Defense invitation

Title: Modeling and analysis of wave and damaging phenomena in biological and bioinspired materials

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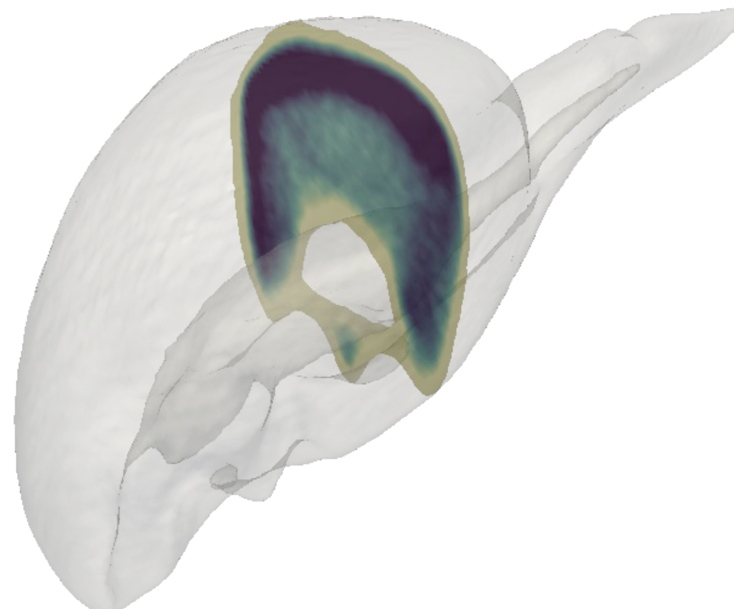
URL:
https://purdue-edu.zoom.us/j/92797156928?pwd=aW52MGpNQjFYaE1MZE5uYkF3Sms5QT09



Computer tomography for the appendage of the mantis shrimp. A cross-section is highlighted.

Abstract

There is a current interest in exploring novel microstructural architectures that take advantage of the response of independent phases. Current guidelines in materials design are not just based on changing the properties of the different phases but also on modifying its base architecture. Hence, the mechanical behavior of composite materials can be adjusted by designing microstructures that alternate stiff and flexible constituents, combined with well-designed architectures. One source of inspiration to achieve these designs is Nature, where biologically mineralized composites can be taken as an example for the design of next-generation structural materials due to their low density, high-strength, and toughness currently unmatched by engineering technologies.

The present work focuses on the modeling of biologically inspired composites, where the source of inspiration is the dactyl club of the Stomatopod. Particularly, we built computational models for different regions of the dactyl club, namely: periodic and impact regions. Thus, this research aimed to analyze the effect of microstructure present in the impact and periodic regions in the impact resistance associated with the materials present in the appendage of stomatopods. The main contributions of this work are twofold. First, we built a model that helped to study wave propagation in the periodic region. This helped to identify possible bandgaps and their influence on the wave propagation through the material. Later on, we extended what we learned from this material to study the bandgap tuning in bioinspired composites. Second, we helped to unveil new microstructural features in the impact region of the dactyl club. Specifically, the sinusoidally helicoidal composite and bicontinuous particulate layer. For these, structural features we developed finite element models to understand their mechanical behavior.

The results in this work help to elucidate some new microstructures and present some guidelines in the design of architectured materials. By combining the current synthesis and advanced manufacturing methods with design elements from these biological structures we can realize potential blueprints for a new generation of advanced materials with a broad range of applications. Some of the possible applications include impact- and vibration-resistant coatings for buildings, body armors, aircraft, and automobiles, as well as in abrasion- and impact-resistant wind turbines.