Electrical characteristics of nanosized ZnO films obtained using polyvinyl alcohol in different atmospheres

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Introduction

Nano-sized zinc oxide films are actively used as transparent electrodes for solar cells, LEDs and other optoelectronic devices, sensitive elements of gas sensors.

In this paper, the influence of different media on the electrical characteristics of such films is studied, which is interesting from the point of view of using zinc oxide films as gas sensors of various media, as well as to take into account the influence of media components on electronic elements based on them.

Methods

The investigated zinc oxide films were obtained from aqueous solutions of zinc acetate with the addition of polyvinyl alcohol as a structuring additive. The initial solutions were applied to the prepared glass substrates. The resulting preparatives were annealed in a muffle furnace.

The films had a porous nanoscale structure, which was confirmed by SEM studies.

The electrical characteristics (CVC, DCTD, Kinetic dependence of conductivity) of the films were measured in an atmosphere of dry air and in atmospheres containing water vapor, ammonia and isopropyl alcohol.

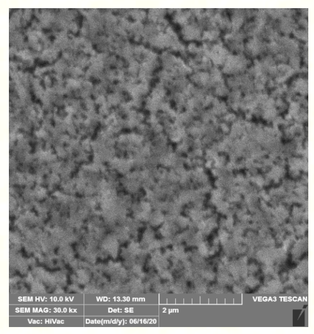

Fig. 1. SEM image of the studied zinc oxide film

Results

CVC of ZnS films

Water vapor

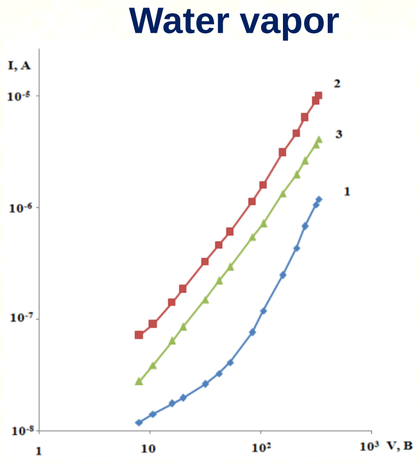

Fig.2. CVC of ZnO film in air atmosphere at 290 K (1) and 420 K (2) and in the presence of water vapor at 290 K (3).

Ammonia vapor

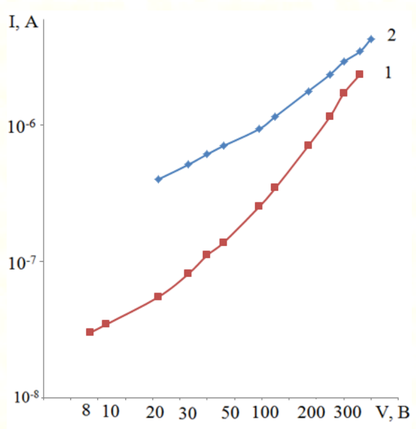

Fig. 3. CVC of ZnO film in air atmosphere (1) and with ammonia vapor (2) at 290 K

In all cases, changes in the electrical characteristics of the studied films were observed, but the nature of these changes differs and depends on the nature of the interaction of the adsorbate with the previously adsorbed oxygen.

In the presence of ammonia vapor at room temperature, the current in the film has almost doubled. Moreover, the adsorption process is quite inertial in contrast to the desorption process. The sensitivity of the film was at the level of 0.82 rel. un.

These same films at room temperature do not react to propanol vapors in the ambient air. However, as the temperature of the layers increases, their electrical conductivity increases. At a temperature of 100 oC, the sensitivity to propanol S is 0.41 rel. un.

The films have also been noticed to be sensitive to moisture at room temperature. However, compared to the reaction to ammonia, the reaction to water vapor was more inertial and the sensitivity was at the level of 0.37 rel. un.

CTD of films ZnS

Water vapor

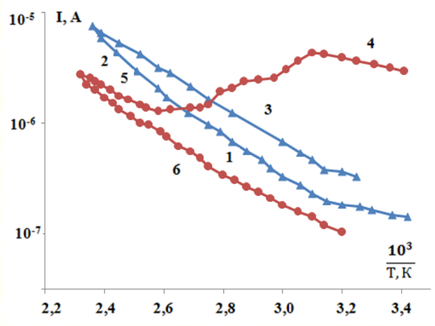

Fig.4. Temperature dependences of current in ZnO film in air atmosphere (1-2-3) and in the presence of water vapor (4-5-6). (V = 200 B)

Ammonia vapor

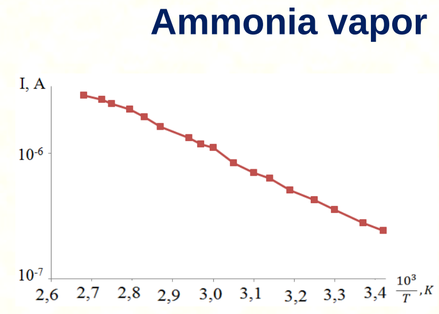

Fig.5. Temperature dependence of current in ZnO film, measured in ammonia vapor (V = 100 B)

Vapor sensitivity of films ZnS

Water vapor

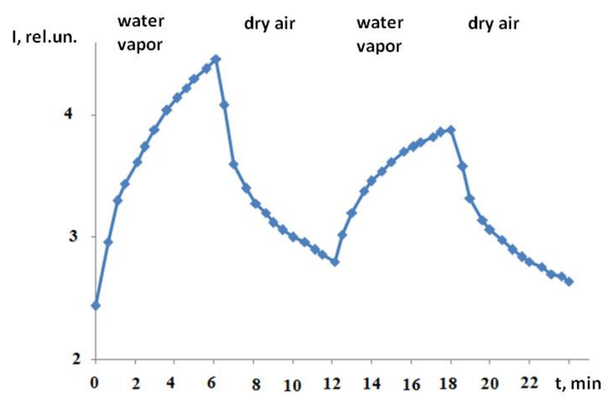

Fig. 6. Relaxation of current in ZnO film at periodic inflow into the chamber of water vapor or dry air (V = 200 B) at T = 293 K.

Ammonia vapor

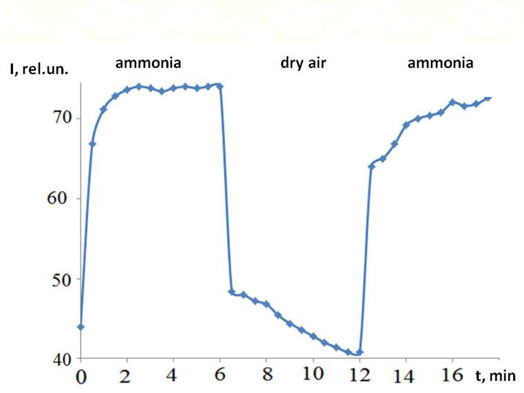

Fig. 7. Relaxation of current in the filmZnO with periodic inflow into the chamber of ammonia vapor or dry air (V = 175B) at T = 293 K

Propanol vapor

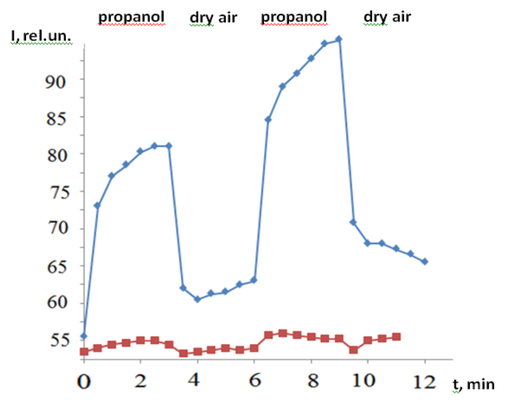

Fig. 8. Relaxation of current in ZnO film when vapor of propanol or dry air is let into the chamber (V = 200 B). Red markers - T = 293 K, blue - T = 393 K.

Conclusion

The difference in the values and temperature of the sensitivity of zinc oxide films to different adsorbates allows to consider them as a sensitive elements of the multisensors.

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