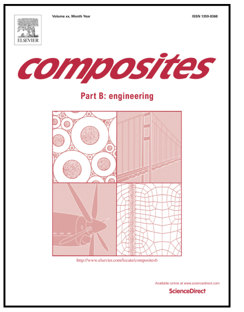

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Homogenized moduli and local stress fields of unidirectional nano-composites

Guannan Wang*, **Qiang Chen****, **Zhelong He**** and **Marek-Jerzy Pindera****
*Mechanical Engineering Department, Texas Tech University, Lubbock, TX 79409, USA
**Civil Engineering Department, University of Virginia, Charlottesville, VA 22904-4742, USA

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Abstract

The recently generalized locally-exact homogenization theory is further extended to enable the determination of homogenized moduli and local stress fields in unidirectional nano-composites with surface effects based on the Gurtin-Murdoch model. The excellent stability and quick convergence of the homogenization theory with the concomitant rapid execution times enables repetitive solutions of the unit cell problem with variable geometric and material parameters, thereby enabling extensive parametric studies to be conducted efficiently. The distinguishing feature of the theory is its ability to provide accurate homogenized moduli as well as accurate local stress fields for square, rectangular and hexagonal arrays of nano-inclusions or nano-porosities. The extended elasticity-based computational capability is validated by published results on homogenized moduli and stress concentrations in nanoporous aluminum obtained using classical micromechanics, elasticity-based, semi-analytical and numerical approaches. New results are generated aimed at demonstrating the effects of nanopore arrays on homogenized moduli and local stress fields in a wide range of porosity volume fractions and nanopore radii. These results highlight the importance of adjacent pore interactions either neglected or not directly taken into account in the classical micromechanics models, nor easily captured by numerical techniques.

Keywords: nano-composites; surface effects; elasticity-based homogenization; homogenized moduli; local stress fields.