Docket #: S09-099

Fiber Bragg Grating Sensors Used in the Slow Light Mode for Ultra-High Sensitivity Sensing

Light with a narrowband spectrum is launched into the FBG, at a wavelength located on one of the two edges of the reflection peak of the FBG, i.e., at a wavelength where the FBG transmits, rather than reflects, light. The frequency of the light is selected to be on the edge of the bandgap of the FBG. The reason for this choice is that on the edge of the bandgap, light experiences a significant group delay, i.e., it travels with a much slower group velocity than the normal group velocity of light in the fiber in which the grating is made. This effect,the existence of slow light on the edges of the bandgap of a fiber grating‹has been known for quite some time. It has been investigated, in particular, to evaluate the potential use of an FBG for dispersion compensation, for example in optical communication systems. A second benefit of this mode of operation is that at this wavelength (and in its immediate vicinity), the power transmission of the FBG is very close to unity, and consequently the loss experienced by the signal as it propagates through the FBG is small. A third benefit is that at this wavelength, the impact of a perturbation (e.g., a strain) applied to the FBG on light traveling through the FBG is that is modifies the phase of the light, not its amplitude. To be more exact, it modifies to first order the phase, and to second order the amplitude. This is in contrast to the reflection mode of an FBG, in which the FBG modifies the frequency of the light that it maximally reflected. Consequently, in the transmission mode, the FBG can be used as any phase sensor, i.e., it can be placed directly in one of any number of interferometer to convert the phase modulation induced by the measurand into a power change (which is the quantity the user measures). This instrument can be, for example, a nominally balanced MZ interferometer. In contrast, in the reflection mode, as described in the prior art section, one needs an instrument that converts a wavelength (or frequency) change into a power change, which requires an imbalanced interferometer (when high precision is required). As hinted above, the use of a balanced MZ instead of an imbalanced MZ results in a great improvement in the temperature stability of the MZ interferometer, and therefore of its phase bias, which simplifies engineering considerably.

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Applications

- The invention is used as strain/temperature sensor with ultra high sensitivity.

Advantages

- The benefits of using FBG as a sensor in transmission mode are a greatly increased sensitivity to a measurand (example, a strain), a significant reduction in the required length of the FBG, and the elimination of the need to use an imbalanced MZ as a measurement tool: the MZ can be perfectly balanced.

Patents

- Published Application: 20150330848
- Issued: 9,019,482 (USA)
- Issued: 9,329,089 (USA)

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