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Stephan Rudykh
*University of Wisconsin - Madison, rudykh@wisc.edu*

Viacheslav Slesarenko

Pavel Galich

Jian Li

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Micromechanics and instabilities of soft architectured composite materials

Stephan Rudykh$^{1,2}$, Viacheslav Slesarenko$^1$, Pavel Galich$^1$, Jian Li$^1$

$^{(1)}$Department of Aerospace Engineering, Technion, Haifa, Israel, rudykh@technion.ac.il
$^{(2)}$Department of Mechanical Engineering, University of Wisconsin – Madison, Madison, WI

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Soft microstructured materials enable modifications of material properties and functionalities through applied deformations, or other external stimuli, for example, electric, or magnetic fields [1]. The deformation induced tunability is mainly due to controllable changes of the microstructural arrangements, on par with material nonlinearities [2]. Moreover, the microstructures can be designed to be prone to elastic instabilities giving rise to dramatic microstructure transformations, and switchable functionalities such as cancelling certain frequency ranges of elastic waves (through induced band gaps). In the presentation, we will show our numerical and theoretical results for multiphase deformable composite materials including deformable layered materials, bio-inspired nacre-like structures [3], periodic 3D fibre composites, and periodically structured particulate materials. These numerical and theoretical results will be illustrated by the experimental observations on 3D printed multiphase composites subjected to finite deformations. Finally, the ways of material properties modifications via application of external magnetic and electric fields will be explored. In particular, magnetorheological elastomers (MRE) [1] and soft dielectric elastomers (DE) with periodic microstructures will be examined, and the coupled magneto- and electro-mechanical stability of these active architectured materials will be analysed.

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References