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# ANALYSIS OF FIBER-OPTIC SENSORS FOR DIAGNOSTICS AND MONITORING OF ELECTRICAL EQUIPMENT

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## ABSTRACT

*The article describes the basic principles to date; one of the applications of fiber-optic technologies for measuring purposes is fiber-optic multi-sensor systems. Fiber-optic multi-sensor systems include quasi-distributed sensor networks built on the basis of fiber-optic sensors, usually based on fiber Bragg gratings. One of the main advantages of fiber Bragg gratings is the unique way of converting the measured value into a change in the wavelength of radiation passing through and/or reflected from the grating, as well as the ease of manufacturing. fiber Bragg gratings have proven themselves well and are widely used in construction, oil production, energy, aerospace engineering, etc.*

**KEYWORDS:** *Fiber-optic sensors, point-to-point sensors, phase-shift sensors, temperature sensors.*

## INTRODUCTION

To date, one of the applications of fiber-optic technologies for measuring purposes is fiber-optic multi-sensor systems. Fiber-optic multi-sensor systems include quasi-distributed sensor networks built on the basis of fiber-optic sensors, usually based on fiber Bragg gratings. One of the main advantages of fiber Bragg gratings is the unique way of converting the measured value into a change in the wavelength of radiation passing through and/or reflected from the grating, as well as the ease of manufacturing. fiber Bragg gratings have proven themselves well and are widely used in construction, oil production, energy, aerospace engineering, etc.

**MAIN PART**

Many factors contribute to the active use of fiber Bragg gratings in various fields: miniaturization-individual developments have an external diameter of the working part of less than 100 microns, which allows them to be used in hard-to-reach places without significant structural modifications of the devices in which they work, multiplicative response to environmental parameters temperature, humidity, mechanical effects, etc., absence of the influence of electromagnetic interference, preservation of operability, in the presence of various coatings at temperatures from -100 to +300℃, etc.

Fiber-optic sensors are often used to measure various physical parameters in the field of energy, such as temperature, current, voltage, analysis of the composition of air, transformer oil, monitoring of structural integrity, etc. [1-2]. Compared to other types of sensors, fiber-optic sensors have the following advantages:

- Made of electrically non-conductive materials, do not require a separate power supply, can be used when working under high voltage;
- Ready to work in an explosive environment;
- Not subject to natural and industrial electromagnetic interference;
- Chemically inert, do not pollute the environment, and are not subject to corrosion;
- Have a wide range of operating temperatures;
- Multiplex able, operable as part of a single field of integrated fiber-optic sensors.

**LIMITATIONS**

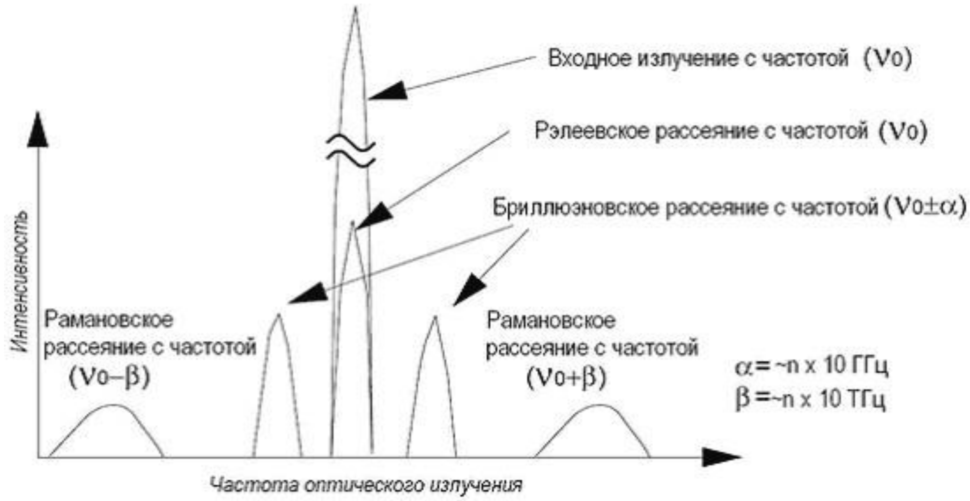
Expensive optical interrogators are used for interrogation;

Require sophisticated signal processing techniques to accurately locate the central Bragg wavelength;

Demanding on the signal/noise ratio in the measuring channel;

**RESULTS AND DISCUSSIONS**

Distributed fiber-optic sensors for temperature measurement include systems based on the use of Raman light scattering. The sensing principle is based on the effect of Rayleigh scattering, Raman scattering, or Brillouin scattering (Fig. 1) [3, 4]. For example, a method of optical time-domain reflectometry, where the position of a region with a weak reflection can be determined using a pulsed probing signal. This method is also used to determine the temperature as a function of the Brillouin frequency shift.




**Pic. 1. Spectrum of scattered optical radiation in distributed fiber-optic sensors**

In some cases, the measured value is the average value over the entire length of the fiber. In other cases, position-dependent values (for example, temperature or voltage) are measured.

The light in the optical fiber is scattered by microscopically small density fluctuations, the size of which is less than the wavelength. In the backscattering, one can find, along with the elastic fraction of scattering (radiated scattering) at the same wavelength, both the penetrated light and additional components at other wavelengths, which are associated with the vibration of the molecules and, thereby, with the local temperature (Raman scattering).

**Dignities:**

- High accuracy (up to +/- 0.5°C);

- High spatial resolution (up to 0.5 m);

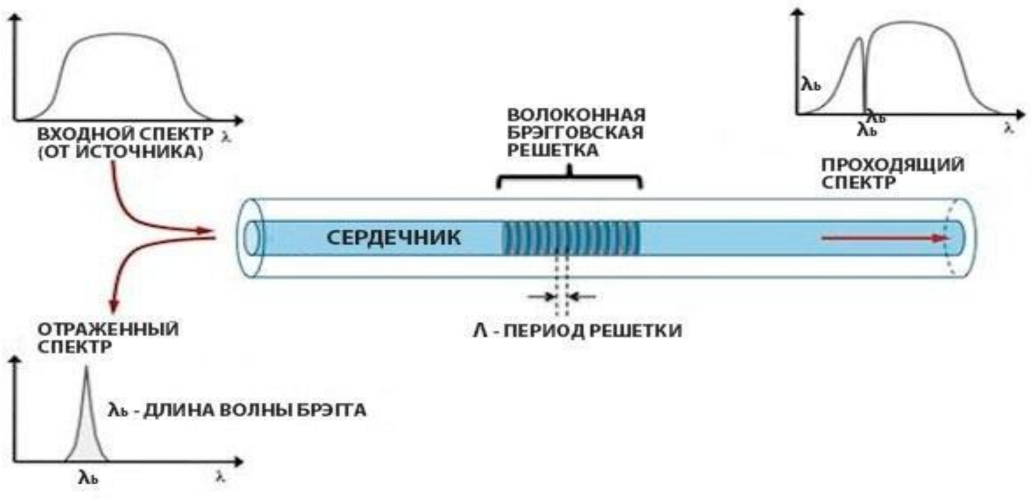
- High length of the measuring system (up to 8 km);

- Low cost;

- Wide range of measured temperatures;

- Low temperature resolution due to the large dispersion of the reflected signals when using non-encoded signals.

Quasi-distributed fiber-optic sensors can contain a series of sensor arrays for monitoring temperature, humidity, and mechanical pressure. VBR links the main mode of the light guide with the same mode propagating in the opposite direction. At a certain wavelength, the radiation propagating through the light guide is reflected from the grating in whole or in part, the main difference in the principle of operation of temperature sensors based on fiber Bragg gratings from other fiber temperature sensors is that the Bragg wavelength in the grating depends not only on its period, but also on environmental factors.




**Pic 2.The principle of operation of the fiber Bragg grid**

**Dignities:**

- Ability to reflect the light signal in a narrow spectral range

-Easy ability to combine into arrays (multiplexing);

- High measurement accuracy;

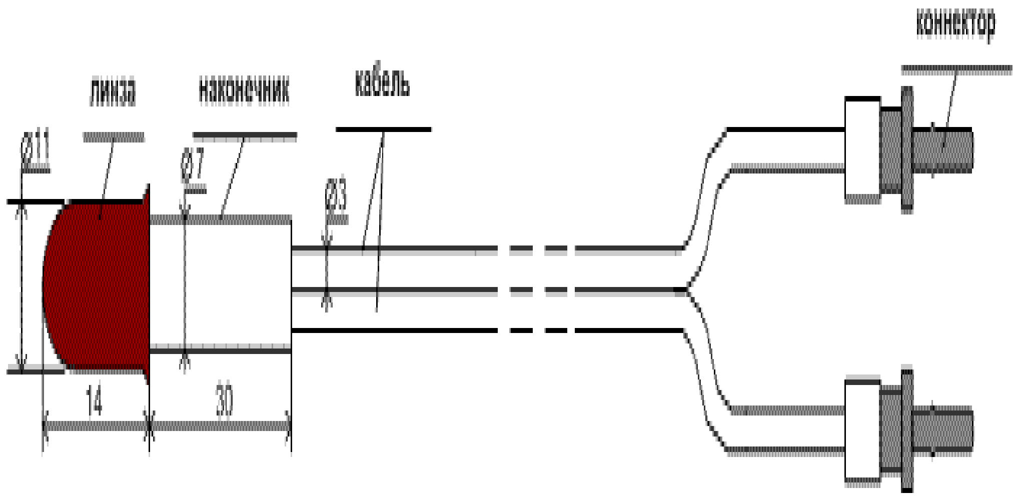
- Small dimensions, weight;

- The difference between temperature and deformation effects on the object;

- Continuous monitoring of parameters along the length (volume) of the object at any point where the sensor light guide is installed;

Point sensors are parametric sensors that respond to changes in a particular physical quantity. Point sensors in the electric power industry have a variety of applications: measuring the gas content in the environment, measuring current and voltage at substations, fixing arc formation, etc. Fiber-optic sensors installed in the compartments of high-voltage cabinets and having an almost circular radiation pattern, record the light flash from the electric arc and transmit it via optical fiber to the light detection unit of the device.

The optical radiation spectrum of an arc flash can vary greatly depending on the materials involved (gas, moisture, etc.). The figure below shows an example of such an optical spectrum. It covers a wavelength range of 300 to 800 nm, with characteristic lines of about 500 nm ("copper" lines). The arc flash emission spectrum plays an important role in selecting a suitable photo-diode for the arc protection sensor




**Pic. 3. Fiber optic sensor in arc protection devices.**

The disadvantage of all of the above systems, except for the last one, is the requirement for an ultra-expensive and precision interrogator. The system with a fiber optic sensor based on a fiber Bragg grid with phase-shift also looks very simple in the option of installing a single sensor. However, it is known that such sensors require at least four complete switchgears in one. In this case, the system for collecting and transmitting information will be implemented according to the scheme "one FOS– one balanced photo detector", and the number of balanced photo detectors will be determined by the number of fiber-optic sensors. In addition, each channel must include a reference fiber Bragg grating for temperature control. Given the narrow width of the transparency window of phase-shifted fiber Bragg gratings, the effect of temperature on the stability of achieving a given measurement accuracy increases incommensurably, compared to the achieved gain in sensitivity and resolution.

## CONCLUSION

The light in the optical fiber is scattered by microscopically small density fluctuations, the size of which is less than the wavelength. In the backscattering, one can find, along with the elastic fraction of scattering (radiated scattering) at the same wavelength, both the penetrated light and additional components at other wavelengths, which are associated with the vibration of the molecules and, thereby, with the local temperature (Raman scattering).

**Dignities:**

- High accuracy (up to +/- 0.5°C);

-High spatial resolution (up to 0.5 m);

- High length of the measuring system (up to 8 km);

- Low cost;

- Wide range of measured temperatures;

- Detection of the optical backscattering signal in a narrow band

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- Small size of the sensors (the weight of the electronic unit is not more than 16 kg),

**Disadvantages:**

-Technically difficult measurement of Raman scattered light due to low backscattering power relative to peak power;

- The need for a large number of measurements in order to increase the signal-to-noise ratio.

**REFERENCES**


1. Berthold J.W., Jeffers L. S. Fiber optic method for sensing diaphragm deflection//Fiber optic and laser sensors. Proc. SPIE. Vol. 412. P. 90-96.
2. Fiber optic attenuators for FOCL [electronic resource] .- http://izmer-ls.ru/ato.html-Handbook of optical cables and fibers.
3. Glushchenko A., Glushchenko L., Tupota V. Evaluation of the security of information circulating in fiber optic lines, Photonics, 2010, No. 4
4. Kotov OI "Multimode Fiber Optic Interferometers". Dissertation for the degree of Doctor of Phys.-Mat. Sciences. 1994, pp. 41 - 45, 94 - 102.
5. Sensor for detecting an electric arc based on a plastic optical fiber [Electronic resource]. - Access mode: http://infiber.ru/biblioteka/stati/ArcFlash_Detective.html
6. Technical features of the construction of perimeter vibration detection mean [electronic resource]. –Http: //www.polyset.ru/
7. Karimov U. et al. USING NEW INFORMATION TECHNOLOGIES IN DISTANCE LEARNING SYSTEM //НОВАЯ ПРОМЫШЛЕННАЯ РЕВОЛЮЦИЯ В ЗЕРКАЛЕ СОВРЕМЕННОЙ НАУКИ. – 2018. – С. 9-11.
8. Karimov A., Muxammadjonov X. INFORMATION TECHNOLOGIES: INFORMATION EDUCATION AND INFORMATICS //Экономика и социум. – 2020. – №. 8. – С. 40-43.
9. Yahyo, Muhammad Amin. Protection from internet threats. Supporting tutorial. Tashkent, 2016.
10. M.Tojiyev, R.Salaxutdinov. Modern information technologies in the educational process. Tashkent, 2001.