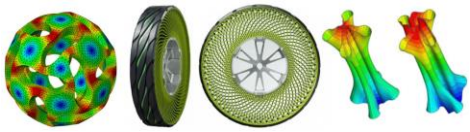
Mechanics and Mathematics of (soft) Materials and Structures @ DISG



Stephan Rudykh

Micromechanics and Instabilities in Soft Functional Composites

Giovedì 20 aprile, ore 12:00

Abstract

Nature actively uses sophisticated designs of microstructures to achieve astonishing material properties and functionalities. Thus, microstructures give rise to the incredible toughness of mother-of-pearl. Another example is an octopus, an amazingly effective soft machine created by the nature. The creature can squeeze its whole body through an extremely narrow space while preserving a large variety of functionalities. The nature created soft machine comprises highly deformable composites that are characterized by different microstructures and phase properties, depending on the required functionalities. By combining the ideas of real biological microstructures with our ability of creating and manufacturing nano- and micro-structured media, we aim to develop the novel, super-effective, and multifunctional materials engineered by the wisdom of nature and powered by human intelligence.

In this presentation, I will specifically focus on the role of microstructures in the overall performance of deformable multifunctional composites. We will explore the behavior of soft electroactive composites that got the name of "artificial muscles." These materials can undergo large deformations when excited by external electric fields, making them extremely attractive as multifunctional actuators and sensors. Next, we will turn to bio-inspired flexible armor, which draws its design principles from fish scale-type dermal protective systems. As a personal armor, these composites grant protection while preserving the flexibility so that the movement is not restricted. We will consider how large deformations and elastic instabilities can be used to trigger dramatic pattern transformations and control a large variety of functionalities; in particular, the design of switchable acoustic metamaterials will be discussed.

The analytical and numerical findings, as well as the experimental results of 3D-printed composites will illustrate the ideas.

Short bio

Stephan Rudykh is Assistant Professor at the Technion – Israel Institute of Technology. Before joining the Technion, he was a postdoctoral scholar at Mechanical Engineering at the MIT (with Mary Boyce). He gained his PhD from the Department of Mechanical Engineering at Ben-Gurion University (with Gal deBotton); he was a visiting graduate student at Caltech (with Kaushik Bhattacharya) and Harvard (with Katia Bertoldi). Stephan received his MS and BS from Saint-Petersburg Polytechnical University.

Rudykh's research focuses on the behavior of soft microstructured materials including soft active materials, bioinspired materials, switchable functional composites, and biological tissues. He uses a combination of analytical and computational approaches, as well as 3D printing and experiments to understand the nonlinear behavior of these materials.

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