's Function

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Abstract

In the modeling of overall property of composites, the effect of particles interaction has been either numerically taken into account within a small sampling volume element with a few particles or neglected/ignored for efficient solution of a large system of particles. In this study, we apply the point-defect Green's function (GF) to take into account the effect of particles interaction. It is applicable to small volume fractions of particles. With high efficiency the method enables a simulation of a large system of particles of generally elastic anisotropy, arbitrary shape and composition, and arbitrary distribution. In particular, we apply the method to study the nanoscale graphite platelets composite, guided by some experimental observations. First, the present method is verified by a comparison of its prediction with the full-field solution available in the case of a regular lattice of particles. The comparison also demonstrates it a considerable improvement over the classical Eshelby's method employing the regular GF and hence ignoring particles interaction effect. Then, the effects of a number of parameters on the overall behavior of composite are examined. The effect of particles interaction is found to be strongly dependent on particle arrangement due to the strong elastic and geometrical anisotropy in graphite platelets. It is the strongest when the platelets are orientated uniformly and stacked in a simple cuboidal lattice. However, it becomes trivial when the platelets are randomly orientated. The effect of geometrical aspect ratio is also studied quantitatively. Finally, a thin soft layer is inserted between the graphite platelets and matrix material to simulate a partial bonding condition. It is found to play a significant role in determining the overall property of composite.