Novel Chiral Cellular Structures with Tailorable Auxetic Effects Under Large Deformation

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Technology description

Overview

Auxetic materials are deformable composites that have a negative Poisson’ s ratio. These materials behave differently than common materials in that they actually expand when stretched. This new process can be used to selectively modify the mechanical properties of auxetic chiral cellular composites by changing the shape of the cellular core to achieve varying levels of structural stiffness and Poisson’ s ratio and adding desired levels of mechanical deformation when tension and compression loading (either through direct mechanical loading or indirect loading due to temperature change, swelling etc.) are applied.

Development Process

The shape of existing chiral cellular structures was changed by altering the re-entrant angle of the cellular core. Square, star, and bow-tie (honeycomb), and chiral shaped core cells were evaluated. Standard chiral structures with counter-rotational and co-rotational core cells were also evaluated:

Market Opportunity

Commercial interest in auxetic materials is growing rapidly in the biomedical device, aerospace, and transportation sectors, mechanical metamaterials, and smart composite materials. In the biomedical space, applications include medical scaffolds and drug delivery bandages. In the aerospace sector, there has been interested in the development of “smart” textile fabrics that harness solar energy. The transportation sector has many application areas that include vibration damping materials and composites that deform to reduce damage. The development of “smart textile” materials in the high performance apparel category is also rising with applications such as the Under Armor Micro G Drive “Volt” sports shoe.

Patent Abstract

An auxetic structure consistent with the present disclosure may include a core cell, capable of rotation, including a plurality of first rib sections, and a plurality of second rib sections . The first rib sections may be transverse to a longitudinal axis of the auxetic structure and at least one of the first rib sections may extend from the core cell . The second rib sections may be transverse to a transverse axis of the auxetic structure and at least one of the second rib sections may extend from the core cell.

Advantages

A multi-step sequence was developed to create enhanced microstructures that can withstand large deformation forces without buckling and collapsing. The process retains the desired auxetic characteristic of having a negative Poisson’ s ratio and adds a structural enhancement by rotating the core cells which allows the structure to withstand high tension and compression deformation, and provide a unique cell opening mechanism.
Traditional rubber materials can easily undergo shape deformation changes, but are relatively incompressible. Auxetic materials will maintain shape and are easy to change the volume. Similarly, metallic materials used for bone implants offer stiffness, but can also cause negative effects such as stress-shielding and surrounding area bone fractures. Use of auxetic materials allows for the design of mesh constructions that better matches bone structure and reduces stress shielding.

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