SENSING PROPERTIES OF SOLID SOLUTIONS $Bi_{1-x}La_xFe_{1-x}Ga_xO_3$

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Multiferroics attract attention due to the possibility of their use in various technological applications (magnetic field sensors, magnetic memory devices, spintronics, etc.), and as object for fundamental researches. $BiFeO_3$ is the most known multiferroic with high values of the Neel (T_N = 643 K) and the ferroelectric Curie (T_c = 1083 K) temperatures **[1]**. Partial substitution of bismuth and iron allows smooth regulation of the properties of substituted ferrites.

In this work, we synthesized and investigated the sensing properties of $Bi_{1-x}La_xFe_{1-x}Ga_xO_3$ (x = 0, 0.05, 0.1) solid solutions prepared by the solid-state reactions method from the corresponding oxides of high purity. Sensing properties were determined using sintered thick-film samples on ceramic substrates. Gas-sensitive element (layer) of the sensor usually had 5 – 7 mm width, 10 – 12 mm length. Its thickness didn't exceed 0.5 mm. Sensing properties were assessed by the difference in electrical resistances of sensors measured in air (R_{air}) and in air containing a certain amount of vapors of the corresponding substances (R_{gas}): $S = 100\% \cdot (R_{gas} - R_{air})/R_{air}$.

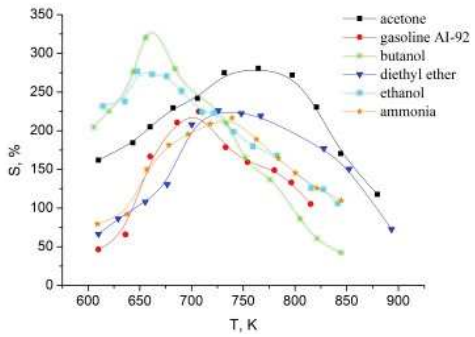

Figure 1. Temperature dependence of the response of a thick film based on $Bi_{0.9}La_{0.1}Fe_{0.9}Ga_{0.1}O_3$ in vapors of various substances.

The sensor properties of the samples were investigated for the content of ethanol, butanol, acetone, diethyl ether, AI-92 gasoline, ammonia in the air. The obtained temperature dependences of the response to the vapor content in the air had pronounced maxima in the range 650 – 750 K **(Figure 1)**, which are close to the Neel temperature and correspond to the transition of the antiferromagnetic phase to the paramagnetic one. The maximum values of the response S to vapors of various substances were observed for a sample with x = 0.1 and varied from ~ 50 to 330 % at vapor concentrations in air up to 25000 ppm. $BiFeO_3$ films had the lowest sensitivity.

The results obtained indicate the possibility of using solid solutions $Bi_{1-x}La_xFe_{1-x}Ga_xO_3$ as materials for the manufacture of gas sensors.

References

[1] G. Catalan, J. F. Scott. Adv. Mater., 2009, 21, 2463-2485.