THE LUMINOUS CHARACTERISTICS OF OLED LIGHT PANEL

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Abstract: OLED is very fast developing and perspective technology. Its parameters compete with existing light sources. It allows radiate homogeneous high-intensity light from a flat surface with small energy consumption. The paper is focused on the verification of characteristics and radiation homogeneity of the OLED panels. The measurement shows the characteristic of the light intensity, wavelength and its distribution over the whole OLED panel surface.

Keywords: OLED, Organic Light Emitting Diode, light panel, the luminous characteristics

1. INTRODUCTION

Organic Light Emitting Diode (OLED) is very fast developing and perspective technology. It is used mainly in imaging techniques, because OLED panels do not need backlight, they are energetically advantageous, have very stable and clear picture with balanced brightness and fast response, and can show 16.5 million colors, while thickness of a panel is very small. OLED technology found wide spectrum of applications in a lighting technology for residential premises too. OLED technology ensures a high homogeneity light on the whole surface area in principle. This paper describes the simple method of measuring whole area of OLED panels and determination of the light intensity and color tone in each point of panel. The deviations indicate some mistakes in production process or some defects of panels. The test should be helpful to verify the proper function of the new OLED panel and allows determining the light emission parameters.

2. OLED TECHNOLOGY

2.1. About OLED

OLED is structurally composed from the hard glass or flexible plastic substrate, transparent anode from the layer of ITO (the mixed oxide of indium and tin) and one or more layers of organic semiconductor or the mixture of metals (magnesium, calcium or aluminum) as cathode, see Figure 1. The whole thickness can be in range from 20 to 200 um [1].

2.2. Principle of OLED

As the electric current passes the circuit, the charge more carries enter the semiconductor. At the cathode electrons are injected to LUMO (Lowest Unoccupied Molecular Orbital) and at the anode are injected the holes to HOMO (Highest Occupied Molecular Orbital). The voltage applied between the electrodes is relatively low (range 2.5 to 20 V). Even when the voltage is low, a strong electric field in range 105 to 107 V/cm is created due to a thin active layer. In the semiconductor the electrons are flowing from the cathode to the anode and, thus, form the excitons and then their recombination occure. The energy is released in the form of the photons which are radiated through transparent ITO electrode to the environment. Wavelength, and i.e. the color, is dependent to specific characteristics of a semiconductor. The radiation emitted by multiple sources combines and it is possible to create any color due to the dopants or other active layers. The result is very low power consumption with high light intensity. In the future it will be possible to increase the performance to more than 80 up to 140 lm/W. [1]

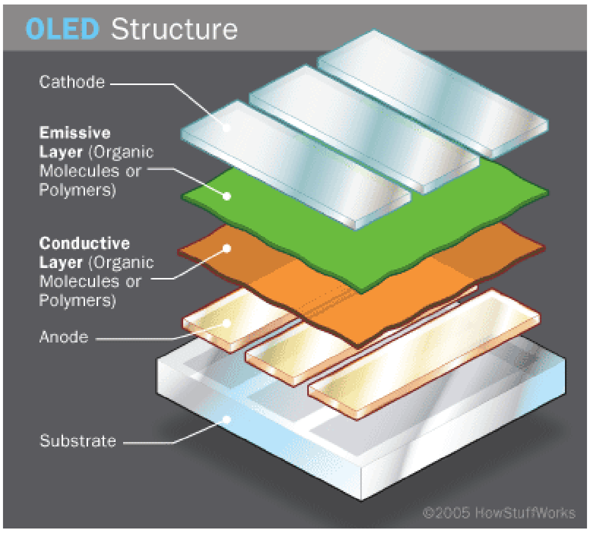

Figure 1: Layers of OLED panel [2].

3. MEASURING SYSTEM

OLED panel is monolithic area of light emitters with defined dimensions. To evaluate the homogeneity of the panel radiation, the OLED was divided into small sections defined by the grid. The measurement system is based on the XY plotter where the OLED panel is located. Above the panel the lens is placed which is focused to one small point on the panel and is relatively moving to the panel in the x and y axis. The lens focuses the light flux into the optic fiber transmitting the light to the spectrometer, see Figure 2.

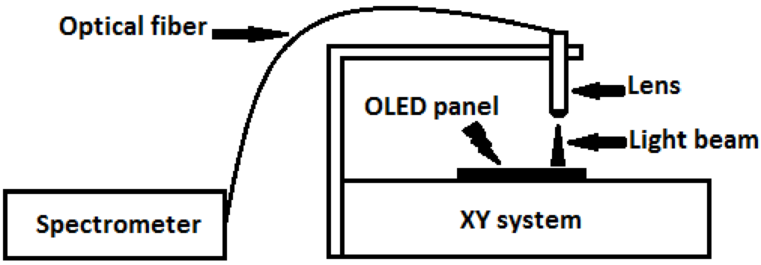

Figure 2: Measuring system and spectrometer

3.1. SPECTROMETER

For measurement of characteristics of the light was used the spectrometer made by PhotonControl, type SPM-002-E, see Figure 2, with spectral range from 200 nm to 1090 nm, resolution in center 0.8 nm, resolution in outer spectral range 2 nm, focal length 70 mm, A/D resolution 12-bit, integration time range 10 us to 65 s and CCD pixels 3648.

All the data were measured at the integration time 10 us, and all intensity measurement presented in figures are closely connected with this value.

3.2. XY SYSTEM

The XY system is based on two stepper motors with minimal step 25 um. For the measurement the step 1 mm was used. The result of measurement is matrix 100x100 (the light area id 90x90 mm). All system is situated in black box for minimizing the environment impacts. Even if the beam of light is focused to the one point, measurement was affected by the ambient shine of the OLED panel.

3.3. MEASURING SOFTWARE

The software in Matlab controls stepper motors and spectrometer. In each point of OLED panel was measured one vector of intensity contributions in particular wavelengths. Data form the structure of 100x100 vectors in matrix from where the quantities distributions were determined. There were measured three OLED panels from the same manufacturer and from the same series and types.

4. MEASUREMENT RESULTS

From the data measured using a spectrometer were designed three characteristics for evaluating the homogeneity of the radiated light. The distribution of quantities is observed. The first quantity is intensity distribution at dominant wavelength. Second is radiated intensity in measured wavelength range. The last is the dominant wavelength.

4.1. INTENSITY DISTRIBUTION AT DOMINANT WAVELENGTH

As show Figures 3, 4 and 5, the OLED panel is relative homogeneous with very small deviations. In Figures are used the central part of the panel thus the deviations are observable. Characteristics of whole area of OLED panel are absolute homogenous, because the ration between the radiating surface and non-radiated panel border is very large.

The first OLED panel is relatively homogeneous, second and third panels are on a downward trend. This can be caused by panel internal structure.

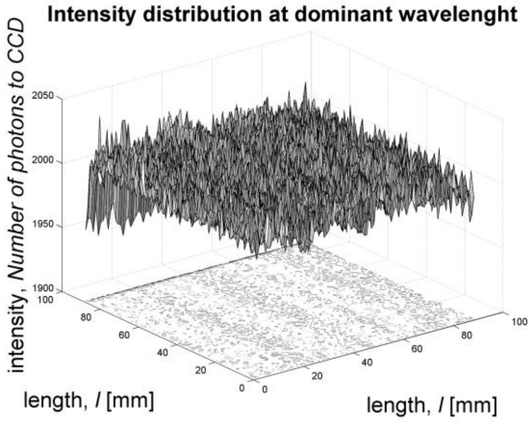

Figure 3: Intensity distribution at dominant wavelength -first panel.

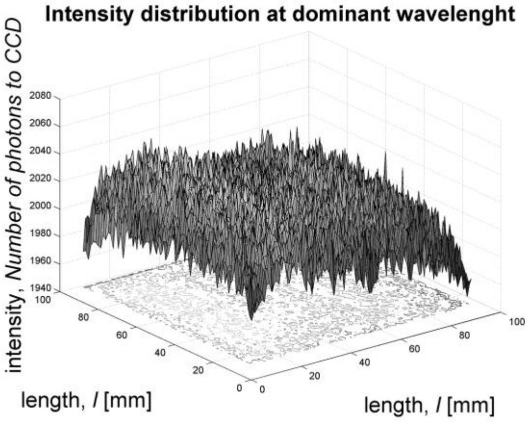

Figure 4: Intensity distribution at dominant wavelength -second panel.

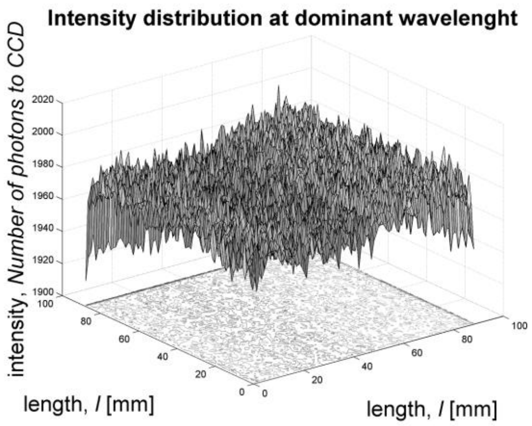

Figure 5: Intensity distribution at dominant wavelength -third panel.

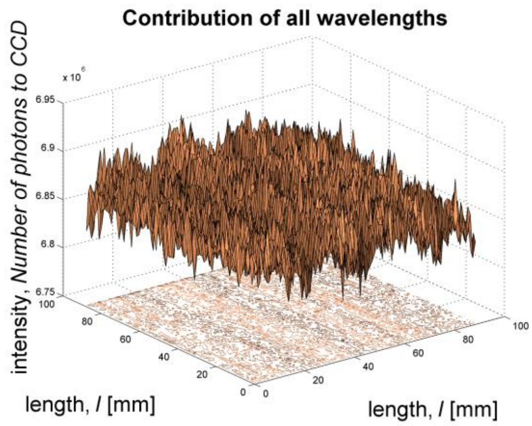

Figure 6: Contribution of all wavelengths first panel.

4.2. CONTRIBUTION OF ALL WAVELENGTHS

In figures 6, 7 and 8 the characteristics of intensity are measured as integral of wavelength contributions. Characteristics emphasize details of maximum of wavelengths. The intensity is decreasing in the direction towards to panel border. It is clear that the luminosity to one side of the OLED panel decrease.

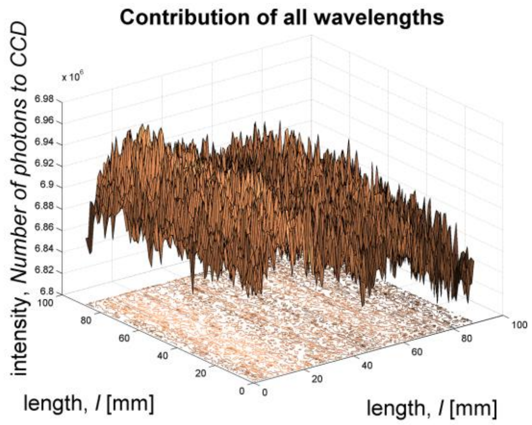

Figure 7: Contribution of all wavelengths second panel.

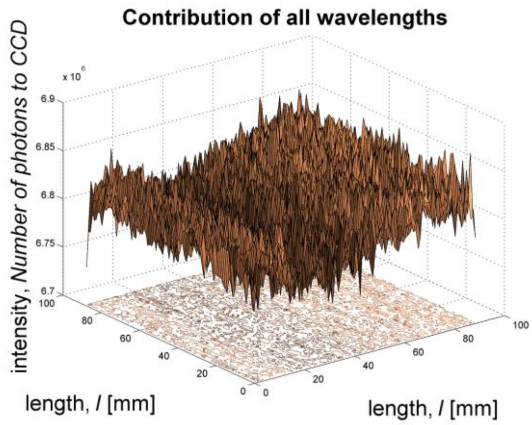

Figure 8: Contribution of all wavelengths third panel.

4.3. OLED PANEL DOMINANT LIGHT WAVELENGTHS

The dominant wavelengths were found for all measured values. As show Figures 9, 10 and 11, the wavelength is homogeneity with small deviations. In the figures it is evident that each OLED panel has different color, thus wavelength. The difference is not significant for human eye, since it is barely recognizable, which corresponds to the most sensitive wavelength as human eye. The most of the dominant wavelengths are around 550 nm.

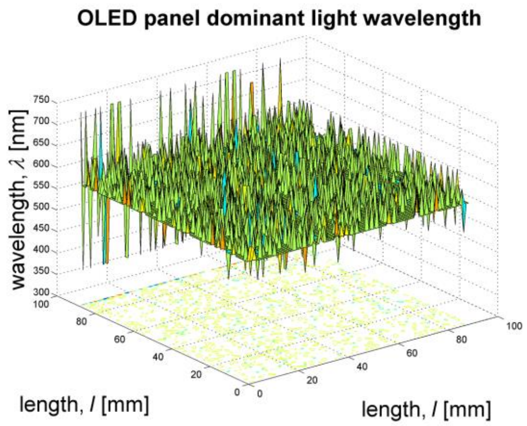

Figure 9: OLED panel dominant light wavelength first panel.

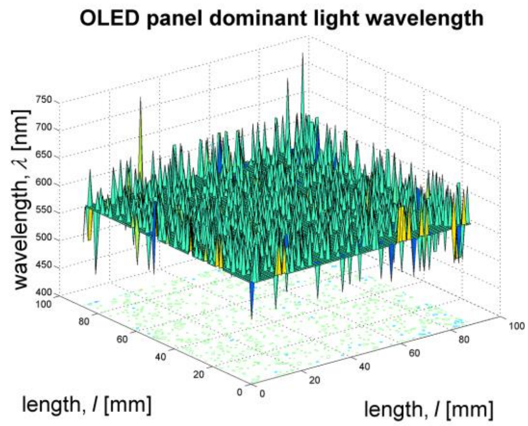

Figure 10: OLED panel dominant light wavelength second panel.

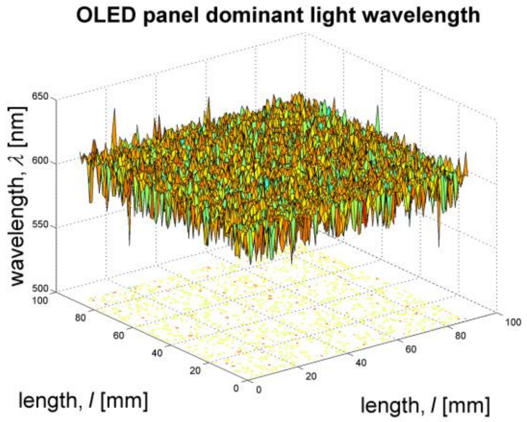

Figure 11: OLED panel dominant light wavelength third panel.

5. CONCLUSION

The OLED panels seem to have very homogeneous light radiation observed by the human eyes, but a simple measurement shows deviations in parameters. The intensity of the light is decreasing due to inside structure of electrodes. The decrease of light is not only limited to the dominant wavelength, but it is mainly the same for all contributions. The light tone of OLED panel is deferent and depends only on composition and technology process.

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