родным участием), Минск, 31 января – 12 февраля 2022 г. [Электронный ресурс] / БГТУ. – отв. за издание И. В. Войтов; УО «БГТУ». – Минск: 2022. – С. 171–173.
6. Raman- and infrared active phonons in $YBaCuFeO_5$: experimental and lattice dynamics / Y. K. Atanassova [et al.] // Phys Rev B. – 1993. – Vol. 47. – P. 15201–15207.

UDC 546.87’725:538.9

A.A. Glinskaya, PhD (Chemistry), senior lecturer (BSTU, Minsk);
G.S. Petrov, PhD (Chemistry), associate professor (BSTU, Minsk);
N.N. Lubinskii, PhD (Chemistry), associate professor (BSATU, Minsk);
I.A. Vialikanava, PhD (Chemistry), associate professor (BSTU, Minsk)

ON THE NONMONOTONOUS CHANGE OF SENSOR PROPERTIES OF SOLID SOLUTIONS $Bi_{1-x}La_xFe_{1-x}Co_xO_3$ BASED ON BISMUTH FERRITE $BiFeO_3$

It is known that bismuth ferrites ($BiFeO_3$, $Bi_2Fe_4O_9$), which are multiferroics, also have good sensor properties [1–2]. The most studied are individual (unsubstituted) ferrites, while solid solutions based on them are studied less often. At the same time, the literature data on the dependence of the physicochemical properties of solid solutions on various factors are often quite contradictory.

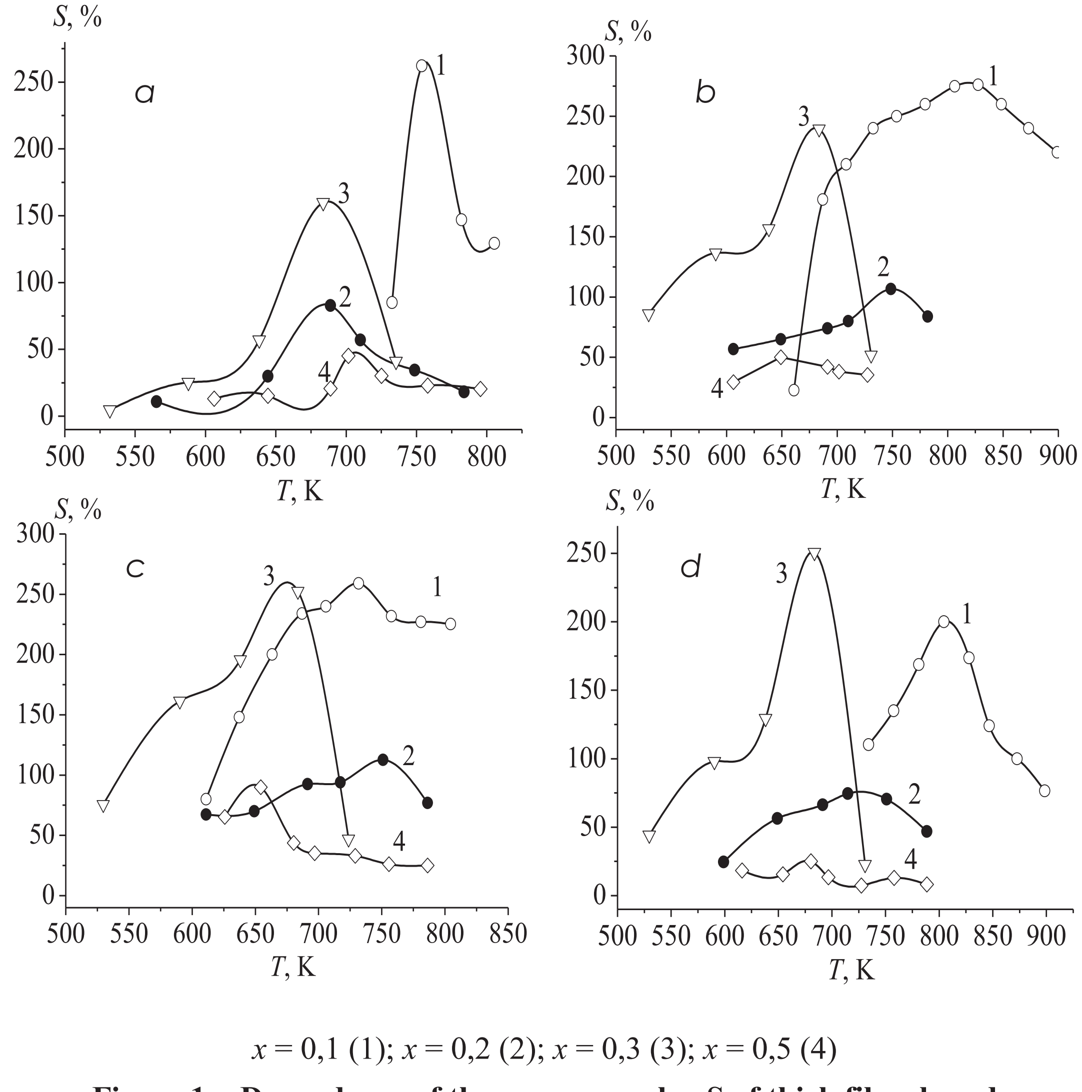
The aim of this work is to study the dependence of the sensory properties of $Bi_{1-x}La_xFe_{1-x}Co_xO_3$ (x =0,1; 0,2; 0,3; 0,5) solid solutions based on bismuth ferrite $BiFeO_3$ on temperature and the degree of substitution x. The study was carried out on thick-film $Bi_{1-x}La_xFe_{1-x}Co_xO_3$ samples. Synthesis of solid solutions was carried out by the ceramic method in air at 800°C from oxide powders (Bi_2O_3, La_2O_3, Fe_2O_3, Co_3O_4) of high purity. La_2O_3 was preliminarily calcined in air at temperature of 1000°C. From the synthesized powders of bismuth ferrites, thick films (layers) of the appropriate composition were obtained by screen printing, deposited on substrates of titanate - lanthanum - calcium zirconate, which had a similar coefficient of thermal linear expansion with the applied materials. Selection of substrates with a similar coefficient of linear thermal expansion is necessary to prevent cracking and destruction of the film (at heating – cooling) due to different thermal expansion of the film and substrate. From powders of bismuth ferrites carefully ground in ethanol, a mass was prepared, which was deposited on substrates. Then the substrates were dried in air at room temperature and then sintered in air at 1073 K for 2 hours. Silver contacts were deposited on the resulting films (from a suspension of silver in isoamyl acetate).

The sensor properties of thick-film samples (their thickness did not exceed 0,5 mm) were evaluated from the change in the electrical resistance of the films in air (R_{air}) and in air containing a certain amount of vapors of various substances (R_{gas}):

$$S = \frac{R_{gas} - R_{air}}{R_{air}} \cdot 100\%$$

When studying the dependence of *S* on *x* and on temperature, the same values of the vapor content of each of the substances in the air were taken.

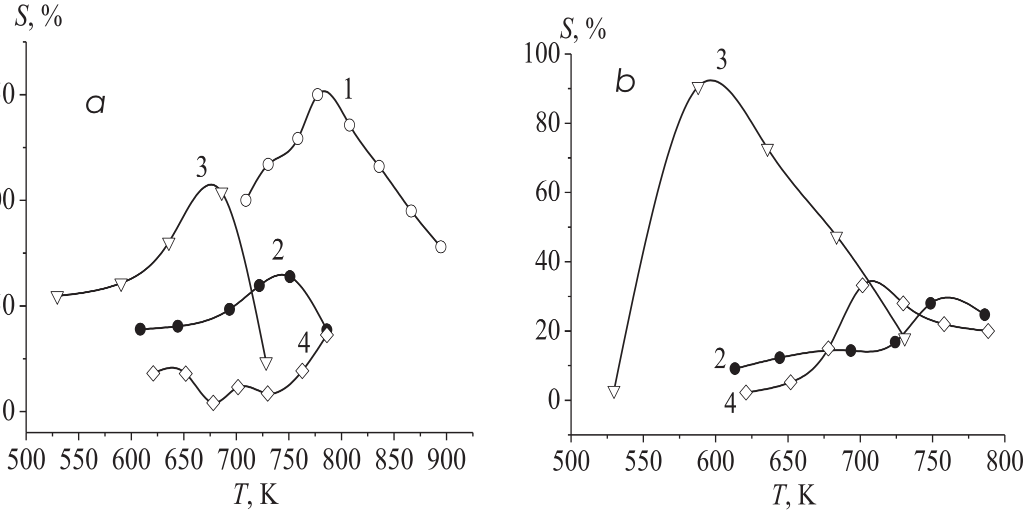
The results of the study of the sensor properties (sensitivity *S*) of thick-film samples of bismuth, lanthanum cobaltite ferrites $Bi_{1-x}La_xFe_{1-x}Co_xO_3$ with (x = 0,1; 0,2; 0,3; 0,5) for the content of ethanol, butanol, acetone, diethyl ether, gasoline, ethylenediamine vapors in the air depending on the temperature are shown in Figures 1, 2.



x = 0,1 (1); x = 0,2 (2); x = 0,3 (3); x = 0,5 (4)

Figure 1 – Dependence of the response value S of thick films based on $Bi_{1-x}La_xFe_{1-x}Co_xO_3$ with (x = 0,1; 0,2; 0,3; 0,5) on temperature to gasoline (*a*), acetone (*b*), diethyl ether (*c*), ethanol (*d*) vapors in the air

From fig. 1 and 2, it can be seen that the dependence of *S* on the temperature and composition of the ferrite (*x* value) is nonmonotonic. The maximum sensitivity (*S*) for most samples is observed at temperatures of 650–750 K, which is close to the Curie temperature for $BiFeO_3$ ferrite.



x =0,1(1); *x* = 0,2 (2); *x* = 0,3 (3); *x* = 0,5 (4)

Figure 2 – Dependence of the response value *S* of thick films based on $Bi_{1-x}La_xFe_{1-x}Co_xO_3$ with (*x* = 0,1; 0,2; 0,3; 0,5) on temperature to butanol (*a*), ethylenediamine (*b*) vapors in the air

The samples show maximum sensitivity (250–300 %) in relation to the content of acetone, diethyl ether and ethanol vapors in the air.

The data obtained may be used for development of gas sensors based on the above solid solutions.

LITERATURE

1. Barrios Ó., Jiménez R., Ricote J., Tartaj P., Calzada M. L., Bretos Í. A Sustainable Self-Induced Solution Seeding Approach for Multipurpose $BiFeO_3$ Active Layers in Flexible Electronic Devices // Advanced Functional Materials. – 2022. – 2112944.

2. Catalan G., Scott J. F. Physics and applications of bismuth ferrite // Advanced materials. – 2009. – Vol. 21(24). – P. 2463–2485.