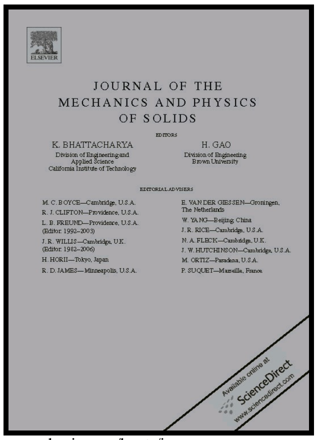
Author’s Accepted Manuscript



www.elsevier.com/locate/jmps

Microscopic and macroscopic instabilities in hyperelastic fiber composites

Viacheslav Slesarenko, Stephan Rudykh

PII: S0022-5096(16)30468-9
DOI: http://dx.doi.org/10.1016/j.jmps.2016.11.002
Reference: MPS3004

To appear in: *Journal of the Mechanics and Physics of Solids*

Received date: 7 July 2016
Revised date: 27 October 2016
Accepted date: 1 November 2016

Cite this article as: Viacheslav Slesarenko and Stephan Rudykh, Microscopic anc macroscopic instabilities in hyperelastic fiber composites, *Journal of th Mechanics and Physics of Solids,* http://dx.doi.org/10.1016/j.jmps.2016.11.002

Microscopic and macroscopic instabilities in hyperelastic fiber composites

Viacheslav Slesarenko[1,2] and Stephan Rudykh[1,*]

[1] Department of Aerospace Engineering, Technion – Israel Institute of Technology, Haifa, Israel

[2] Lavrentyev Institute of Hydrodynamics of RAS, Novosibirsk, Russia

Abstract

In this paper, we study the interplay between macroscopic and microscopic instabilities in 3D periodic fiber reinforced composites undergoing large deformations. We employ the Bloch-Floquet analysis to determine the onset of microscopic instabilities for composites with hyperelastic constituents. We show that the primary mode of buckling in the fiber composites is determined by the volume fraction of fibers and the contrast between elastic moduli of fiber and matrix phases. We find that for composites with volume fraction of fibers exceeding a threshold value, which depends on elastic modulus contrast, the primary buckling mode corresponds to the long wave or macroscopic instability. However, composites with a lower amount of fibers experience microscopic instabilities corresponding to wavy or helical buckling shapes. Buckling modes and critical wavelengths are shown to be highly tunable by material composition. A comparison between the instability behavior of 3D fiber composites and laminates, subjected to uniaxial compression, reveals the significant differences in critical strains, wavelengths, and transition points from macro- to microscopic instabilities in these composites.

Keywords: finite deformation, instability, bifurcation, fiber composites