METROLOGICAL SUPPORT ANDRATIOS OF COMPONENTS TO INCREASE THE MOISTURE SENSITIVITY OF A COMPOSITE MATERIAL WITH NANOSIZED PARTICLES

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ANNOTATION

A moisture sensor based on a composite material with nana scale structures has been developed and the main static characteristics have been studied depending on the relative humidity of the air, and are also used to measure the moisture content of agricultural products. Shown is the effectiveness of the proposed method for measuring the temperature and humidity of agricultural products. The results of experimental studies show that with an increase in the area of the regions (contact), the crystal shunts producing nana particles with a simultaneous decrease in the total porosity of the sensor material with an increase in the duration of heat treatment, which leads to an increase in the volume of the sensor with a simultaneous decrease in its passive volume. This proves the effectiveness of the application in sensors for assessing the moisture content of silicon crystals.

A humidity sensor based on a composite material with nano-sized structures has been developed and the main static characteristics depending on the relative humidity of the air have been studied, and it has also been used to measure the moisture content of agricultural products. The effectiveness of the proposed method for measuring the temperature and humidity of agricultural products is shown. The results of experimental studies show that with an increase in the area of areas (contact) of the crystal shunts producing nanoparticles with a simultaneous decrease in the total porosity of the sensor material with an increase in the duration of heat treatment, which leads to an increase in the volume of the sensor while reducing its passive volume. This proves the effectiveness of applications in sensors for assessing the moisture content of silicon crystals.

Keywords: silicon, nano size, composite material, temperature dependence, properties, stability, sensitivity, speed, technology, nano structure, humidity.

INTRODUCTION

At present, it is difficult to imagine the development of science and technology, technical means of resource saving and rational use of fuel and energy resources, as well as the successful solution of environmental problems without the use of semiconductor sensors. Existing sensors and their manufacturing technology have almost exhausted their capabilities in terms of sensitivity and speed. In this regard, scientists and developers are now faced with scientific problems of increasing the sensitivity and speed of sensors; increasing the service life of sensors; simplification of the process of operation of sensors; remote humidity measurement.

These problems are very science-intensive, including fundamental research and the development of new technological methods for manufacturing a fundamentally new class of sensors.

Based on the foregoing, it can be concluded that the development of technology and the creation of high-speed highly sensitive humidity sensors is an urgent task. One of the ways to solve this problem is to develop a technology for producing highly sensitive materials with nano-sized particles [2].

The implementation of the proposed work makes it possible to create a fundamental class of universal sensors of physical quantities with improved degradation properties and stability of parameters, low energy intensity and miniaturization, the absence of additional amplification circuits that provide ease of operation, surpassing similar existing sensors in threshold sensitivity and speed in the form of the fact that they function on the basis of fundamentally new physical phenomena. Therefore, in order to create sensors that are more sensitive, fast-acting, easy to use and do not require additional devices, it is necessary to develop fundamentally new materials and physical phenomena. In this regard, the use of silicon with nano-sized structures is of interest.

In this work, a number of studies were carried out on the selection of the composition and ratio of components to increase the moisture sensitivity of a composite material with nano-sized particles. For the manufacture of sensors, an optimal design of the moisture sensing element and a technology for manufacturing ohmic contact with stable parameters and good adhesion to the composite material were developed.

The principle of operation of sensors is based on the well-known principle of changing its electrical resistance when absorbing moisture from the environment. At the same time, unlike previously known sensors, for example, from *Liwithl* [1], solutions of electrolytic dislocation salts are not used, and the conductivity of the material has the character of jump conductivity between nano particles, which changes during adsorption of water on nano-sized conductive particles located in a porous dielectric matrix.

To assess the operating voltage range and contact stability, the current-voltage characteristic of the sensors at $T = 300\ K$ in the dark was investigated. The operating (linear) range, which tests the voltages of a unit of volts, which indicates the high sensitivity of the sensor.

Studies of the temperature dependence of the current of the sensors are carried out in the range from 293 to 363 K. The conductivity of the sensor (at a constant supply voltage of 5 V) to 253 K increases, that is, it has an activation character, then a decline begins due to drying (intensive withdrawal of moisture from the volume) of the sensor substance [2].

On the basis of humidity sensors made of composite material with conductive nano particles, a device for measuring the absolute moisture content of agricultural products has been created [3].

Below are the results of the study, i.e. the characteristics of moisture-sensitive sensors based on nano composites. The current-voltage characteristic, the temperature dependence of the sensor current, as well as the speed of the sensors to changes in air humidity are investigated. It is shown that the developed new composite material with conductive nanoparticles makes it possible to create not only sensitive, but also high-speed moisture sensors and use them in the agro industry.

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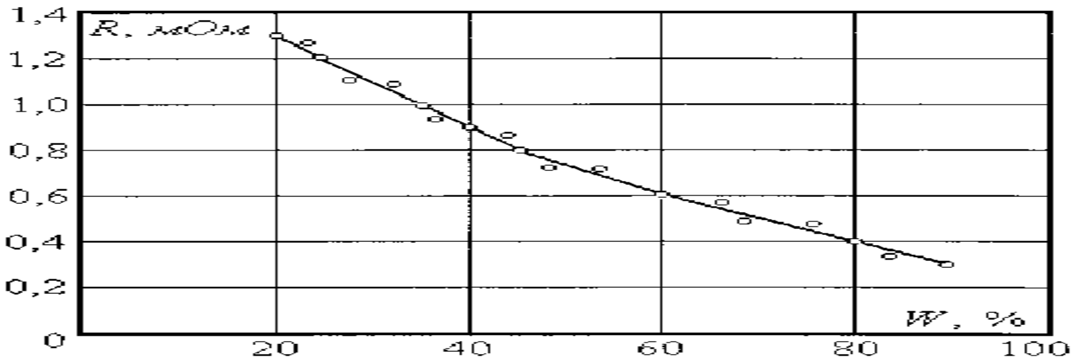

To determine the metrological characteristics of the developed sensors, a relative humidity calibration was carried out using saturated solutions of some salts, the calibration was given at a temperature of 24^0 *C*. The results of calibration of the sensor 1 of 13 batches are shown in Table 1.

Sensor calibration results Table 1

№	Salt	Relative humidity, *W*, %	Initial resistance of the dry sensor R_0, *Ω*	The resistance of the sensor located above the saturated solution, R, *Мом*
1	Хлорид магния, $Mgcl_2$	33	3,93	1,16
2	Нитрат магния, $Mg\,(NO_3)_2$	55	3,91	0,68
3	Sodium nitrate, $NaNO_2$	65	3,91	0,52
4	Sodium chloride, *NaCl*	76	3,92	0,48
5	Сульфат аммония, $(NH_4)SO_4$	81	3,39	0,32
6	Хлорид калия, *Kcl*	86	3,91	0,28

Based on the results obtained, a static characteristic of the sensor is constructed depending on the humidity (Fig. 1).

Fig.1. Static characteristic of the sensor depending on the relative humidity of the air

A study of the speed of the sensor to changes in air humidity showed that when the humidity of the air changes from 0 to 100%, the electrical resistance of the sensors changes more than three times in less than a minute, that is, the speed of the sensors is good.

Table 2 shows the characteristics of sensors obtained under the same conditions, depending on the annealing temperature of the ceramic mixture. With an increase in the annealing temperature, the sensitivity of the sensor increases significantly, therefore, the response time to changes in humidity also increases [4].

The main characteristics of measuring humidity sensors. Table 2

№	Annealing temperature of sensors, ${}^{0}C$	Dry resistance sensors, R_0, 10-6 *mΩ*	Sensor resistance at 100 % RH, R_0, 10-6 *Ω*	Response time, humidity change, *t*, *min.*
7-party	600	6,4	4,2	2
8-party	650	4,8	3,2	2
Game 9	700	5,9	3,4	2
10-party	750	4,6	1,9	1
Game 11	800	3,9	1,6	1
12-game	850	4.2	1,8	1
13-game	900	2,3	0,5	0,96

The results of experimental studies show that with an increase in the area of the "contact" regions, the crystal shunts of conductive nanoparticles with the same decrease in the total porosity of the sensor material with an increase in the duration of heat treatment, which leads to an increase in the active volume of the sensors while reducing its passive volume.

A further increase in the annealing temperature leads to an increase and deterioration in the performance of humidity sensors.

Measurement of the moisture resistance of the sensing element of the sensors from air humidity showed good sensitivity, weak nonlinearity and low temperature error of the sensors.

Thus, the humidity sensors developed by us can be used to measure not only the humidity of the air, but also the absolute humidity of some agricultural products.

LITERATURE

1. Egamberdiev, B. E., Sadiy, S. A., & Isroilov, M. R. (2021). Electron spectroscopic studies of cosi2 epitaxial films on silicon. *Journal of Physical and Mathematical Sciences*, *2*(1).

2. Murodkosimovich, I. F., Ganisherovich, B. A., & Sunnatievich, A. B. (2021). Method for determining the standard measurement error Measurement. *International Engineering Journal of Research and Development*, *6*(ICDSIIL), 5-5.

3. Egamberdiev, B., Isroilov, F., & Rahmatullaev, C. (2020). Humidity sensors based on composite material with nano-dimensional structures. *Euroasian Journal of Semiconductors Science and Engineering*, *2*(3), 36.

4. Egamberdiev, B. E., Tachilin, S. A., Toshev, A. R., Isroilov, F. M., and Dekhkanov, M. S. (2020). Investigation of the formation of clusters of gadolinium atoms in silicon. *Journal of Critical Reviews*, *7*(3), 297-301.