

THE INFLUENCE OF BIOLOGICAL ENVIRONMENTS ON THE PROPERTIES OF NANOSTRUCTURED FILMS SnO₂

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Currently, the most practical use as a sensitive material for gas sensors of the resistive type find of nanocrystalline oxides SnO₂ and In₂O₃. The signal of the gas sensor of the resistive type is an integral value that corresponds to content in the atmosphere of various gases as oxidizing agents and reducing agents. The greatest sensitivity of the electrical properties and reactivity of oxide semiconductor materials to change the microstructure of their surface should be expected for nanocrystalline oxide as SnO₂.

In our work the films were obtained using Sol-gel method using polyvinyl acetate (PVA) as structuring substances and dichloroacetylene tin (DCAT) as a precursor.

The temperature dependence of dark current measured in vacuum, is induced by activation. In the process of heating in the low temperature region the current flow is controlled by donor levels with ionization energy (0,21 – 0,26) eV, they are doubly ionized oxygen vacancies V_O⁺⁺ in the amount of SnO₂¹. When the temperature of the sample (110-115) °C there is a sharp kink on the curve and, as a further increase in temperature the current increases with the activation energy E_a = (0,65 – 0,73) eV. This area can be associated with desorption of water molecules from the surface of the SnO₂ film².

The behavior of dark current curves measured in air (Fig. 1) in the region of temperatures up to +150°C have a little difference from curves measured in vacuum. However, in the region of higher temperatures (150°C - 220°C) on the curves of the temperature dependence of the current appears steep sections with activation energy (1,0 - 1,4) eV.

Perhaps these areas are determined by the processes of dissociative adsorption of water on the surface layers of tin dioxide³.

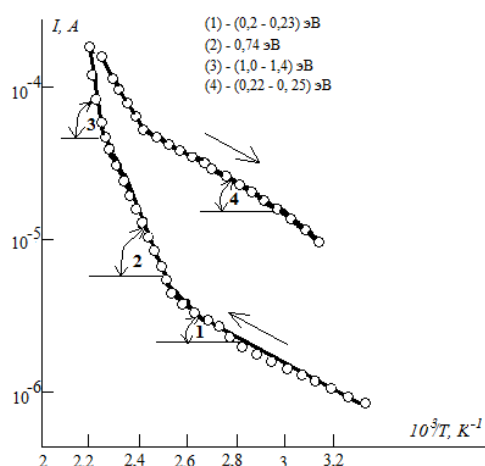


Fig. 1. The temperature dependence of dark current of the SnO₂ films measured in air (V = 500 B).

Conclusions

The temperature dependence of dark current in the region of low temperatures (in vacuum and in air) is determined by the donor with the ionization energy (0,21 - 0,26) eV. These are doubly ionized oxygen vacancies $V_{O^{++}}$ in the volume of the tin dioxide films.

References

1. *Fonstad C.G., Rediker R.H.* Electrical properties of high quality stannic oxide crystals. - Journal of Applied Physics, 2003, Vol.42, № 7, P.2911-2918.
2. *Kalinina M.V. et al.* Temperature dependence of the resistivity for metal-oxide semiconductors based on tin dioxide. - Glass physics and chemistry, 2003, Vol.29, № 4, P. 422-427
3. *Гаман В.И., Севастьянов Е.Ю., Максимова Н.К., Алмаев А.В., Сергейченко Н.В.* Характеристики резистивных полупроводниковых сенсоров водорода при работе в режиме термоциклирования. – Известия ВУЗов, Физика, 2013, Т.56, № 12, с. 96-102.