Actively Controlled Microarchitectures with Programmable Bulk Material Properties

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SUMMARY

Professor Jonathan Hopkins and colleagues have developed amechanical programmable metamaterial consisting of an array of actively, independently controlled micro-scale unit cells. This technology allows for the application of materials which have instantly changeable, programmable properties that can exceed those of conventional, existing materials.

BACKGROUND

Materials selection is a part of the design of any physical product. During this process, the engineer balances the properties of all available materials in order to select the optimum material for a given application. Although new materials are constantly being researched, the design and development of new materials for a specific application is often not practical. In most cases, an existing material is chosen as the optimal one, always at the compromise of some properties. Metamaterials are part of an emerging field that attempts to create material properties not found in nature. These materials consist of an array of individual elements, which together result in an object with unique bulk properties for use in applications where conventional materials could not be applied. Mechanical metamaterials that can have bulk properties beyond existing materials and on-the-fly property tunability can revolutionize material selection and product design.

INNOVATION

Professor Jonathan Hopkins and colleagues have developed a mechanical programmable metamaterial consisting of an array of actively, independently controlled micro-scale unit cells. The bulk properties of the material are programmed and manipulated through the intelligence in each unit cell, which can be altered by replacing the IC chip or through remote reprogramming. Additionally, the actively controlled cells can have material properties unachievable using materials that do not have power sources. This technology allows for the application of materials which have exceptional, programmable properties without having to compromise during the materials selection process.

APPLICATIONS

- Active protective material, which can route shock waves upon impact away from critical areas
- Vibration dampening, such as to protect instruments or to absorb shock
- Aircraft panels, which can alter their stiffness during flight for improved efficiency and maneuverability
- Structural materials, which can actively adjust to earthquakes
- Medical devices with changeable shapes and stiffness properties
- Infinitely configurable soft robots, with jointless sections that become compliant when bending is required
- Reconfigurable microfluidic devices

ADVANTAGES

- Programmable bulk material properties
- Improved bulk material properties compared to conventional materials
- Active microarchitecture, which allows for rapid adjustment of properties during use

STATE OF DEVELOPMENT

Microarchitectures have been designed and fabrication methods are in development.

RELATED MATERIALS

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INVENTORS

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OTHER INFORMATION

KEYWORDS

Metamaterials, materials selection, high strength, microarchitecture, armor, damping, structural materials, programmable, MEMS

CATEGORIZED AS

- **Engineering**
  - Engineering
  - Robotics and Automation
- **Materials & Chemicals**
  - Nanomaterials
  - Other
- **Security and Defense**
  - Other
- **Sensors & Instrumentation**
  - Other
  - Position sensors
  - Process Control

RELATED CASES

2014-789-0

▶ J. B. Hopkins, K. J. Lange, and C. M. Spadaccini, Designing Microstructural Architectures With Thermally Actuated Properties Using Freedom, Actuation, and Constraint Topologies, in J. Mech. Des., 2013.

PATENT STATUS

Country	Type	Number	Dated	Case
United States Of America	Issued Patent	10,065,322	09/04/2018	2014-789

ADDITIONAL TECHNOLOGIES BY THESE INVENTORS

▶ Mattress for Bed Sore Prevention

▶ Boundary Learning Optimization Tool

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