TECHNICAL NOTE

PRINCIPLE OF **FISO** FIBER-OPTIC SENSORS

Because of their great versatility, high accuracy, and large dynamic range, Fabry-Pérot sensors are among the most attractive fiber-optic sensors available on the market today.

FISO Technologies' fiber-optic gauges are designed around a Fabry-Pérot interferometer (FPI). Basically, an FPI consists of two mirrors facing each other, the space separating the mirrors being called the cavity length. Light reflected in the FPI is wavelength-modulated in exact accordance with the cavity length. Since well-designed FPI gauges convert strain, temperature, load, or pressure into cavity length variations, the key to the successful use of FPI technology is to find a practical way of obtaining precise and reliable Fabry-Pérot cavity length measurements. Fiso's patented **white-light cross-correlator** offers a unique and powerful way to make absolute Fabry-Pérot cavity length measurements with astonishing accuracy and linearity, providing consistency time after time.

Fiso's white-light sensing method is illustrated in Figure 1. Light from a broadband source is launched into one arm of a 2 x 2 coupler and directed toward the Fabry-Pérot gauge.

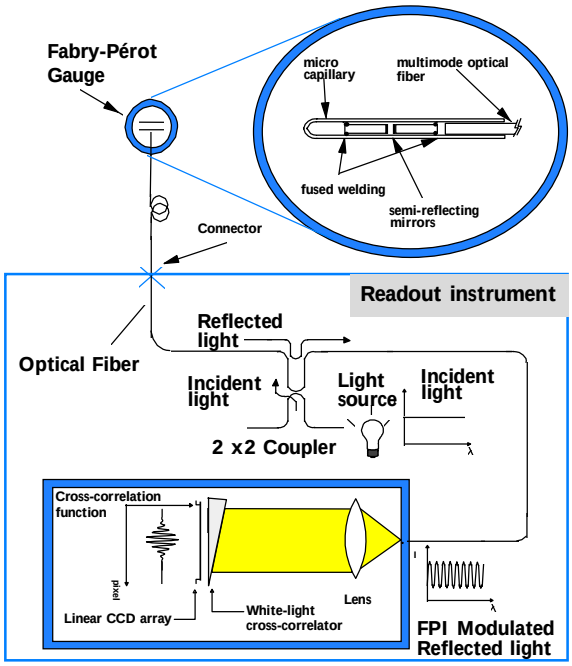

Figure 1

The light signal, which is wavelength-modulated by the gauge, is reflected back toward the readout Fiber-Optic Sensor Instrument, focused on a line, transmitted through our patented white-light cross-correlator, and detected by a linear CCD array. Our white-light cross-correlator can be described as a spatially-distributed Fabry-Pérot cavity in which the cavity length varies along the lateral position. Facing the CCD array, each pixel is associated with a predefined Fabry-Pérot-like cavity length. Thus, this device works like an optical cross-correlator with a spatially varying cavity length.

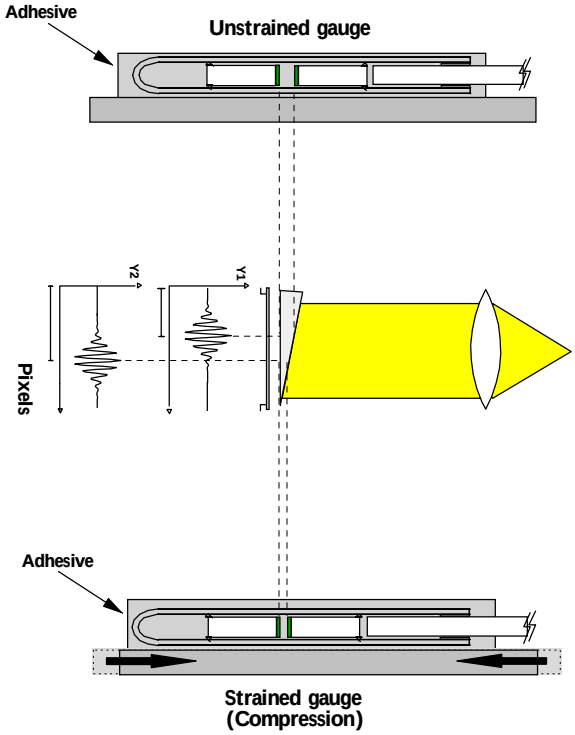

Figure 2

Consider a Fabry-Pérot gauge with a cavity length of d µm. The light reflected by this gauge will be transmitted maximally at the pixel of the CCD array with which a Fabry-Pérot cavity of d µm is associated, i.e. at the lateral position where the spatially-distributed Fabry-Pérot cavity is equal to d µm. As shown in Figure 2, a variation of the Fabry-Pérot cavity length is converted into #a displacement of the pixel that sees the maximum transmission.

FISO TECHNOLOGIES

This technique provides accurate and reliable measurements of the cavity length of FPI gauges as long as the white-light cross-correlator is perfectly stable. Fiso Technologies makes use of a fully integrated optical cross-correlator based on the depositing of a shaped dielectric coating. The accuracy is guaranteed over a wide range of temperatures and for long periods of time.

Important features include:

-*Absolute measurements* allow the user to disconnect the gauge, shut the system down, etc. while always keeping track of the actual value (i.e. there is no loss of reference).

-*Perfect linear response* achieved through absolute measurement of FPI cavity length.

-*Insensitivity to light loss* due to fiber bending, cable length, or light source fluctuations. The light signal detected by the CCD array may vary, but the position of the maximum is maintained.

-*Versatility of the technique* allows the user to perform various types of measurements with the same Fiber-Optic Sensor Instrument. Fiso offers a wide range of FPI gauges for strain, force & load, temperature, pressure, linear postion & displacement applications.

-*Dynamic range* of 1:15 000.

-*Precision* better than 0.025%.

-Resolution of 0.01% or better.

-*50/125 µm multimode fiber* used to make the gauges meet telecommunications standards. Connector installation and fiber splicing are easier to do with multimode fibers than with single-mode-type fibers.

-*Ease of use:* no tuning or calibration procedures. You connect the gauge to a Fiso signal conditioner instrument (Fiso's Universal Fiber-Optic-Sensor Instrument), enter the associated serial number, and you are ready to start taking measurements.

References:

[1] Belleville, C. and Duplain, G., "White-light interferometric multimode fiber-optic strain sensor," Optics Letters, Vol. 18(1), 78-80 (1993).

[2, 3] US patent No. 5,202,939 and 5,392,117.

Further reading

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Fiso Technologies Inc. "Fiber-optic strain gauge installation Guide" (1997)

FISO Technologies, Incorporated reserves the right to make any changes in the specifications of their products without prior notice.

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2014 Jean-Talon N. – suite 125 – Sainte-Foy (Québec) Canada G1N-4N6 – Phone: 418-688-8065 - Fax: 418-688-8067 - E-Mail: sales@fiso.com
www.fiso.com