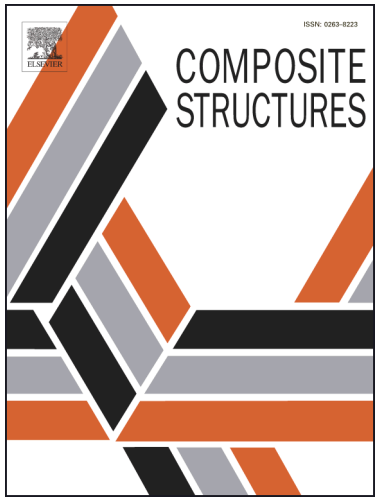

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A micromechanics approach for effective elastic properties of nano-composites with energetic surfaces/interfaces

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Abstract

The mechanics of structure genome is generalized to model nanocomposites taking into account the surfaces/interfaces stress effect at nano-scale. This full field micromechanics approach is applied to predict the effective properties of composites containing nano-inhomogeneities. Examples of binary composite materials, fiber reinforced composite materials and particle reinforced composite materials are used to demonstrate the robustness and accuracy of this micromechanics theory with surfaces/interfaces effects. The size-dependency of the overall elastic moduli shows the importance of energetic surfaces/interfaces in modeling the mechanical behavior of nano-scale composite materials. The proposed micromechanics approach is versatile enough to be applied for estimating the effective elastic properties of many nano-composite materials.

Keywords: Micromechanics, Interface elasticity, Nano-inhomogeneities, Elastic properties

1. Introduction

Many research investigations are devoted to nano-scale science and developments of nano-composites due to the advances in nanotechnology. Nano-composites/nano-materials are of interest because of their unusual mechanical, thermo-mechanical, electrical, optical and magnetic properties as compared to composites of similar constituents, volume proportion and shape/orientation of reinforcements. Nano-materials can be generally classified into two groups. In the first group (called nano-structured material), the characteristic length of the microstructure, such as the grain size of a polycrystal material, is in the nano-meter range. In the second group (called nano-sized structural element), at least one of the overall dimensions of a structural element is in the nano-meter range. Therefore, this may include nano-particles, nano-films, nano-wires [1, 2]. In the present study, nano-composites are defined as either bulk materials that consist of a matrix containing inhomogeneities with at least one dimension within 1 to 100 nm, or a nano-scale structure with inhomogeneities. Obviously, the latter case involves nano-scale inhomogeneities since these inhomogeneities should be about one order smaller

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