# METHODS FOR LIGHTWEIGHT HYPERDAMPING MATERIALS

Damping materials provide vibration and noise attenuation solutions for a wide range of commercial products and services. These materials are prominently used in the automotive and aerospace industries and are also found in conventional building practices, such as insulation materials. Most standard damping materials work in a limited frequency range, or they have too much mass to be useful in the many industries where added mass is a penalty to efficiency, such as for vehicle systems. A material that has the combination of being lightweight and providing a substantial, broad damping performance is the next technological advancement needed in this field.

## THE TECHNOLOGY

Researchers at The Ohio State University, led by Dr. Ryan Harne, developed lightweight hyperdamping materials that provide substantial vibration and noise attenuation performance over a broad spectrum of frequencies. One sample design of these material systems, created by Dr. Harne, is an architected elastomer cylinder which is fabricated through various suitable molding procedures. Once manufactured, the elastomer cylinder is inserted into a thin metal shell, geometrically constraining the elastomer cylinder near the elastic stability limit. When a structure or material is at the elastic stability limit the fundamental elastic stiffness, and hence natural frequency, vanishes. The material system at the elastic stability limit therefore exhibits unusually large damping properties also known as hyperdamping. Moreover, because the material has large hollowed cavities due to the strategic interior molded architecture, the weight of the hyperdamping material is significantly less than comparable materials, including other engineered metamaterials not possessing these key design and manufacturing characteristics. These are the two most desirable features that Dr. Harne's hyperdamping materials exhibit: large, broadband vibration/acoustic energy damping in a lightweight material.

Other material systems may adopt Dr. Harne's design and manufacturing methods. Examples include using materials with square cross-sections, thin sheets, or linear strips. Once fabricated, the hyperdamping materials may be inserted into structural or material systems for retrofitted vibration and acoustic energy damping effects, such as within automotive trim panels or in building insulation. Alternatively, the hyperdamping materials may be incorporated into the original system that requires vibration or noise control, providing a valuable integrated solution and design, such as a vehicle chassis component with embedded hyperdamping elements.

## INVENTOR

Dr. Harne is an Assistant Professor at The Ohio State University in the Department of Mechanical & Aerospace Engineering. Dr. Harne is published in numerous scholastic journals for his research in high-performance and efficient structural/material systems, including metamaterials. His main research focuses are acoustics, structural dynamics, energy harvesting, sensors, vibration and noise control, and smart material system development including the use of piezoelectric and magnetoelastic materials.

## THE MARKET

- Metamaterials have a predicted Compound Annual Growth Rate (CAGR) of 20.5% between 2019 and 2024.
- Market capitalization is predicted to be $1.9 billion in 2019 and $3.0 billion in 2024.
- Industries that can benefit from noise attenuation:
  - » Automotive
  - » Aerospace
  - » Marine
  - » Construction
  - » Machinery/Factories

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