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Study on the Influence Violet Light Gas Sensitivity Sensors Based on Sno_2

[1]**Wasfi. Mohammed . Kadem**
Lecturer
[2]**Shaymaa M. Mostafa**
Senior biologist
[1,2] Science Department, College Of Basic Education ,Diyala University, Iraq

Abstract

The article presents the results of studies of the effect of light purple low-power LEDs on the magnitude of the response of the gas under the influence of films SnO_2 gas-reducing acetone, ethyl alcohol and isopropyl alcohol.

Keywords: electrical resistivity, violet light, gas sensitivity, touch, film

Introduction

Active effect of light in the fundamental absorption on the electrical sensor elements, as well as previously performed experiments [1, 2, 3, 4, 5] allow the expected increase in gas sensor response when illuminated with violet light

Exposure violet light resistance sensing element [6] reduces the electrical resistance by nearly 25% due to the generation of nonequilibrium charge carriers (Fig. 1). Duration achieve the lowest value of resistance (τ_{1ef}) is about 5 minutes of slow relaxation τ_{2ef} = 25 min and relaxation after lights τ_{3ef} = 30 minutes. It should be noted that after turning off the light resistance is not returned to baseline values

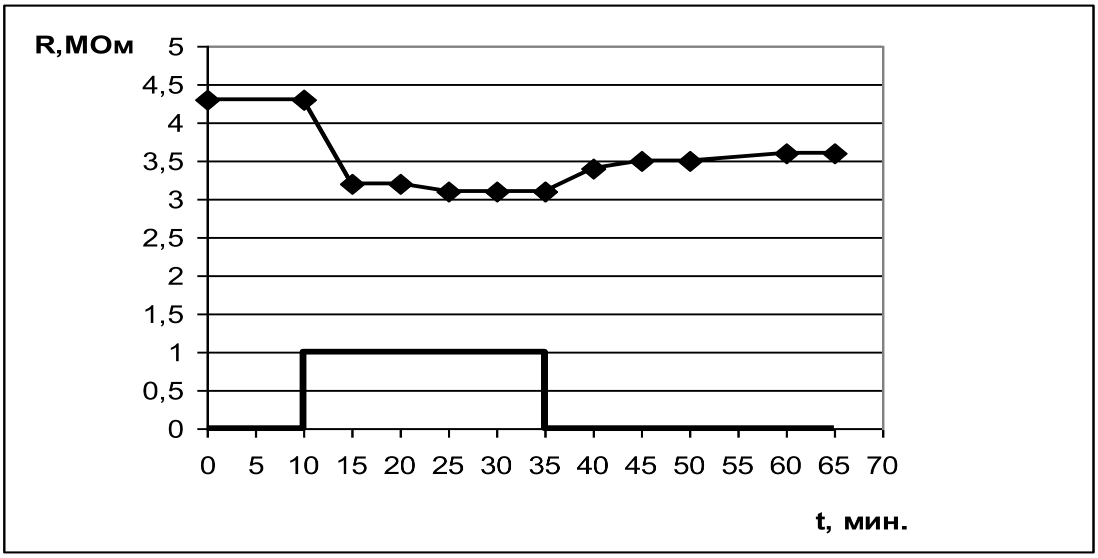

Fig. 1. The nature of the change in resistance sensing element (1) under the action of light pulses purple LED (2).

With simultaneous interaction with the gas, and light can be recharged SnO_2 film surface state under the influence of light, which may lead to changes in the gas sensitivity. Therefore, it was investigated the variation of the resistance elements sensitive gas sensors in interaction with pairs of different substances in the air under the action violet radiation. LED brand ALR2-513UVC, with a wavelength of 407 nm and a power of 76 mW of radiation was located at a distance of 2 mm from the surface of the sensor element. We investigated the sensitivity of gas sensors gas test structures to vapors of ethyl, isopropyl alcohol and acetone in air at temperatures of 20 - 400 °C. To change the temperature sensors on the heater to a voltage of 1 to 5 V. datchka temperature was controlled by the resistance heating element. Typical temperature dependence of the resistance on the temperature of the heater is shown in Fig. 2. The resistance *heater at room temperature is Rd = 22.3 ohms*

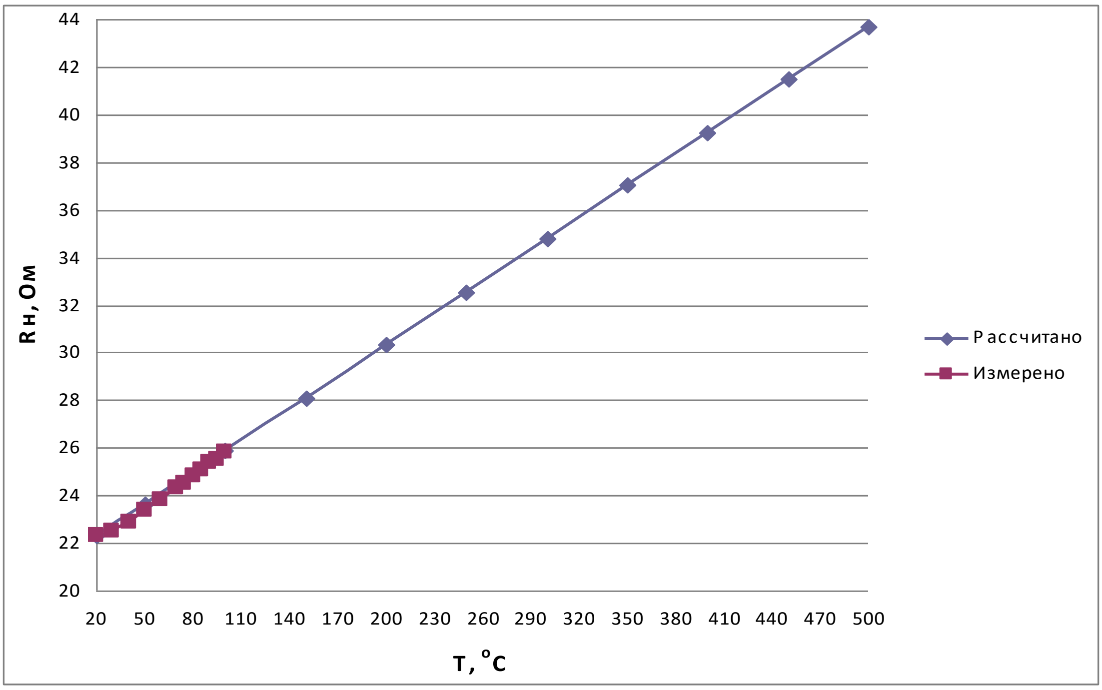

Fig. 2. The dependence of the resistance heater temperature test structures for gas sensors [7]

The results of experimental measurements and calculated values are shown in Table From the linear dependence of R = *f* (T) calculates the value of the temperature coefficient of resistance (TCR) according to the formula

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U_H,B	I_H,Ma	R_H,Ом	T,˚C
0	0	22,3	20
1	26,7	23,638	50
1,5	39,1	25,868	100
2	49,6	28,098	150
2,5	59,7	30,328	200
3	68,8	32,558	250
3,5	75,8	34,788	300
4	81,9	37,018	350
4,5	88,5	39,248	400
5	93,4	41,478	450
5,5	104,3	43,708	500

(T) = Ro (1 +α ΔT)
where Ro - resistance heater at room temperature To
R (T) - T resistance at elevated temperatures
Δ T = T - To - temperature change
The value of TCS was α = 0,002 1 / K

The temperature dependence of the resistance heater at different values of the external voltage. The temperature dependence of the sensitivity of the gas sensor element of the sensor to the gas vapors of ethyl alcohol in the air, as well as optical radiation in the presence of ethyl alcohol are shown in Fig. 3 [8]. It is found that the maximum gas sensitivity to ethanol vapor in air (1700 ppm) without exposure to light is observed at a temperature of 330 °C and 1.8 RLU The irradiation test structure violet light temperature of maximum sensitivity of the gas is reduced to 290 ° C. The value of the gas sensitivity is 6 relative units, as well as a peak appears more sensitivity at 130 ° magnitude 4.8 RLU Thus, the effect of violet light increases the sensitivity of the gas main peak 3 times and reduces the temperature of the maximum gas sensitivity at 40 ° C. Peak more sensitivity to ethanol at 130 ° C can be used for low-temperature measurement of ethanol in air at light exposure.

The temperature dependence of the sensitivity of the gas sensor element to the gas sensor isopropyl alcohol vapor in the air, as well as optical effects in the presence of isopropyl alcohol are shown in Fig. 4

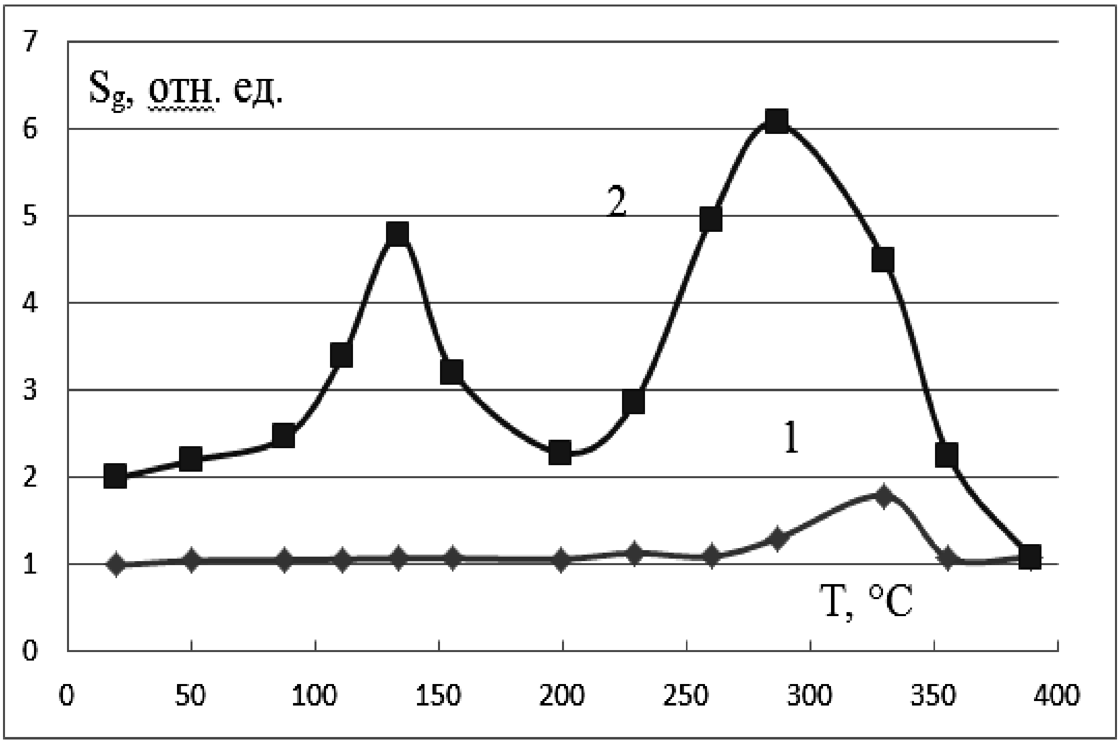

Fig. 3. The temperature dependence of the sensitivity of the gas sensor element to vapors of ethyl alcohol (1700 ppm) in air at an irradiation with violet light (1) without illumination (2).

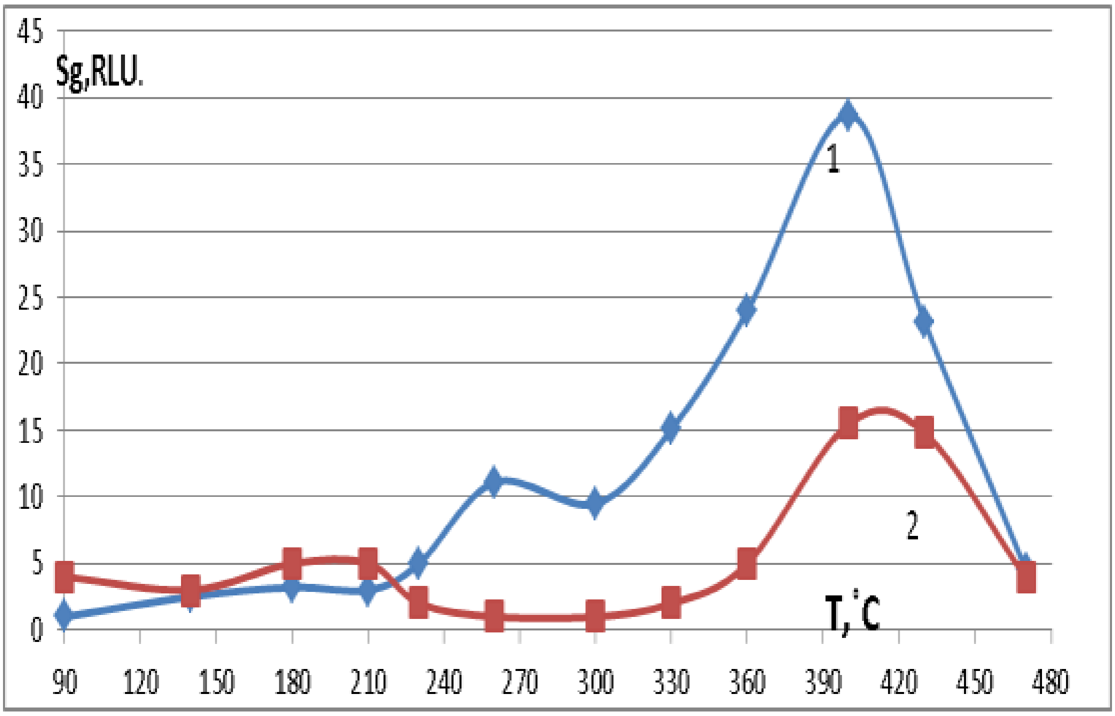

Fig. 4. Temperature dependence of gas sensitivity of the sensor element to the gas sensor pairs isopropyl alcohol (1300 ppm) in air at an irradiation with violet light (1) without illumination (2)

Maximum sensitivity of the gas sensor element of the sensor to the gas vapors of isopropyl alcohol (1300 ppm) in air with no exposure to light is observed at a temperature of 400 ° C and 15.5 relative units The irradiation test structure violet light temperature of maximum gas sensitivity decreases by 10 ° C, and the amount of gas sensitivity increased to 38.7 rel. U., and a peak appears more sensitive at 260 ° C value of 11.1 RLU In this case, the quantity of gas sensitivity while covering the main peak increases more than two times. Secondary peak at 260 ° C can also be used for the determination of propanol in air when exposed to light by the gas sensor.

The temperature dependence of the sensitivity of the gas sensor element to the gas sensor acetone vapors in the air, as well as an optical exposure in the presence of acetone are presented in Fig. 5. The maximum gas sensitivity to acetone vapors (1700 ppm) in air with no exposure to light is observed at a temperature of 360 ° C and 7.4 rel. u The irradiation test structure LED temperature maximum gas sensitivity is practically unchanged, the amount of gas sensitivity is 10.1 relative units, as well as a peak sensitivity at a temperature of more 136 ° C, the magnitude of 8.6 relative units

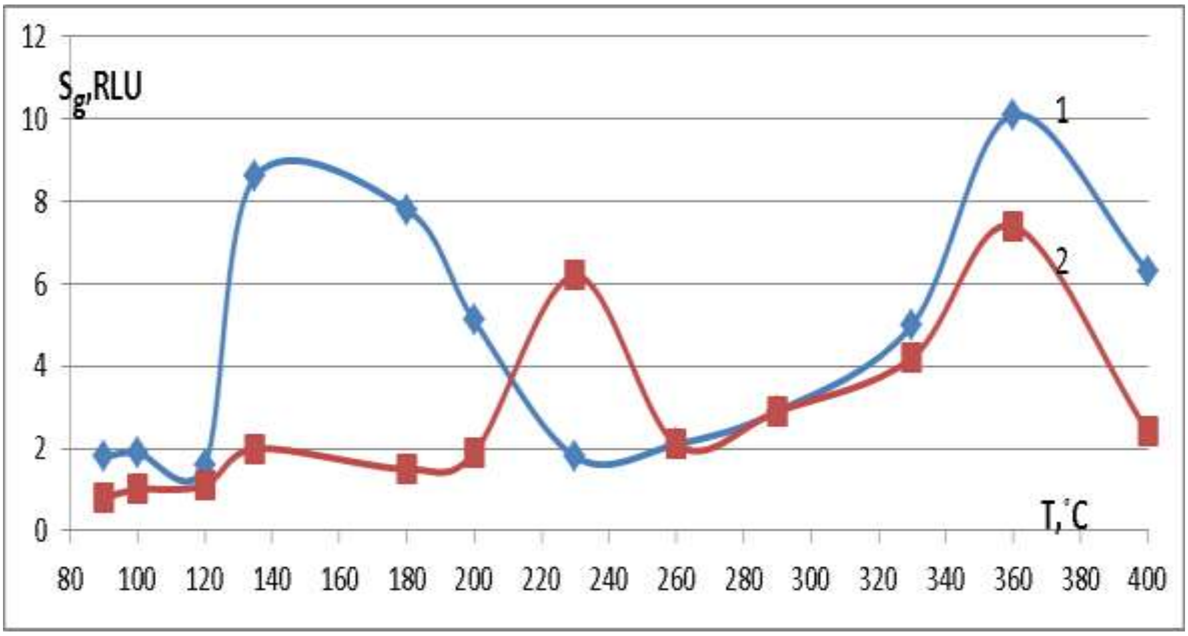

Fig. 5. Temperature dependence of gas sensitivity of the sensor element to the gas sensor pairs acetone (1700 ppm) in air at an irradiation with violet light (1) without illumination (2)

Thus, in all the experiments carried out, the effect of light gas increases sensitivity to vapors of ethyl, isopropyl alcohol and acetone in the main peak is 1.5 - 3 times. The temperature of the maximum sensitivity of the gas is reduced by 10 - 40 ° C, or does not change (acetone). Also, at lower temperatures of 130 - 260 ° C, an additional gas peak sensitivity values are comparable or superior to the sensitivity of the sensor to a corresponding gas without lighting. The advent of low-temperature gas sensitivity peak indicates that light photons activate new mechanisms gas sensitivity absent in the non-illuminated samples. Such mechanisms can be attributed directly to the interaction of light with charged surface states, such as oxygen vacancies and their activation, and low-temperature interaction of light with molecules of controlled gases. For additional peak temperature of maximum sensitivity of the gas sensor to ethyl alcohol and isopropyl alcohol and acetone is 2 - 3 times lower than the temperature of maximum sensitivity for the same gas, but in the absence of light exposure on the surface of the sensor. These additional peaks can also be used for monitoring air quality at lower temperatures, resulting in lower power consumption of gas sensors.

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