МАТЕРИАЛЫ

V - МЕЖДУНАРОДНОЙ НАУЧНО-ПРАКТИЧЕСКОЙ КОНФЕРЕНЦИИ «ИНФОРМАТИКА И ПРИКЛАДНАЯ МАТЕМАТИКА», ИНСТИТУТА ИНФОРМАЦИОННЫХ И ВЫЧИСЛИТЕЛЬНЫХ ТЕХНОЛОГИЙ

29 сентября - 01 октября 2020 года

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Рассмотрены актуальные вопросы в области математики, информатики и управления: математического моделирования сложных систем и бизнес-процессов, исследования и разработки защищенных и интеллектуальных информационных и телекоммуникационных технологий, математической теории управления, технологий искусственного интеллекта.

Материалы сборника предназначены для научных работников, докторантов и магистрантов, а также студентов старших курсов.

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1. Mozer D., Fofanov O., Yavorskiy V. Satellite radar interferometry as a reliable tool for monitoring displacements of rock masses // Proceedings of 2015 International Conference on Mechanical Engineering, Automation and Control Systems, MEACS 2015.

2. Архипова Н.И., Кульба В.В. Управление в чрезвычайных ситуациях. Учебное пособие. – М.: Российский государственный гуманитарный университет, 2008. – 470 с.

3. Матвеевский В.Р. Надежность технических систем. Учебное пособие – М.: Московский государственный институт электроники и математики, 2002. – 113 с.

4. Основы расчета надежности технических систем по надежности их элементов. [Электрон.ресурс]. – 2015. – URL: http://www.obzh.ru/nad/4-5.html. (Дата обращения: 13.08.2020).

5. Karagiannis, G.-M., Piatyszek, E., Flaus, J.-M., 2010. Industrial emergency planning modeling: a first step toward a robustness analysis tool. J. Hazard. Mater. 181. 1. 324–334.

6. Валиуллина В.А., Садофьев В.А. Разработка функциональных схем автоматизации технологических процессов. Учебное пособие. – Казань: Издательство КНИТУ, 2013. – 126 с.

RESEARCH OF NEW STRUCTURES OF THE TILT FIBER BRAGG GRATINGS AND THEIR PROPERTIES

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Abstract. *In this paper new structures of tilted fiber Bragg gratings and their properties are considered. The article presents the results of experimental research of periodic structures with a linearly variable value of the period of chirped tilted fiber Bragg gratings (CTFBG) and twisted tilted fiber Bragg gratings (TTFBG). Among the many new types of periodic structures, that are currently being developed, the structures considered are promising. The proposed designs represent a new approach to reducing the sensitivity to polarization of tilted fiber Bragg gratings, which can be used to measure the refractive index, and open up wide possibilities for their practical application in creating fiber-optic systems in various industries and other fields of activity. The properties of the indicated periodic structures are experimentally researched, their parameters and functional capabilities are determined.*

Introduction

Chirped tilted fiber-optic Bragg gratings (CTFBG) periodic structures with variable period.

One of the groups of periodic structures with tilted modulation of refractive index are tilted structures with linear variable value of CTFBG period. Those structure types are used as edge filters in the filtration systems signals, for insrance, from sensors, on the basis of standard, simple and uniform Bragg gratings [1-5], as well, as the structures, used for restrainting the effect of combinational scattering in fiber lasers [6].

Apart from that, CTFBG structures recording on optic fibers with large mode area (LMA) allows limit their sensitivity to the temperature [7].

Mutual arrrangement of CTFBG transfer characteristics, used in the system and FBG reflection characteristics is shown in the Figure 3. Unbroken red line in the Figure demostrates the CTFBG characteristics form, while the dotted lines show the form and position of FBG characteristics. In the situation, when CTFBG transmission characteristics have symmetric downslopes, there might be operated the system both at the left (discending) and at the right (ascending) downslopes of CTFBG. System's operating area at the ascending CTFBG downslope is indicated in green color, and system's characteristics, changing the position at the descending downslope, denoted in bleu color.

As it can be seen, the FBG structure can work as a sensor, for instance, of voltage, at that, there is possible both compression and extension.

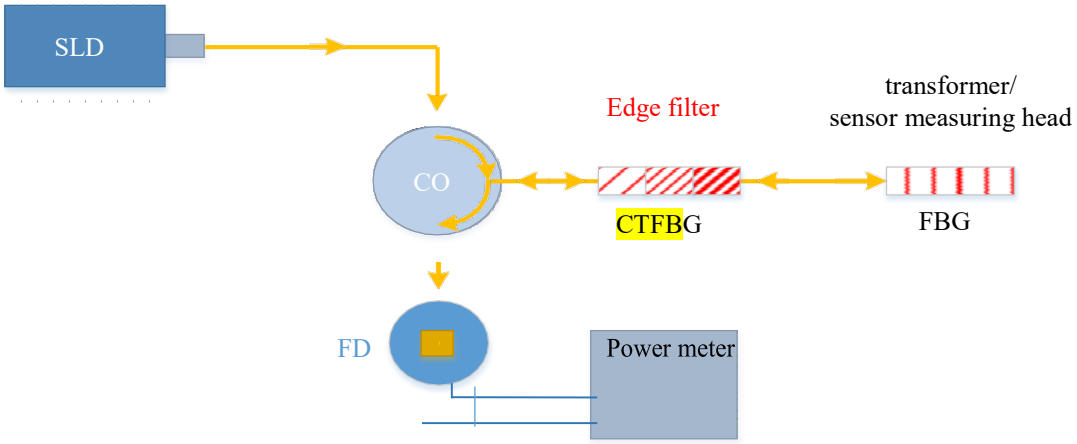

Fig. 1 CTFBG usage in edge filter system for FBG sensors

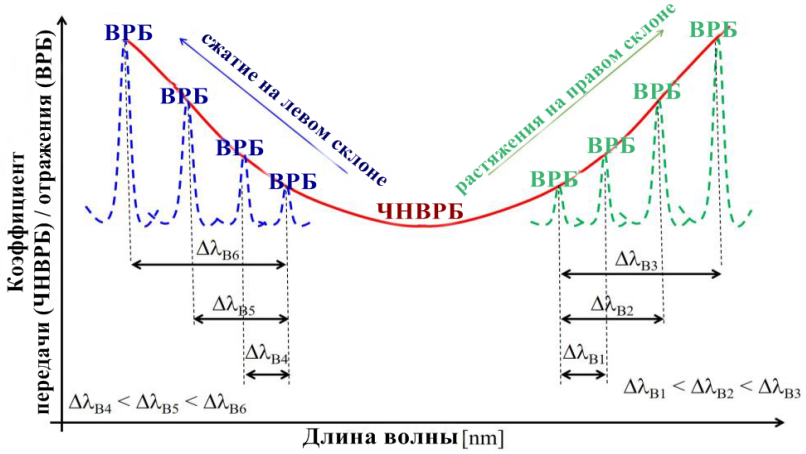

Fig. 2 Edge filter characteristics on the basis of tilted gratings with variable period (CTFBG) and sensors, using uniform and simple Bragg gratings (FBG)

Fig. 8 Outcomes of numerical computations of CTFBG structure transmission index change for different angles ϕ: a) for P type mode, б) for S type mode.

In case of twisted structure the form of transmission modes changes is asymmetric. Therefore, both polarization rotation direction and such grating rotation direction cannot be defined on the basis of spectral characteristics. In case of structure for which $\phi = 45°$, when polarization plane rotation angle changes in the range from-22,5 to +22,5°°, such discrimination is acceptable. Such structure's twisting angle also can be identified. The grating, turned for 180 degrees along its length, does not show polarization sensitivity.

Conclusion

In the result of conducted experimental researches it has been shown, that the inlet light polarization state influences at TFBG structures optic parameters. In the work it has been proved, that twisting of already tilted modulation of refraction index lowers the sensitivity of such structure to rotation angle of the inlet light polarization. As well, it should be noted, that offered structures represent a new approach to decreasing the sensitivity to the tilted fiber Bragg gratings polarization, which might be applied to refraction index measuring. Obtained results are of interest upon fabricating the fiber-optic measuring systems in different industry fields, for instance, automobile industry (refractometers for working liquids), food industry, agriculture, cattle-breeding (refractometers for measuring concentration of, for instance, sugar, salt in water solutions), industrial technologies (refractometry, for example, of oil products, refractometer for measuring oil emulsions, cooling oils), as well, in the area of point by point measurements applying. As well, attention should be paid to practical aspects of the CTFBG structures usage, comparing them, for example, with two structures, fabricated under 180° angle in respect to each other. Technologically, it is better to conduct one process of periodic structure recording on a single-mode fiber.

Experimental researches have been carried out in the laboratories of Optoelectronic faculty of electric engineering and computer sciences of Lublin technical university in the frame of the project SF #AP05132778 «Research and development of interrogation system of signals with optic-fiber refractometer, using telecommunication networks» IICT CS MES RK.

References

[1]Guo T., Tam H.-Y., Albert J., Chirped and tilted fiber Bragg grating edge filter for in-fiber sensor interrogation. CLEO:2011 – Laser Applications to Photonic Applications 1-2 (2011). doi: 10.1364/CLEO_SI.2011.CThL3

[2]Guo T., Tam H.-Y., Albert J., Linearly chirped and weakly tilted fiber Bragg grating edge filters for in-fiber sensor interrogation. Proceedings of SPIE 7753, 21st International Conference on Optical Fiber Sensors, 77537V-1- 77537V-4 (2011). doi: 10.1117/12.884956

[3]Liu Y., Zhang L., Bennion I., Arbitrary spectral response fibre edge filters based on tilted chirped grating structures. Technical Digest. Summaries of papers presented at the Conference on Lasers and Electro- Optics. Postconference Edition. CLEO '99. Conference on Lasers and Electro-Optics (IEEE Cat. No.99CH37013), 297 (1999). doi: 10.1109/CLEO.1999.834214

Содержание