



*The official review of the thesis paper prepared by Khabay Anar in candidacy for a degree of the Doctor of Philosophy (PhD) in the specialty 6D071600 - Instrument engineering "Development and research of the combined temperature and humidity sensors".*

## REVIEW

**The relevance of the research topic and its relation to the general scientific and national programs (requests for practice and the development of science and technology).**

Sensors that measure temperature and humidity are widely used in process control of microelectronic production, in chemistry, biology, meteorology, electronics, automotive metrology, in control of agriculture, in providing systems with energy and in multiple measuring and control fields of medical technology. Currently there are a lot of sensors that use different physical principles. However, it is necessary to further develop the sensitivity, selectivity, reliability and response time of the sensors.

In this thesis paper the methods of measuring temperature and humidity, types of sensors that measure temperature and humidity are presented, and its analysis is also conducted. At present, the advantages and disadvantages of the operation of sensors, measuring temperature and humidity in unity, are analyzed, and in the direction of correcting these major disadvantages, the operation of the sensor was considered,

complying with the strict requirements of measuring a small volume range that does not accept internal electromagnetic interference. According to these requirements, a sensor measuring humidity and temperature in unity, based on optical fiber, in connection with portability and anti-electromagnetic resistance, is studied with interest in terms of sensitivity and rapid response.

**In order to improve the reliability of the sensor considered in the thesis paper**

An analysis of recent scientific works and applications in the field of production of strict environmental zoning using fiber-optic laser radiation and fiber Bragg gratings has been carried out. In recent years, sensors based on the internal



sensitivity of a

fiber-optic laser have been extensively investigated, because the peak of its spectral resonance has been improved and its conductive ability has reached 3-dB.

The thesis research was carried out on a sensor, measuring temperature and humidity in unity, based on optical fiber in the high-level laboratory of the Center for Information Sciences and radio-photon information processing of electronic computing equipment at the College of Control of Scientific Engineering of Zhejiang University of China, according to the research plan of Kaz NTU named after K.I.Satbaev.

### **Scientific novelty in the framework of the requirements for the dissertation**

Analysis of the sensor determines the temperature and humidity, based on the internal sensitivity of the fiber-optic laser.

The following basic results were achieved in the thesis paper:

Bragg gratings are installed on the optical fiber of the unidirectional mode, the fiber cross section is closed by semi-reflective glass, and it is connected to the vacuum cavity of the FPI. In the vacuum cavity of FPI, there is an agrose gel, which is sensitive to moisture, prepared by pouring the FPI vacuum cavity into the silicon diaphragm. The cavity, the length of which is defined as  $h$ , has two front and rear reflecting surfaces, the second surface is an agrose gel, which is sensitive to moisture. With the help of the interference that appears between the light reflected from these two surfaces, it is possible to determine the change in humidity, and to control the temperature by the phase change in the spectrum that is reflected back in the FBG.

2. Analysis of the determination method for the phase shift temperature of a femtosecond laser reflected from the Bragg gratings located on a functionally varying fiber in connection with the temperature of the optical unidirectional mode.

3. Based on the practical results obtained on the basis of the abovementioned analyzes, the provision of a microdevice, measuring temperature and humidity in unity, the operation of a sensor that is immune to internal electromagnetic interference.

4. Based on the practical and actual values provided, the definition of the measuring range of the sensor measuring temperature and humidity in unity.



## **Determination of the main concepts, results, summary and conclusions of the thesis paper in publications.**

Concepts and conclusions of the main results of the thesis paper were published in publications approved by the Committee for Control in Education and Science of MH of RK: 4 scientific articles, in foreign editions: 1 scientific article, in collections of International and Republican conferences: 4 thesis reports and 1 scientific article in a leading scientific publication registered in «Scopus».

### **A foreign-appointed supervisor:**

Professor Zhi Wang

