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Employ Property Volt - amp Movies SnO_2 to improve Sensors Combustible Gases

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Abstract

The article presents the results of a study of the current-voltage characteristics of test structures microelectronic. Gas sensors based on tin dioxide SnO_2 thin films at various temperatures in air sensitive layer in ethanol pairs.

Keywords: current-voltage characteristic, the test structure, gas sensor, tin dioxide, ethanol.

الخلاصة

خصائص دراسة نتائج المقالة هذه وتقدم الإلكترونيات اختبار لهياكل أمبير فولت أساس على الغاز الاستشعار أجهزة الدقيقة ثاني
على رقيقة الأفلام SnO_2 القصدير أكسيد حساسة طبقة في الحرارة درجات مختلف الإيثانول أزواج في للهواء.
وهيكل الجهد، لحالية السمة :البحث كلمات وثاني الغاز، الاستشعار وأجهزة اختبار، والإيثانول القصدير، أكسيد

Introduction

Currently great interest in semiconductor gas sensors based on tin dioxide. When their relative dese curvature sensors are small and sufficiently high sensitivity. The main drawback of such sensors is the necessity of heating to high temperature of about 500 °c in determining the sensitivity of the gas and the desorption gas, which limits their use for the control of flammable and explosive gases. Thus, the decrease in the maximum temperature of the gas sensitivity of micro electronic sensors gazovyavlyaetsya actual problem.

There have been attempts to measure the sensitivity of the gas using the volt-ampere haptics (CVC) [1.2] on the thin films, the goal of our work to explore the temperature hovered imosti CVC test structure microelectronic gases with platinum contacts

Experimental Procedure

Measurements of current-voltage characteristics (CVC) were carried out on test structures microelectronic gas sensors. Crystal sensor measuring 1 × 0.12 × 1 mm^3 It contains platinum tonkoplènochny heater and contacts with opposed type pin 10 micron distance from each other, on which a layer of sputtered gazochuvtvitelny SnO2 (Fig. 1) [3].

When studying CVC microelectronic gas sensors for measuring electrical parameters of the high-temperature annealing of the

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stabilizer-used setting lysis, which is a block diagram in Fig. 2.

On a stand measuring stand is placed a printed circuit board with the gas sensor, in research neè put cap dlyapolucheniya stationary experimental conditions.

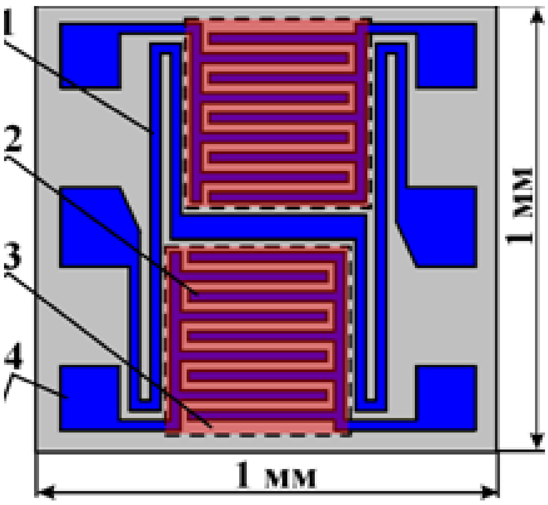

Fig. 1. Topology of the test gas crystal structure Sensor 1 - platinum meander heater,
2 – colliding but the interdigital electrodes of the sensor element, 3 - gas sensitive film of SnO2, 4 - contact pads

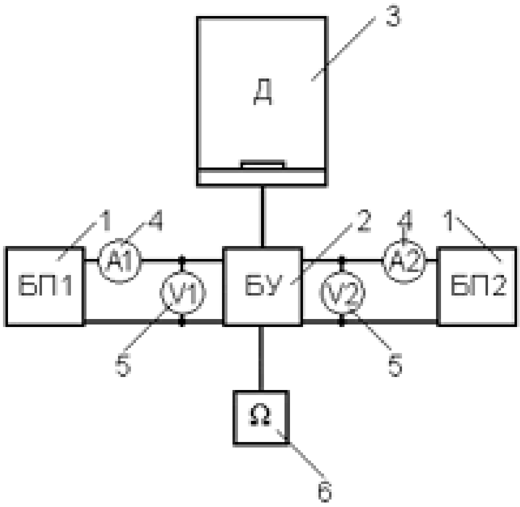

Fig. 2. Block diagram of the setup for the study of the current-voltage characteristics of the gas sensor 1 - Power Supplies; 2 - control unit; 3 - test stand 4 - ammeters; 5 - voltmeters; 6 – ohmmeter

For prolonged storage in air resistance of the sensing element increases. To return the sensor to the operating state state, it is necessary to carry out its stabilization and high-temperature desorption joke [4].

Annealing test structures gas sensors is carried out at a temperature corresponding to the operating conditions of the sensor 350 - 400 ° C, under a cap in the air. In order to heat the crystal to a temperature sensor, it is necessary to the heating element, depending on its resistance to apply a voltage of 5 V. In the annealing process was controlled by resistance sensors and sensing elements built according to the relative resistance of the sensitive elements of the time. Relative resistance – ratio current sensor resistance or sensor heater resistance measured prior to annealing in air at room temperature.

The criterion for the end of the process is the stabilization, i.e., constancy with oprotivleniya sensitive elements [5,6]. Figure 3 shows the typical dependence include itelnogo resistance test structures on the annealing time. It shows that to stabilize the electrical parameters of the sensing elements is enough 30 - 40 minutes later it was taken into account when carrying out the experiments.

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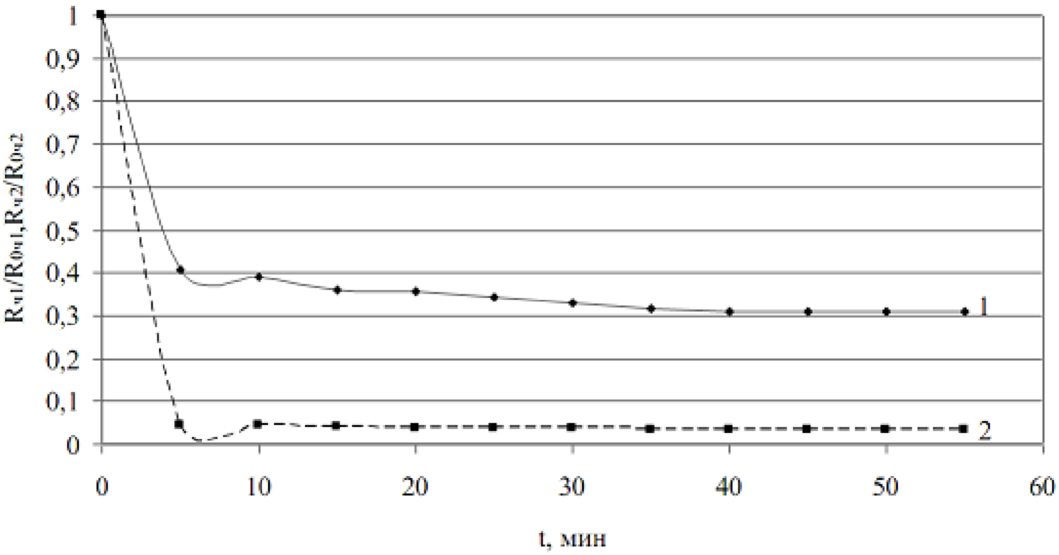

Fig. 3. Typical electrical resistance changes depending on test structures with: thermal stabilization: 1 - the first sensor; 2 - the second sensor

Results And Discussion

Research CVC studies were carried out in air and ethanol vapors (1000 ppm, 2000 ppm and 4000 ppm) at eight different temperatures: room temperature, 75 °C, 100 °C, 125, 150 °C, 175 °C, 200 °C, 225 °C C°

In Fig. 4 shows the typical current-voltage characteristics of the sensor in air and ethanol vapors (4000 ppm) at Temperature 75 0C on a heater. For other concentrations of ethanol (1000 ppm and 2,000 ppm) curves are similar in nature and differ only in the amount of current through the sensing element

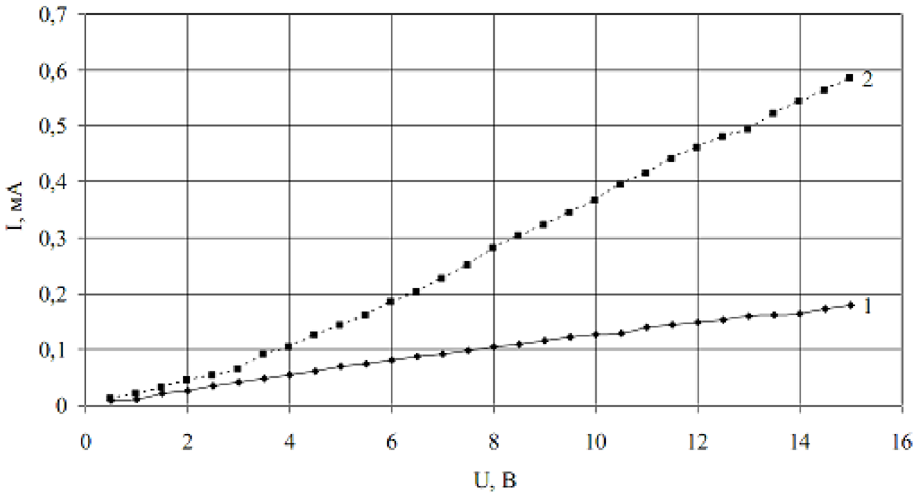

Fig. 4. The current-voltage characteristic of the sensor at T = 75 ºC: 1 - in the air; 2 - in pairs ethanol (4000 ppm)

From Fig. 4 shows the sensor response to the presence of ethanol in the air at a temperature of 75 0C. The same dependence observed for the other concentrations in the whole range of temperatures studied, but at different temperatures, the degree of sensitivity of the sensor to ethanol varies, with the greatest differences are observed in all plots at 15 V. For the compilation and analysis of experimental data typical dependencies, the same as in Fig. 4, and similar data obtained with other concentrations of ethanol in air (1000 ppm and 2000 ppm), according to the formula S = Ichg / Ichv (where Ichg - current sensing element in the presence of gas Ichv - current the sensor in the air), the relative sensitivity of the gas for all temperature values were calculated at 15 as a result of plots include itelnoy gas chuvstvitelnos minute the temperature (Fig. 5) were constructed.

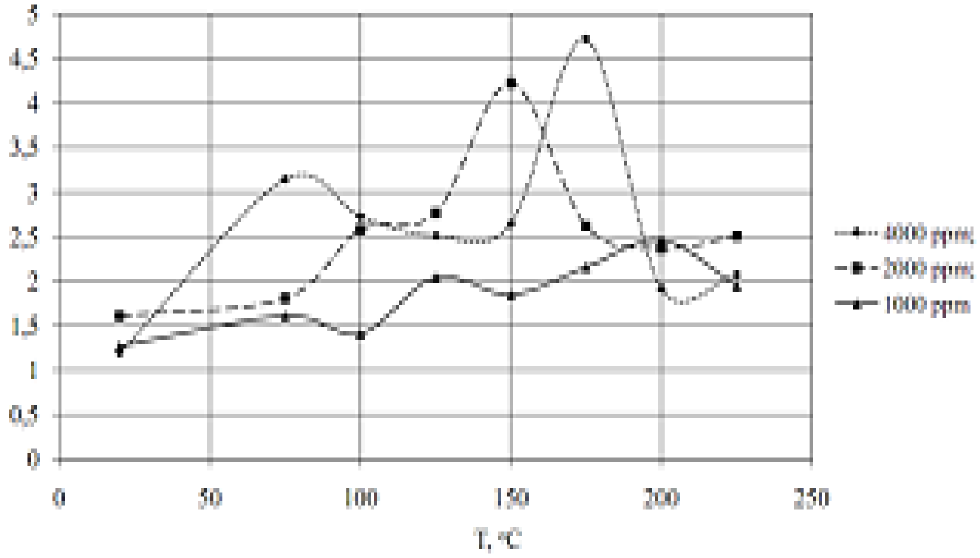

Fig. 5. Dependence of the relative sensitivity of the test structures of gas-gas sensors to ethanol on temperature, provided the flow of current through the sensing element

From Fig. 5 shows that for all the studied concentrations of ethanol in the air gas maximum sensitivity is observed in the range of from 150 to 200 ° C, and it increases with increasing gas concentration. However, from the literature it is known that under normal conditions the maximum gas temperature sensitive thin film gas sensors to ethanol of about 400 ° C [4,7,8,9], ie we were able to take a big step on the way to maximum temperature reduction gas sensitive semiconductor gas sensors to enhance consumer market, increased lifetime and efficient in their use, in terms of energy consumption, of portable gas indicators. In Fig. 6 shows the dependence of the maximum gas sensitivity of the ethanol concentration in the air.

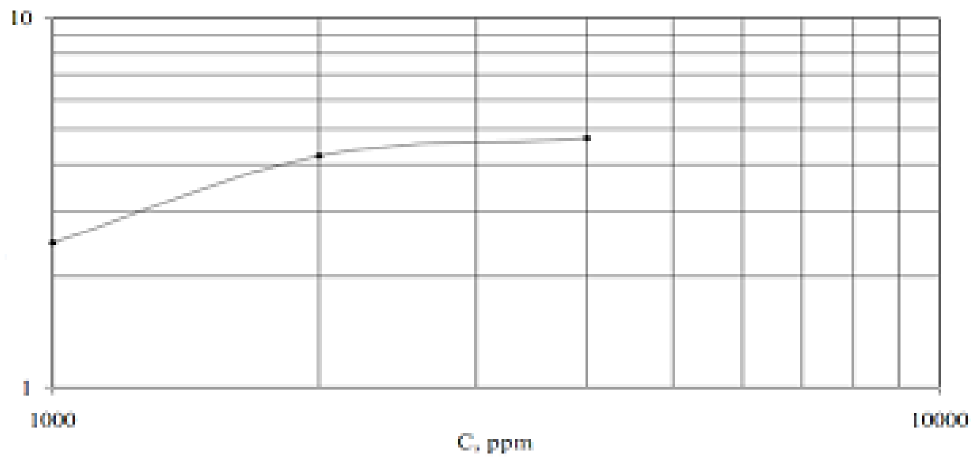

Fig. 6. Relative gas sensitivity test structures of gas sensors concation ethanol provided in the air current flowing through the sensor element

From Fig. 6 shows that the quantity is sufficient sensitivity for use in a gas sensor device signaling schemes without additional reinforcement. Also it should be noted that the dependence of the relative sensitivity of the gas sensor test structures ethanol concentration of gases in the air flow provided by current sensor has a fairly sharp angle that will allow use of such devices in precise devices capable of measuring small concentrations of gases

Conclusions

1) Because of this work, the following conclusions:

2) Current-voltage characteristics of the sensor elements for different temperatures of the crystal in air and in the presence of ethanol vapor in air are the same and differ only the amount of current flowing through the sensing element

3) Gas Maximum sensitivity occurs in the temperature range 150 - 200 ° C, which is two times less than the supply voltage without the sensing element, and it increases with increasing ethanol concentration.

4) The dependence of gas sensitivity of the test structures on the ethanol concentration in the air under the condition of current flow through the sensor has a clear angle, allowing to use this way to reduce the maximum temperature of the gas sensitivity vtochnyh devices that can detect small concentrations of gases in the air.

5) For the various concentrations of ethanol in the air gas maximum sensitivity is observed in the range of 150 - 200 ^{0}C

6) The value of the maximum gas sensitivity varies from 2.5 to 4.7, and is sufficient to use the sensor in a hazardous gas alarm devices without additional reinforcement schemes

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