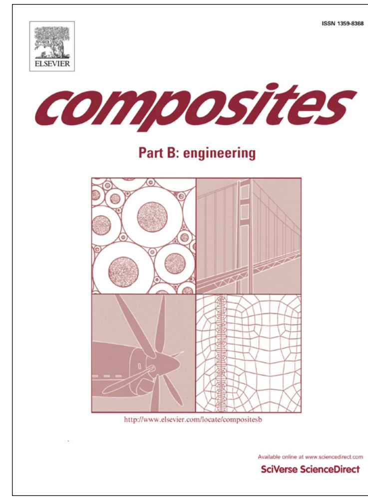

Nanostructured interfaces for enhancing mechanical properties of composites: Review of computational micromechanical studies

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PII: S1359-8368(14)00367-9
DOI: http://dx.doi.org/10.1016/j.compositesb.2014.08.029
Reference: JCOMB 3146

To appear in: *Composites: Part B*

Received Date: 30 January 2014
Revised Date: 9 July 2014
Accepted Date: 12 August 2014

Please cite this article as: Mishnaevsky, L., Nanostructured interfaces for enhancing mechanical properties of composites: Review of computational micromechanical studies, *Composites: Part B* (2014), doi: http://dx.doi.org/10.1016/j.compositesb.2014.08.029

NANOSTRUCTURED INTERFACES FOR ENHANCING MECHANICAL PROPERTIES OF COMPOSITES: Review of computational micromechanical studies

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Abstract:
Computational micromechanical studies of the effect of nanostructuring and nanoengineering of interfaces, phase and grain boundaries of materials on the mechanical properties and strength of materials and the potential of interface nanostructuring to enhance the materials properties are reviewed. Several groups of materials (composites, nanocomposites, nanocrystalline metals, wood) are considered with view on the effect of nanostructured interfaces on their properties,. The structures of various nanostructured interfaces (protein structures and mineral bridges in biopolymers in nacre and microfibrils in wood; pores, interphases and nanoparticles in fiber/matrix interfaces of polymer fiber reinforced composites and nanocomposites; dislocations and precipitates in grain boundaries of nanocrystalline metals) and the methods of their modeling are discussed. It is concluded that nanostructuring of interfaces and phase boundaries is a powerful tool for controlling the material deformation and strength behavior, and allows to enhance the mechanical properties and strength of the materials. Heterogeneous interfaces, with low stiffness leading to the localization of deformation, and nanoreinforcements oriented normally to the main reinforcing elements can ensure the highest toughness of materials.

Keywords: B: Interface/interphase, C: Computational modelling, C: Micro-mechanics, B: Damage tolerance

1. Introduction

Mechanical properties and strength of materials can be enhanced by modifying the structures of the materials at micro- and nanoscales. Various strategies and techniques of the structure modification have been developed to ensure the better service properties of materials [1]. One of the promising directions of the materials modification for the properties enhancement is based on the control and modification of interface properties [2-11]. Interfaces, phase and grain boundaries represent often relatively instable and deformable regions of materials. The typical deformation and degradation scenario of materials includes the formation and development of highly deformed regions (e.g., shear bands), defects, cracks in the deformable regions. One of the ways to control the deformation scenario is to modify the structure of the less stable, deformable elements of the material at the lower scale level, thus, influencing the deformation development and damage initiation processes. The introduction of geometrical structural