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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_2Se_3 as contrasting intermediate layer into SnO_2-As_2Se_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_2Se_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.

Keywords: Electroluminescence, powder ZnS (Mn,Cu), thick film, chalcogenide glasses

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_2Se_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_2Se_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_xSe_{100-x} system showed that in the region of $\alpha>10^3$ cm^{-1} (α is absorption coefficient) the dependence α versus the energy of photons may be described by a typical relationship $\alpha=(h\nu-E_o)^2$ (E_o is pseudoenergy bandgap) for chalcogenide vitreous semiconductors.

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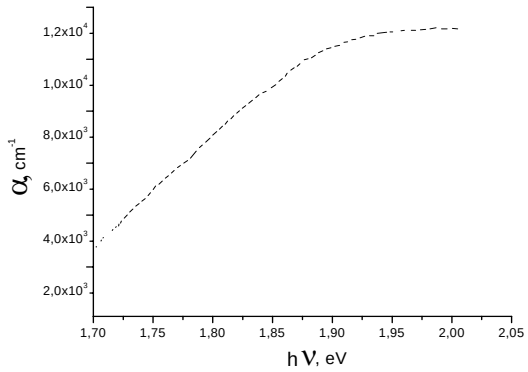


Fig. 1. Absorption coefficient versus photon energy for a-As_2Se_3 film prepared at 773 K.

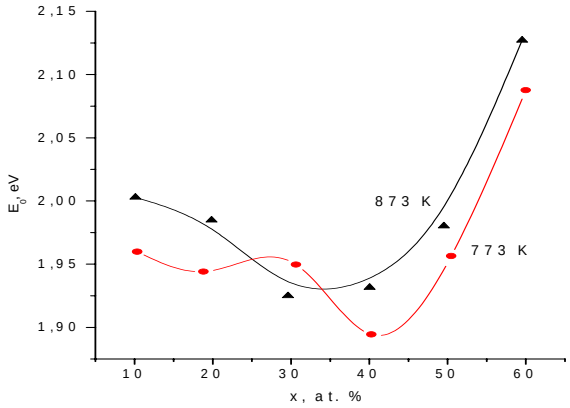
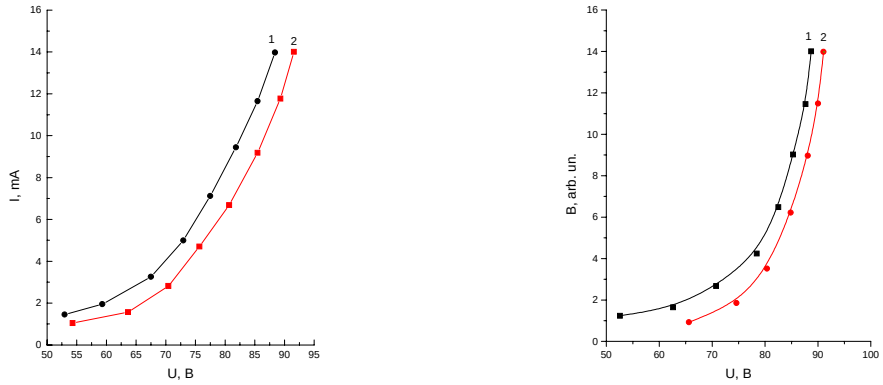


Fig. 2 Concentrational changes of energy gap of film a-As_xSe_{100-x}, produced at different temperatures of evaporator (temperatures are shown at Fig.).

Concentration changes E_o of As-Se films prepared at different evaporator temperatures are given in Fig. 2. Below $\alpha<5x10^3$ cm^{-1} the absorption edge of the films is described by the relationship $\alpha\sim\exp(h\nu/S)$, where S is the absorption edge slope [3]. As_2Se_3 has the sharpest edge that allows one to limit the background diffuse-mirror reflection from SnO_2-As_2Se_3-ZnS(Mn, Cu)-Al structure in the region of wavelength $\lambda<500$ nm due to a high diffuse reflection ($\rho=0.88$) of powder ZnS (Mn,Cu). Measuring of diffuse-mirror reflection show that introduction of a-As_2Se_3 as intermediate layer causes a decreasing of reflection ρ from powder ZnS (Mn, Cu) by about 50%. The calculations showed that the decrease in the background reflection from the structure with a-As_2Se_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_2Se_3 layer into a structure causes the decrease of brightness $\Delta B\leq10$ %. This is less than decreasing of intensity of spectral contrasting 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_2Se_3 dielectric layer into the structure does not change the shape of voltage-current characteristics ($I\sim U^n$, n=6-8) and shifts them both into the region of larger voltages only (Fig. 3).



a) b)

Fig. 3 Volt-current (a) and volt-brightness (b) characteristics of structures: 1 – SnO_2-ZnS(Mn,Cu)-Al, 2 - SnO_2-As_2Se_3-ZnS(Mn,Cu)-Al.

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

The durability of data representation 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 connecting with electrostimulated optical changes described in [7]. The dynamic of the brightness changes depending on relative humidity is given in Fig. 4.

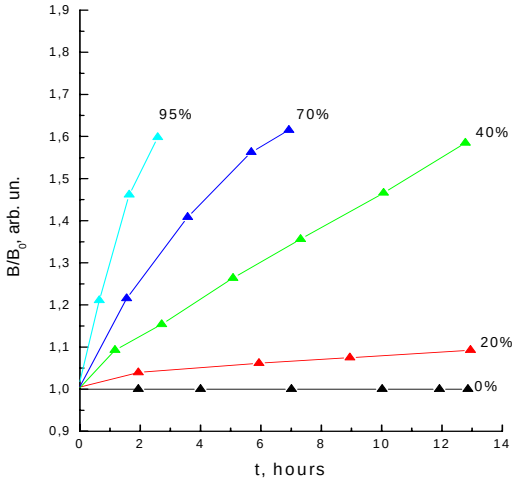


Fig. 4 Changes of radiation intensity of electroluminescent direct current structure on relative humidity (%).

4. Summary

An existence of high-ohmic chalcogenide layer in SnO_2-As_2Se_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_2Se_3 film under the action of relative humidity allows one to control the state of structure air-tightness.

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