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Increased Selectivity of Sensors based on Sno_2 to Couple Alcohol in the Air

[1]**Wasfi. Mohammed . Kadem**
Lecturer
[2]**Nawar Thamer Mohammed**
Assistant Lecturer

[1,2] Science Department, College Of Basic Education ,Diyala University, Iraq

Abstract

The increase in the gas sensor sensitivity is obtained by doping gas sensing elements based on doped SnO_2 by impregnating Pd. For personnel life safety in chemical, mining, metallurgical and other facilities, as well as in everyday life and for environmental monitoring, it is necessary to use sensors toxic and explosive gases. Such devices should provide a selective response to certain components of the gaseous medium which shaws highly reliable and reproducible results. Touch elements of such systems must have the highest possible sensitivity, selectivity, stability properties and processability in production. In case of burglar, alarm and gas detectors must also have miniature for stealth, low power consumption to increase battery life and resistance to mechanical stress. The presence of these devices, such as sensors of gas leakage in every house increases the safety of human life.

لزوجين الكحول في الهواءSnO_2أساس
كلية التربية /جامعة ديالى /مدرس / وصفي محمد كاظم
قسم العلوم/الاساسية
الخلاصة

يتم الحصول على زيادة في حساسية استشعار الغاز عن طريق المنشطات عناصر الاستشعار الغاز على أساس SnO_2 مخدر عن طريق تشريب بالشلل الرعاش. لسلامة حياة العاملين في الصناعات الكيميائية والتعدين والمرافق التعدينية وغيرها، وكذلك في الحياة اليومية والرصد البيئي، فمن الضروري استخدام أجهزة استشعار للغازات السامة والمتفجرة. وينبغي أن توفر مثل هذه الأجهزة ردا انتقائية لبعض مكونات الوسط الغازي نتائج موثوق بها للغاية وقابلة للتكرار. تلمس عناصر هذه الأنظمة يجب أن يكون على أعلى درجة ممكنة حساسية والانتقائية، خصائص الاستقرار وللتجهيز في الإنتاج. في حالة السرقة، يجب أن يكون كشف عن التنبيه والغاز أيضا مصغر بطريقة سرية ، وانخفاض استهلاك الطاقة لزيادة عمر البطارية ومقاومة للإجهاد. وجود هذه الأجهزة، مثل أجهزة استشعار تسرب الغاز في كل بيت يزيد من سلامة حياة الإنسان0

Introduction

The disadvantage of the existing solid-state gas sensors is their low selectivity in the recognition of different gases and the need to operate at high temperatures. Solving these problems can be controlled by the activation of the processes of interaction with the system-controlled gas surface states of the semiconductor sensor film(for example, SnO_2)due to her doping-catalysts. [1]

The aim is to increase the selectivity of the sensor based on SnO_2 for couples with alcohol films, surface alloyed with palladium.The researchen investigated the semiconductor gas sensor manufactured by microelectronic technology, one containing a heater and two sensors based on SnO_2 films. The silicon substrate in this design has a span-ry $1{,}0 \times 1{,}0 \times 0{,}12$ mm^3. The thickness of the gas-sensitive film 250 nm [2].

Palladium is used as a catalyst in chemical reactions, which improves the selectivity to a specific gas, namely, to the pairs of ethanol. For doping samples were prepared of 3 mM - 12 mM solutions of $PdCl_2$ + H_2O and placed in special containers. Before applying the impurity gas sensors previously annealed at a temperature 450˚C for removing absorbed molecules from the surface of the semiconductor. Local doping solution of palladium chloride was achieved by the impregnation of a surface of the sensor microdroplets solution controlled microscope MBS-1 to 56-fold increase, followed by drying in air at room temperature for 30 minutes, and heating the admixture at a temperature of 350 ° C for 60 minutes. The second sensor element was left undoped and used as comparative characteristics.

Experimental details

Gas sensitivity Sg doped sample was defined as the ratio of the resistance of the film in air (RB), the resistance of the film at puffing into the measuring chamber volume of 10 liters of known concentration test gas (Rg): Sg = RB / Rg. The resistance of the films was measured by the firm Mastech multimeters series MY64. The concentration of ammonia gas was determined by controlled dilution. The basis of his supposed equation Mendeleev-Clapeyron, namely the conversion of concentration of a substance from a liquid to gaseous state [3-5].

Results and discussions

The influence of dopant concentration of palladium in the film resistance SnO_2. Figure 1 shows the change in resistance of the SnO_2 film dopant concentration at room temperature. The dependence is linear

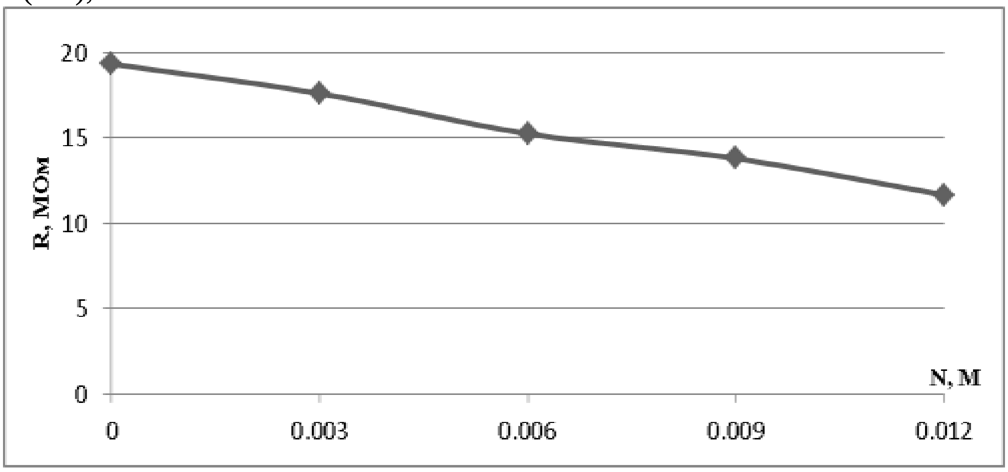

Figure 1 - The dependence of the resistance change SnO_2 film of dopant concentration of palladium at room temperature

Dependence of gas sensitivity of SnO_2 film gas sensor from the dopant concentration is shown in Figure 2. It was found that the admixture of palladium has a significant impact on improving the sensitivity of the sensor (30 times) until the concentration of the dopant solution of 6 mM. The subsequent increase in the amount of impurities Pd reduces sensitivity.

Thus, when the three doping mM sodium sensitivity of Sg = 50 RLU, the subsequent deposition of palladium to 6 mM solution - Sg = 100 RLU at 9 mM - Sg = 7.22 RLU, while at 12 Sg = 1.6 mM RLU Dependence has the character of a similar nature, depending upon doping silver discussed earlier [3-7].

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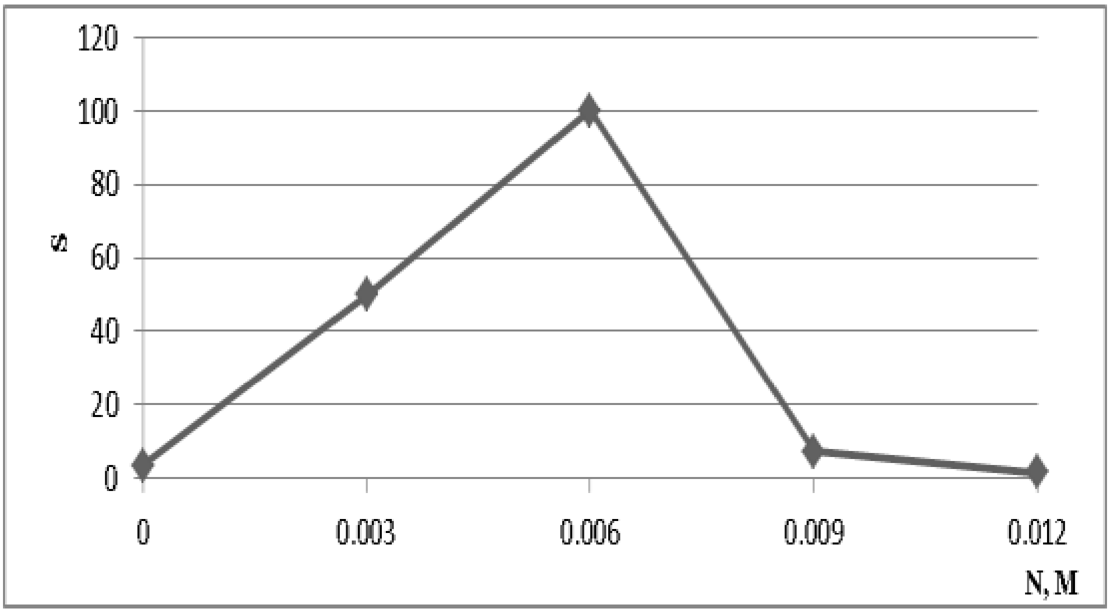

Figure 2 - The dependence of the sensitivity of the film SnO_2 gas sensor from the dopant concentration of palladium in ethanol vapor Cs = 3000 ppm at a temperature

Effect of alloying 3 - 12 mM sodium Pd-SnO_2 sensor layer was investigated in the temperature range 25 - 450 ° C in the vapor alcohol with Cs = concentration of 3000 ppm. Figure 3 shows the results of measurements of gas sensitivity to ethyl alcohol sensor layers SnO_2, doped with different amounts of Pd.

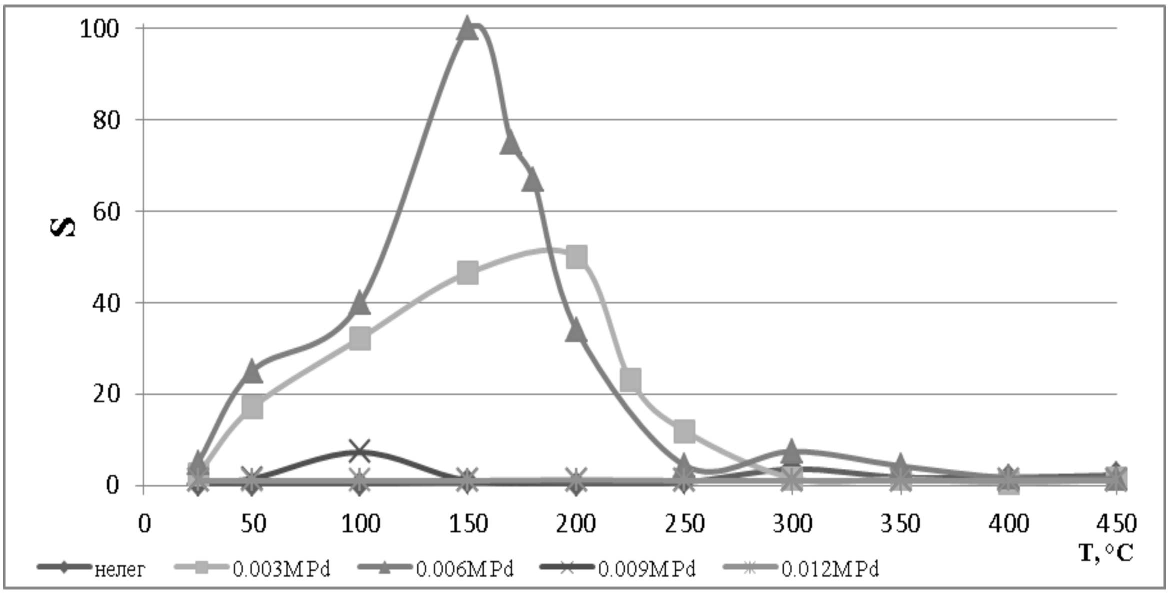

Figure 3 - The temperature dependence of the sensitivity of the gas sensor, with the SE-doped palladium to alcohol vapors 3000 ppm in air

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It was found that the samples doped with 3 mM of 6 mm and have the greatest sensitivity to alcohol vapors S = 50 rel. u and S = 100 rel. u respectively (Figure 3). The concentration of Pd, of 6 mm, as in the case of silver, is optimal when doped SnO_2 films. The sensitivity of the doped samples to alcohol has increased, as shown in the graph, and, in addition, the operating temperature sensor decreased. Not doped SnO2 film exhibit maximum sensitivity to alcohol S = 3,53 rel. u at a temperature of 300 ° C, whereas 6 mM palladium alloy have S = 100 rel. u at 150 ° C. It should be noted that the sensor sensitive element with doped begins to react to alcohol vapors already at 100 ° C, and alloyed at 200 ° C.

Conclusions

The study developsd a method of impregnating a sensory doping SnO_2 layers in microelectronic gas sensors. It has been found that the dopant $PdCl_2$ can lower the temperature from 350 ° C to 50 ° C and increase the sensitivity of about 30 times. Thus, Pd doping SnO_2 layers of touch sensors in the gas can improve metrological characteristics (sensitivity, selectivity, power consumption) of the samples and make them a promising material for creating a selective indicator of toxic and explosive gases.

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