ELECTROOPTICAL PROPERTIES OF DC ELECTROLUMINESCENT ZnS:Mn,Cu POWDER PANELS WITH CHALCOGENIDE GLASS INTERMEDIATE LAYER

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Introducing of amorphous (a) a-As$_2$Se$_3$ as contrasting intermediate layer into SnO$_2$-As$_2$Se$_3$-ZnS(Mn, Cu)-Al structure allows one to increase by about 50% a light contrast range of the device that facilitates the perception of symbol-alphabetic information. The bleaching of a-As$_2$Se$_3$ film under the action of humidity allows one to control the state of the structure air-tightness. The absorption edge of As-Se films and electrooptical characteristics of SnO$_2$-ZnS(Mn, Cu)-Al active structure have been investigated.

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1. Introduction

Electroluminescent direct current ZnS:Mn, Cu powder flat panels (EDCFP) occupy an important place in developing of modern means of representation [1]. One of the disadvantages of powder EDCFP is their relatively low light contrast range and the decrease in the brightness with time [2-3]. The special contrasting substrate increases the contrast range but decreases luminescent intensity of SnO$_2$-ZnS(Mn,Cu)-Al structure.[3] The aim of the given work is to investigate the possibilities of the usage of As-Se high-ohmic chalcogenide glasses (GhG) as an intermediate contrasting layer in SnO$_2$-As$_2$Se$_3$-ZnS(Mn, Cu)-Al structure and for visual control of the air-tightness of data representation electroluminescent flat panels.

2. Experimental technique

First conducting transparent layer SnO$_2$ was deposited on a glass substrate by conventional method [3]. Amorphous As$_2$Se$_3$ layer was prepared by vacuum flash evaporation at different evaporator temperature – 773 and 873 K. An electroluminescent layer of powder ZnS (Mn,Cu) with the thickness 5x10$^4$ nm was produced by stenciling method [3]. The upper aluminum electrode was formed by the vacuum evaporation.

Optical investigations of the absorption edge of As-Se films were carried out by conventional method, with the measurement of reflection and transmission. Electrooptical measurements were carried out in accordance with generally accepted method [4].

3. Results and discussions

The data on the absorption edge of the films of As$_x$Se$_{100-x}$ system showed that in the region of $\alpha$$>$$10^3$ cm$^{-1}$ (R is absorption coefficient) the dependence $\alpha$ versus the energy of photons may be

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described by a typical relationship \( \alpha = \frac{(h\nu - E_0)^2}{E_0} \) (\( E_0 \) is pseudoenergy bandgap) for chalcogenide vitreous semiconductors.

\[
\begin{align*}
\text{hV, eV} & \quad \text{\( \alpha \), cm}\text{⁻¹} \\
1.70 & \quad 2.0 \times 10^4 \\
1.75 & \quad 1.2 \times 10^4 \\
1.80 & \quad 8.0 \times 10^3 \\
1.85 & \quad 6.0 \times 10^3 \\
1.90 & \quad 5.0 \times 10^3 \\
1.95 & \quad 4.0 \times 10^3 \\
2.00 & \quad 3.0 \times 10^3 \\
2.05 & \quad 2.0 \times 10^3
\end{align*}
\]

Fig. 1. Absorption coefficient versus photon energy for a-As\textsubscript{2}Se\textsubscript{3} film prepared at 773 K.

\[
\begin{align*}
\text{x, a.t. %} & \quad \text{E, eV} \\
10 & \quad 2.00 \\
20 & \quad 2.05 \\
30 & \quad 2.10 \\
40 & \quad 2.15 \\
50 & \quad 2.20 \\
60 & \quad 2.25
\end{align*}
\]

Fig. 2. Concentration changes of energy gap of film a-As\textsubscript{2}Se\textsubscript{100-x} produced at different temperatures of evaporator (temperatures are shown at Fig.).

Concentration changes \( E_0 \) of As-Se films prepared at different evaporator temperatures are given in Fig. 2. Below \( \alpha<5\times10^{3} \text{ cm}^{-1} \) the absorption edge of the films is described by the relationship \( \alpha = \exp(h\nu/S) \), where \( S \) is the absorption edge slope [3]. As\textsubscript{2}Se\textsubscript{3} has the sharpest edge that allows one to limit the background diffuse-mirror reflection from SnO\textsubscript{2}-As\textsubscript{2}Se\textsubscript{3}-ZnS(Mn, Cu)-Al structure in the region of wavelength \( \lambda<500 \text{ nm} \) due to a high diffuse reflection \( \text{p}=0.88 \) of powder ZnS (Mn,Cu). Measuring of diffuse-mirror reflection show that introduction of a-As\textsubscript{2}Se\textsubscript{3} as intermediate layer causes a decreasing of reflection \( \text{p} \) from powder ZnS (Mn, Cu) by about 50%. The calculations showed that the decrease in the background reflection from the structure with a-As\textsubscript{2}Se\textsubscript{3} layer results in an increase of the brightness contrast \( K \) by about 50% in comparison with \( K \) of the structure without a contrasting intermediate layer based on ChG.

Introducing As\textsubscript{2}Se\textsubscript{3} layer into a structure causes the decrease of brightness \( \Delta B \approx 10 \% \). This is less than decreasing of intensity of spectral contrastin substrate. Such substrate decreases the structure luminescent by about two times [3,5,6].

The measurement of voltage-current and voltage-brightness characteristics showed (Fig. 2) that the introduction of As\textsubscript{2}Se\textsubscript{3} dielectric layer into the structure does not change the shape of voltage-
current characteristics ($I-U^n$, $n=6-8$) and shifts them both into the region of larger voltages only (Fig. 3).

Thus the introduction of $As_2Se_3$ layer into $SnO_2$ active structure increases 1.5 times its light contrast range and does not practically change electrooptic characteristics.

The durability of data representation in electroluminescent flat devices is limited by the decay of an electroluminophor layer. The influence of relative humidity due to depressurization is considered to be one of possible reason of the decrease in the luminescent brightness [2,3]. Placing $SnO_2-As_2Se_3-ZnS(Mn)-Al$ depressurized structure into the chamber with different relative humidity the bleaching of $As_2Se_3$ film was observed. The nature of photobleaching is connected with electrostimulated optical changes described in [7]. The dynamic of the brightness changes depending on relative humidity is given in Fig. 4.
4. Summary

An existence of high-ohmic chalcogenide layer in SnO$_2$-As$_2$Se$_3$-ZnS(Mn,Cu)-Al structure does not change a shape of volt-current and volt-brightness characteristics. Chalcogenide layer in electroluminescent direct current structure increases diffuse-mirror reflection and light contrast range by about 50%.

The bleaching of As$_2$Se$_3$ film under the action of relative humidity allows one to control the state of structure air-tightness.

References