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FIBER BRAGG GRATING DEFORMATION SENSOR

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Анотація
Метою роботи э удосконалення сучасних волоконно-оптичних датчиків деформації на основі ВБҐ використовуючи новий метод побудови дифракційної ґратки. Довести вигідність використання ОВ і ВБҐ. Цим буде підвищена якість і простота нових приладів та технологій. Розповісти про основні принципи побудови ВБҐ, датчиків на їх основі та про їх практичне використання.
Ключові слова: датчик деформації, брегівська ґратка, оптичне волокно, оптоволоконний сенсор

Abstract
The goal of the work is improvement of modern fiber-optic deformation sensors based on FBG using a new method of constructing a diffraction grating. Prove the profitability of using OF and FBG. This will increase the quality and simplicity of new devices and technologies. Tell about the basic principles of construction of FBG, sensors on their basis and about their practical use.
Keywords: deformation sensor, Bragg grating, optical fiber, fiber-optic sensor

The purpose of technological progress is to increase the accuracy of measuring instruments while reducing their size. For this purpose it is necessary to use more and more new materials, principles, discoveries, etc.

One of the options that will be described in this paper is the use of OF and FBG. This method has a number of significant advantages that will undoubtedly help us achieve our goal.

Diffraction optical elements belong to the class of optical products that perform various tasks of control and analysis of radiation due to multibeam interference inherent in their periodic structure. This structure allows you to accurately and quickly determine the required parameters, including deformation on buildings, structures and more.

The formation of a time-constant grating in the core of the optical fiber (OF) was first demonstrated in 1978. The fibers used in the experiment were made on the basis of silicon dioxide SiO_2 with the addition of germanium dioxide GeO_2 in the core as an alloying impurity. The software modulation was induced by a standing wave in the core of the fiber formed by the interference of two rays from an argon-ion laser (488 nm) propagating in opposite directions: a light wave reflected from the end of the fiber at the interface of the two media, and a light wave in the forward direction. [1]

And already in 1989 the possibility of forming software gratings by irradiating the fiber through the side surface with an interference pattern formed by two intersecting rays of UV light was demonstrated. From that moment, an active study of fiber Bragg gratings began.

Induction of Bragg gratings in OF by a single pulse of an excimer laser by the phase mask (FM) method is the simplest and most effective, as it allows to exclude expensive vibration isolating tables from the recording scheme, foundations required for multipulse recording, and thus obtain gratings with the desired characteristics.

The principle of recording of FBG by the method of FM: Cylindrical lens focuses radiation on one of the axes to achieve the desired energy density. The radiation, passing through the phase mask, diffracts by +1 and -1 orders. The interference pattern of +1 and -1 orders records the grating in the core of the OF, fixed at a distance of several microns from the FM.

This method does not allow changing the wavelength of the reflection FBG, due to the fixed value of the period of FM. Also, this method does not allow recording of the Bragg grating in the process of extraction of the fiber, because it requires the absence of optical elements near the moving fiber.

In addition, when using UV light, it is necessary to carry out the procedure of removing the protective polymer shell of the fiber before recording the grating. This procedure is necessary because the standard polymers used as the fiber covering are opaque to UV light. Removal of the covering leads to a lengthening of the manufacturing process of fiber with the diffractive structure recorded in it and reduces the strength of the OF.[1]

Another recording method is the step-by-step method. The attractiveness of this method is that it eliminates the need of using a phase mask and allows you to record the grating with Bragg resonance at any wavelength. In addition, this method allows to form arbitrary profiles of a single grating stroke and the entire distribution of the amplitude of the software as a whole, as well as to change the period along the grating length, i.e. to create chirped FBG without the use of FM with variable length.

However, this method has a number of significant disadvantages: it is the need for precise mechanical translation of OF along the focused radiation, and the inability to record the grating with a single pulse.[1]

The method of recording the Bragg grating in the Talbot interferometer allows you to record the Bragg grating during the extraction of OF, due to the lack of optical elements near the moving fiber.

In addition, by changing the angle between the rays in this scheme the period of the interference pattern can be changed, and, consequently, the period of the grating, which reflects the radiation in accordance with the Bragg condition.

Thus, in this way, the grating can be recorded to display any wavelength in a very wide range. Also, this method allows you to completely remove the zero diffraction order from the phase mask, due to the use of an absorbing screen and has no dependence of the visibility of the interference pattern on the distribution of spatial coherence in the laser beam due to interference of light rays from one point of the beam.

Such an interferometer can be created, for example, using a dielectric mirror that divides the front of the beam into two equal parts. The only disadvantage of this scheme is the high requirements for spatial coherence of optical radiation, as interfering rays emanating from different points of the light beam.[2]

Due to their unique characteristics, fiber-optic sensors based on Bragg gratings have found application in many areas, such as construction and geotechnics, aerospace, energy, oil and gas industries.

Monitoring systems based on this technology are cost-effective when used on large-scale facilities where it is necessary to install hundreds of sensors for long-term measurements of various physical parameters.

Creation and implementation of VOS in industrial and civil facilities involve the development of a certain component base and, above all, fiber-optic sensors of different physical quantities of the minimum nomenclature: pressure, displacement, speed, acceleration, fluid level, rotation frequency, force and temperature.

Conclusion. Diffraction optical elements belong to the class of optical products that perform various tasks of control and analysis of radiation due to multibeam interference inherent in their periodic structure. This structure allows you to accurately and quickly determine the deformation of buildings, structures, parts, etc. The sensitive element of FOS does not contain electronic components and therefore it is completely passive that means possibility of its use in a zone of the increased explosiveness, aggressiveness, strong electromagnetic disturbances. A big amount of Bragg gratings can be installed in one fiber, each of which responds to its own wavelength. In this case, instead of a point sensor, we get a distributed registration system for sealing along the wavelength. The use of the wavelength of light in the information parameter makes the sensor insensitive to long-term drift parameters of the source and receiver of radiation. These technologies are very promising because, over the past 30 years, they have developed to unprecedented proportions.

References

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