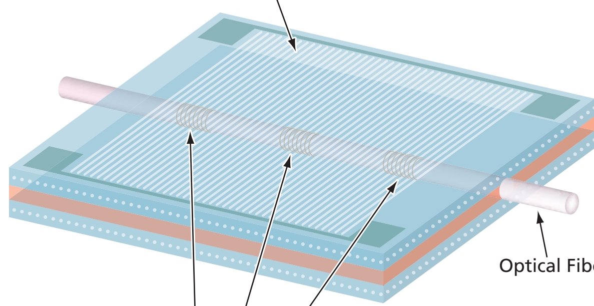
Tunable Optical Assembly With Vibration Dampening

Flat actuators are mechanically simple and offer vibration dampening.

Langley Research Center, Hampton, Virginia

Since their market introduction in 1995, fiber Bragg gratings (FBGs) [wherein "fiber" signifies optical fiber] have emerged as excellent means of measuring such parameters as strain and temperature. Distributed-grating sensing is particularly beneficial for such structural-health monitoring applications such as those of "smart" structures or integrated vehicle health management in aerospace vehicles. Because of the variability of their output wavelengths, tunable lasers have become widely used as means of measuring FBGs.

Several versions of a lightweight assembly for strain-tuning an FBG and dampening its vibrations have been constructed. The main components of such an assembly are one or more piezoelectric actuators, an optical fiber containing one or more Bragg grating(s), a Bragg-grating strain-measurement system, and a voltage source for actuation. The piezoelectric actuators are, more specifically, piezoceramic fiber composite actuators and, can be, still more specifically, of a type known in the art as macro-fiber composite (MFC) actuators. In fabrication of one version of the assembly, the optical fiber containing the Bragg grating(s) is sandwiched between the piezoelectric actuators (see figure) along with an epoxy that is used to bond the optical fiber to both actuators, then the assembly is placed in a vacuum bag and kept there until the epoxy is cured.



In This Tunable Optical Assembly, an optical fiber containing Bragg gratings is sandwiched between two MFC actuators.

Two other versions of the assembly can be characterized as follows:

- During the fabrication of one of the piezoelectric actuators, the optical fiber containing the Bragg grating(s) is embedded in the actuator in place of one of the piezoceramic fibers.
- The surface of an MFC actuator is roughened by sandblasting to improve subsequent bonding, then the optical fiber containing the Bragg grating(s) is bonded to the roughened surface by use of an adhesive.

In operation of any version of the assembly, when the optical fiber is strained by the actuator(s), the wavelength of light reflected from the Bragg grating(s) changes by an amount that depends on the amount of strain. This method of straining an optical fiber containing Bragg gratings to produce a shift in the reflected wavelength holds promise because it may also be useful for tuning an optical-fiber laser.

Bonding an FBG directly into an MFC actuator greatly reduces the complexity, relative to assemblies, of the type described in the immediately preceding article, that include piezoceramic fiber composite actuators, hinges, ferrules, and clamp blocks with setscrews. Unlike the curved actuators, MFC actuators are used in a flat configuration and are less bulky than are the assemblies described in the immediately preceding article. In addition, the MFC offers some vibration dampening and support for the optical fiber whereas, in an assembly of the type described in the immediately preceding article, the optical fiber is exposed, and there is nothing to keep the exposed portion from vibrating.

This work was done by Qamar A. Shams, Sidney G. Allison, and Robert L. Fox of Langley Research Center. Further information is contained in a TSP (see page 1).
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Passive Porous Treatment for Reducing Flap Side-Edge Noise

Advantages include broadband noise reduction with no aerodynamic-lift penalty.

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A passive porous treatment has been proposed as a means of suppressing noise generated by the airflow around the side edges of partial-span flaps on airplane wings when the flaps are extended in a high-lift configuration. The treatment proposed here does not incur any aerodynamic penalties and could easily be retrofit to existing airplanes. The treatment could also be applied to reduce noise generated by turbomachinery, including wind turbines. Innovative aspects of the proposed treatment include a minimum treatment area and physics-based procedure for treatment design. The efficacy of the treatment was confirmed during wind-tunnel experiments at NASA Ames, wherein the porous treatment was applied to a minute surface area in the vicinity of a flap edge on a 26-percent model of Boeing 777-200 wing.

The flap side-edge noise constitutes a significant portion of the overall airframe noise during descent and landing of an aircraft. The acoustically relevant flow features at typical flap side edges