Reconfigurable Acoustic Topological Insulator (#8294)

Operates at low cost for small-scale operations in electrical communications industry

Inventors at Georgia Tech have demonstrated proof of concept for a device that propagates topologically protected acoustic waves along reconfigurable interfaces. An enabling feature is the use of piezoelectric disks with negative effective capacitance circuits to achieve reconfigurability. When integrated with topological protection, the device makes the acoustic signals robust to backscattering.

Because acoustic waves have much smaller wavelengths than electromagnetic waves, the device has potential for use in small-scale operations at low cost. The technology could pave the way for mechanical multiplexing and de-multiplexing, acoustic logic, and other functionality in communication devices.

Benefits/Advantages

- **Improved accuracy**: Makes the acoustic signals robust to backscattering by integrating with the topological protection
- **Reconfigurable**: Uses piezoelectric disks with negative effective capacitance circuits as a means for reprogramming interface location
- **Robust**: Operates in harsh conditions (high electromagnetic/radio frequency interference [EMI/RFI], high temperatures) where existing electrical counterparts fail
- **Low cost**: Leverages inexpensive materials and avoids digital signal processing and associated battery drain

Potential Commercial Applications

- Signal routing in communication devices
- Signal processing in harsh environments
- Acoustic logic

Background/Context for This Invention

A significant challenge in guiding elastic waves is the presence of reflection and scattering at sharp edges, defects, and general disorder. Mechanical topological insulators have begun to overcome this challenge by supporting backscattering-resistant wave transmission. Topological protection makes this media ideal for near-lossless information transmission. However, a challenging issue of mechanical topological insulators is the lack of reconfigurability, which is essential for enabling important topological insulators–based applications.

Field communications and computer networking integrate multiplexing and de-multiplexing—that is, the
process to which analog or digital input signals are transmitted over channels—to improve speed of transmission over a single medium (i.e., telecommunications of multiple calls over a single wire). Multiplexing and de-multiplexing processes refer to the hardware entity of the communications field. Current technologies are unable to operate in harsh conditions (e.g., high EMI/RFI, high temperatures) and do not offer the specificity for small-scale operations due to the nature and science of electromagnetic wave transmission. This reconfigurable design is a stepping-stone toward implementing acoustic components in communication-based devices.

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Reconfigurable Floquet Elastodynamic Topological Insulators Based on Synthetic Angular Momentum Bias, Science Advances (under review)

Experimental Realization of a Reconfigurable Electroacoustic Topological Insulator, Proceedings of the National Academy of Sciences (under review)
Experimentally measured interface waves

For more information about this technology, please visit:
https://industry.gatech.edu/technology/reconfigurable-acoustic-topological-insulator