VIDEO ARTICLE

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An Emerging Class of Hyperbolic Lattice Exhibiting Tunable Elastic Properties and Impact Absorption Through Chiral Twisting

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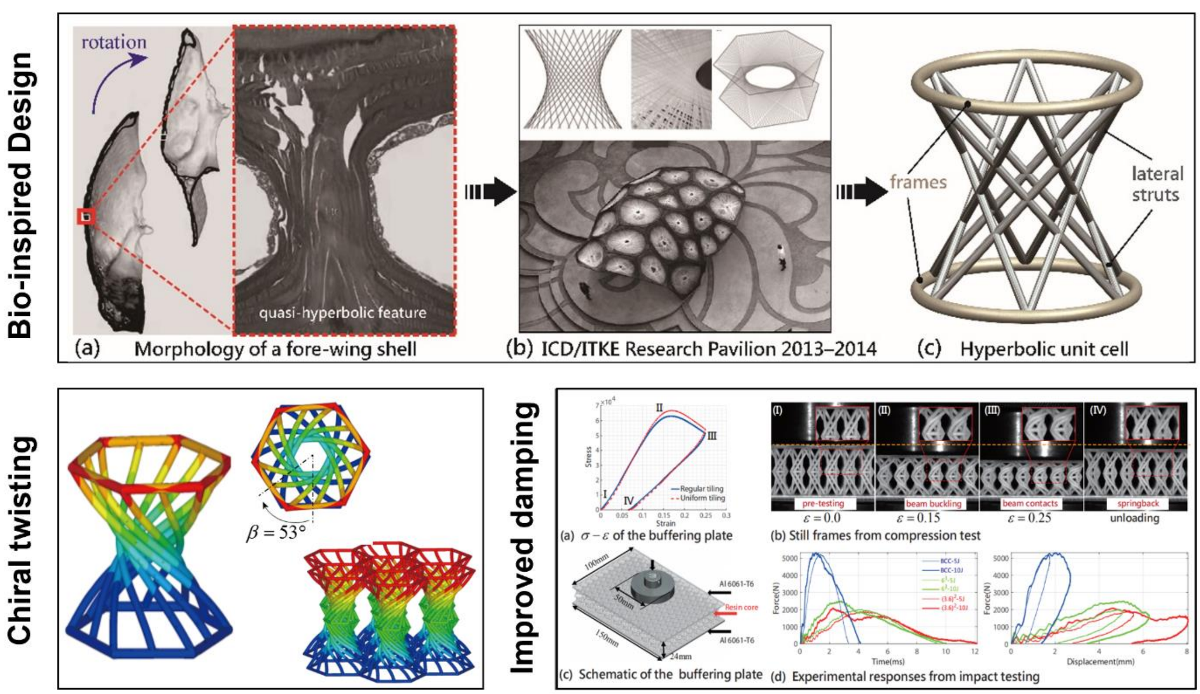
Graphical Abstract



Abstract

Lightweight lattice structures and chiral metamaterials have both received extensive attention during the past decades. This work builds up a systematic design procedure for an emerging class of architected materials, achieving chirality and achirality under the same framework of parameterization. The design of the so-called 'hyperbolic unit cell' takes inspiration ultimately from the double-layered morphology of the fore-wing shells of flying beetles, being intended to replicate the hyperbolic geometric feature. The tessellation schemes that populate the microstructure to a component level are stirred up by the similarity with Euclidean tiling of convex regular polygons. Numerical and experimental studies revealed a wide variation of elastic constants for hyperbolic materials maintaining the same volume fraction, making more visible their applications under various loading scenarios, including compression, tension and shear. Also, a significant twisting effect, observed on the chiral cellular material, is shown to be advantageous in the design of buffering plates and energy-absorbing devices.

Keywords: Hyperbolic lattice; architected material; mechanical property; chiral twisting.

Biography of Presenting Author

Liang Meng is currently an assistant professor at the School of Mechanical Engineering at Northwestern Polytechnical University (NPU). He received his Master's Degree in Aeronautics and Astronautics Manufacturing Engineering from NPU in 2014. Financed by the China Scholarship Council (CSC), he started his Ph.D at Université de Technologie de Compiègne (UTC) in the framework of "NPU-UTC Common Research Group", and obtained the Degree of Doctor of Mechanical Engineering on October 2017.

Dr. Meng has been awarded the "Best Thesis award" of Structural Calculation and Modeling Association (France, 2017) for his thesis entitled "Reduced Shape-space Approach to Material Characterization Instrumented Indentation Test Case". His thesis has also been nominated for the "ECCOMAS Ph.D Award" of European Community on Computational Methods in Applied Sciences (2018). His research has been published in leading academic journals on topics such as computational mechanics, structural shape optimization design, and inverse identification of material properties.

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