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TECHNOLOGY OF THICK-FILM ELECTROLUMINESCENT ANIMATED ADVERTISINGS

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ABSTRACT

Because of the undeniable advantages of powder electroluminescent light sources the authors have designed and tested an animated thick film electroluminescent advertising panel. The paper describes the design steps and phases of the technological process. Finally, the brightness characteristics and influence of color translucent inks covering the segments are presented. The expected life time of the electroluminescent structure under normal exploitation conditions is evaluated.

1. Introduction

The electroluminescent structure operating on a base of the Destriau phenomena [1] is in its nature a capacitive structure, consisting of conducting, dielectric and luminescent layers [2]. Thick-film, screen-printed on flexible substrates, electroluminescent light sources possess a number of advantages which predestine them to applications where the problem of the light quality is of basic importance. These features: cold, uniform and not glaring light, perfectly visible from long distances in the dark and clouded environment, very small power consumption, the emission of flicker-free light, and high resistance to mechanical and climatic influence make it an ideal light source for the widespread use. Thick-film EL lighting technology has been greatly improved in the past decade, so that it is now available as a low-cost, highly reliable, and efficient source of illumination for portable and handheld control and monitoring devices. The use of polymer chemistry with printing techniques for manufacturing also means that the technology provides a low-cost, high-reliability manufacturing process and expands the innovation that can be applied to both the graphic and visual versatility of the displays. This versatility enables the use of multisegmented and multicolor displays, variable sizes and shapes, and the integration of flexible lamp technology with switch packages that include membrane switch systems too.

2. Design and manufacturing steps

The idea of animated advertisings relies on partition of the main picture into separated segments, which are sequentially back-lighted in programmed cycles. Electroluminescent structure designed by authors consists of eight luminescent capacitors emitting light as shown in Fig. 1. Every capacitor is supplied individually from an inverter with individually controlled, separated outputs. The complete structure with all segments powered is shown in Fig. 2a.

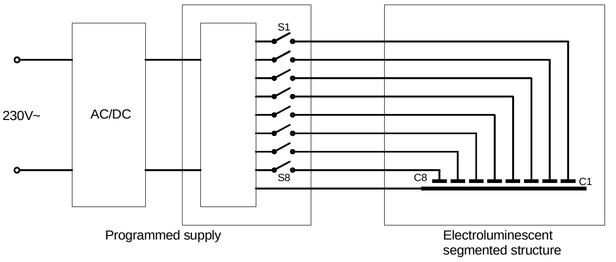


Fig. 1. The capacitive segmented structure of electroluminescent backlight.

How the advertising coupled with electroluminescent light source is built? The authors start with a thermally stabilized polyester substrate (foil) with thickness of 120 μm, covered on its one side with thin conductive translucent ITO (indium tin oxide) layer. On this side the electroluminescent structures are created using a screen-printing process. The advertising picture is deposited on the opposite side also using a screen-printing process. As shown in Fig. 2a the picture consists of a logo and inscriptions printed with white translucent ink, ovals symbolizing CD's printed with yellow translucent ink and a masking layer printed with black covering ink. The printed layers are shown in Fig. 2b and the exact geometry geometry of the conductive layers is shown in Fig. 2c.

a) b) c)

Fig. 2. The view of advertising picture and layers of electroluminescent structure.

The author's main goal was building an electroluminescent structure, which would be cheap to manufacture and reliable in exploitation. Base materials are Du Pont Luxprint ink series, characterized by microencapsulated phosphors for the electroluminescent layer. Microencapsulating enhances the resistance of phosphors to the degradation effect of humidity. Minimization of consumption of electroluminescent (phosphor) and conductive inks (most expensive materials) was achieved by designing the luminescent and electrode layers in the form of inscriptions, whereas dielectric layer covers the maximum surface of the ITO layer, necessary for printing of conductive paths connecting each segment with output contacts. The output contacts and crossovers were placed on an additional dielectric layer with high electrical strength (Fig. 2c).

The sequence of printed layers was as follows: electroluminescent layer (DP 8150), dielectric layer (three prints of DP 8153), conductive layers (DP5000), crossover dielectric layer, crossover conductive layer. The layers were deposited on a polyester substrate using polyester screens. After deposition every layer was pre-dried at ambient temperature and subsequently cured in a ventilated box oven at the temperature of 120°C for 10 – 15 minutes. Additionally the structure was prevented from the influence of humidity by lamination of the structure from the side of rear electrodes. Finally, all structures were tested for evidence of short-circuits between ITO and rear electrodes and for break-down strength of dielectric and luminescent layers.

3. Results of measurements

The manufactured advertising panel can operate under a wide range of supply voltage and frequency. It should be pointed out that the higher the voltage and frequency, the higher the brightness, but simultaneously the shorter the life time. In Fig. 3 the results of brightness investigations are shown.

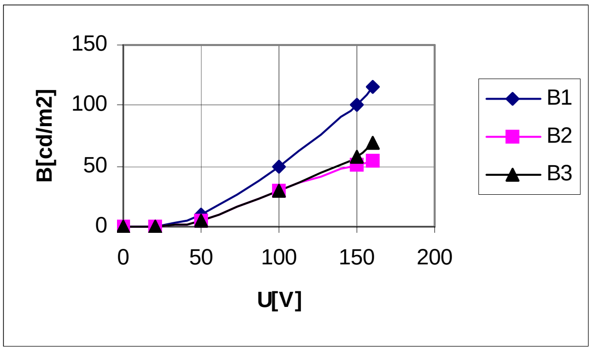
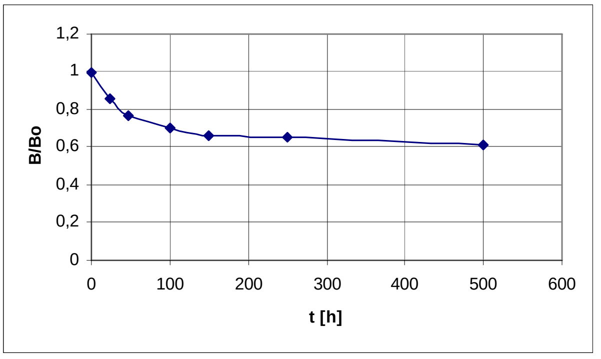


Fig. 3. Brightness of different electroluminescent segments at the frequency f = 1 kHz. $B1$ – brightness of segments not covered by translucent ink, $B2$– brightness of segments covered by white translucent ink, $B3$ – brightness of segments covered by yellow translucent ink.

The investigations of brightness were performed at the frequency of supply voltage f = 1 kHz, which is simultaneously the frequency of the exploitation supply voltage. The RMS values of supply voltage varied from 0 V to 160 V (0 to 440 $V_{p\text{–}p}$). The obtained results show that the print of white and yellow translucent inks causes approximately 50% decrease of brightness in comparison to uncovered segments. There is no significant difference in light attenuation introduced by yellow and white translucent inks.

The life of electroluminescent structures ($t_{1/2}$) is defined as time period after that the luminance decreases to the 50% of its initial value. In order to determine its value, we have performed preliminary exploitation test under the following condition: V = = 100 V, f = 1 kHz during 500 hours. The results are shown in Fig. 4a. The figure shows the relative brightness (B) change in time, with relative to the initial brightness B_0. In order to determine the expected life time, we employ the model described in [3]. If the relative brightness value $y = B/B_0$ is plotted against a logarithm of time $x = \log(1 + t\ [\mathrm{h}])$, as in Fig. 4b, the measurement points will form a straight line of equation $y = ax + 1$. Then, the time to half brightness can be expressed as: $t_{1/2} = 10^{1/2a}$. As seen in Fig. 4b, $a = -0.1435$, thus $t_{1/2} = 3019$ h. Also, after 10 000 hours the brightness will drop to about 40% of its initial value.

a)



b)

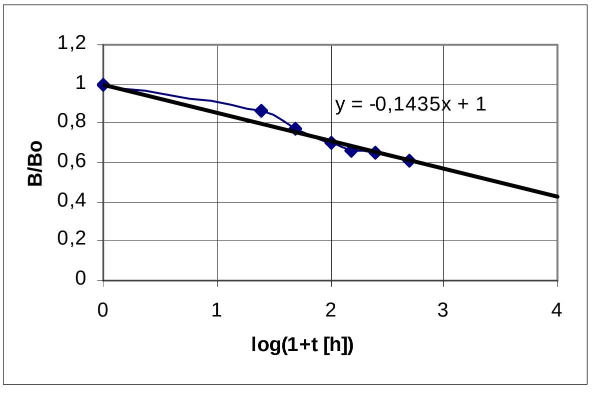


Fig. 4. Results of exploitation tests: a) top, b) bottom.

4. Conclusions

The parameters of measured electroluminescent structures with segmented elements show, that design and technological processes enable the manufacturing of high quality animated advertising. The values of brightness and expected life time fulfill the requirements of most customers.

The obtained test results indicate, that the biggest decrease in brightness occurs during the first 100 hours of exploitation. This suggests the advisability of introducing of initial aging of the electro-luminescent structures, which increases the effective operational life time.

References

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