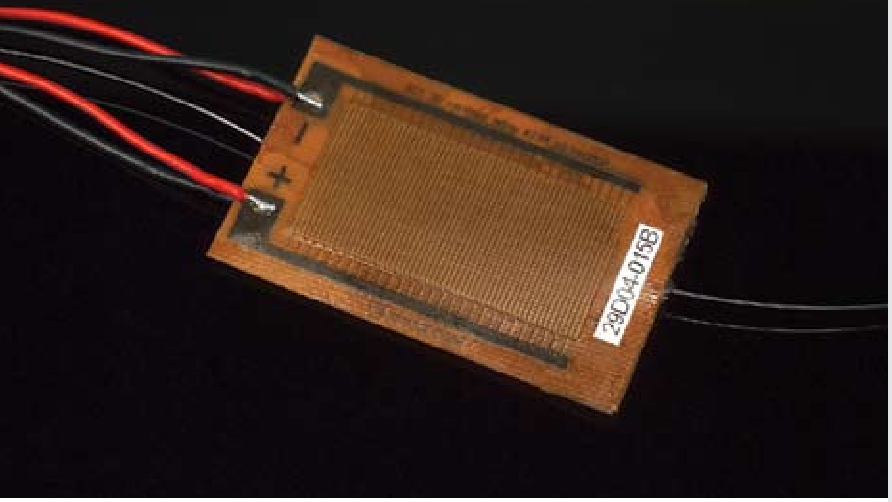
National Aeronautics and Space Administration



NASA Langley's

Piezoelectric Fiber Composite Actuator Portfolio

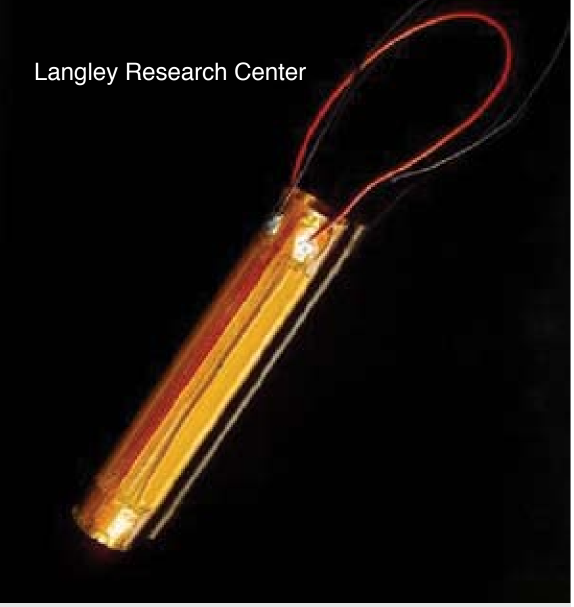
A unique portfolio of electro-active fiber composite actuator designs for tunable optical fiber and micro-displacement devices

NASA Langley has developed a technology portfolio and core competencies around advanced piezoelectric actuator designs. Leveraging NASA-patented macro-fiber composite (MFC) and piezoelectric fiber composite (PFC) actuator technology, NASA Langley has developed a variety of award-winning actuator architectures specifically designed to strain-tune optical fiber sensors; they also hold potential as microdisplacement devices. The NASA portfolio includes curved piezoelectric actuators for stretching optical fibers (CASF), interdigitated electrode actuators for straining optical fibers (IDEAS), and cylindrical shaped macro-fiber composite (CMFC) actuators. NASA has refined these actuators to enable high-speed strain-tuning of Bragg-grating-based fiber lasers. The versatility of the NASA electroactive actuator designs may be broadly applied to numerous applications requiring high-speed response, large displacement, and a small, lightweight profile.

Benefits

- Curved, planar, and cylindrical actuator architectures for a broad variety of applications
- Small, lightweight, simple design, and low-hardware-cost actuators not possible with traditional piezoceramic stack technologies
- Up to 150% greater actuation performance than other piezoactuators
- MFC sandwich innovation integrates fiber Bragg grating (FBG) devices into a compact, vibration-damped package with simple design (no complex moving parts) for reliable high-speed laser tuning
- High frequency (0-100Hz) FBG strain-tuning for fiber lasers
- Concentric, telescoping CMFC actuators enable incremental additive displacement
- Laser tuning of 4 nm in planar actuators and >28 nm for stack incorporating >7 concentric cylindrical actuators

partnership opportunity



The Technology

The NASA Langley Composite Actuator portfolio utilizes a NASA-patented (US 6,629,341) and commercialized MFC piezoelectric fiber composite actuator platform. This actuator platform enables compact, lightweight electroactive actuators, which can be broadly applied to a variety of actuator applications. NASA Langley has developed novel patent-pending actuator designs using the MFC actuator platform and other piezoelectric fiber composites to advance the performance of tunable fiber-optic lasers for distributed FBG sensing. The use of distributed fiber-optic-based sensors has enabled robust, low-cost, intrinsically safe measurement of physical parameters like stress, temperature, pressure, and the presence of certain chemicals. However, widely tunable, mode-hop-free, narrowband laser sources are required to interrogate current NASA-built distributed FBG sensing systems, and traditional diode- and fiber-based lasers cannot meet these requirements.

To address these tunable laser shortcomings, NASA Langley has developed a portfolio of actuator architectures – CASF, IDEAS, and CMFC. When an optical fiber containing FBGs is strained by the NASA Langley MFC actuators, it shifts the reflected wavelength of the FBG and can be used to tune an optical fiber laser to a specific, mode-hop-free, narrowband output. In addition to providing a wide (4 nm and larger) tuning range, the NASA actuators can also tune the fiber laser at high frequencies (up to 100 Hz), which enables the high-speed interrogation required for NASA distributed sensing systems. The CMFC is also envisioned for applications requiring larger (>25 nm) displacements, yet can be provided in a smaller, lighter form factor than microstages.

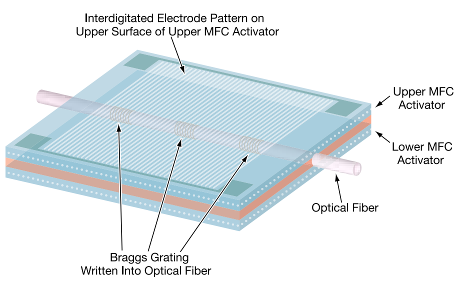


Figure 1: Planar and curved fiber-optic strain-tuning device using MFCs

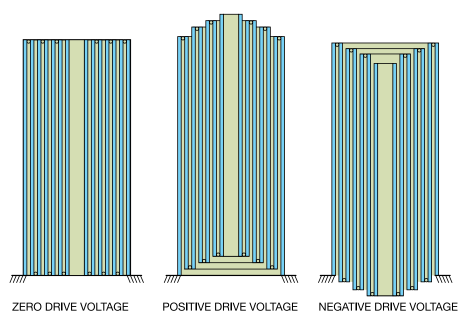


Figure 2: CPFC actuators in a concentric telescoping arrangement depicted in meridional cross-sections under three different drive-voltage conditions to illustrate how displacements are added

Applications

The technology offers wide-ranging market applications, including:

- Aerospace/civil structures – tunable lasers for use in distributed fiber-optic integrated structural health monitoring (e.g., wing, fuselage)
- Industrial – micro- and nano-displacement actuators in a small form factor
- Photonic – high-speed, widely tunable, mode-hop-free fiber lasers
- Optics – deformable and adaptive optic actuators

For More Information

If your company is interested in licensing or joint development opportunities associated with this technology, or if you would like additional information on partnering with NASA, please contact:

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