

## DESIGN OF LED-BASED MEDICAL EQUIPMENT FOR BRIGHT LIGHT THERAPY

Kukhta M.<sup>1</sup>, Sidorenko E.<sup>1</sup>, Simutkin G.<sup>2</sup>, Glushkov G.<sup>3</sup>

<sup>1</sup>Tomsk Polytechnic University, 634050, 30 Av. Lenin, Tomsk

<sup>2</sup>Mental Health Research Institute, 634014, 4 Str. Aleutskaya, Tomsk

<sup>3</sup>Research Institute of Semiconductor Devices, 634034, 99a Str. Krasnoarmeyskaya, Tomsk  
[eukuh@mail.tomsknet.ru](mailto:eukuh@mail.tomsknet.ru)

### INTRODUCTION

The high prevalence rate of depressive disorders is an onerous economic burden for the modern society. The efficacy lack of synthetic antidepressants at mental depression therapy determined the necessity to develop new efficient approaches to the mental depression therapy.

The use of the bright light as a therapeutic agent in case of depressive disorders is based on the data demonstrating that the natural cycle “light - darkness” is the main external synchronizer of the biological rhythms. The abnormality of these rhythms plays an important role in the seasonal affective disorder nature. The perfect example of the chronobiological disorders is the co-called seasonal affective disorders in other words the clinical cases when at a certain time of year a person has autumn – winter depressions. The studies show that the seasonal affective disorders are a quite generalized mental disorder that the population of mid-latitudes has. The rise in winter depression prevalence rate towards the north latitudes can be explained by an increasing sunshine deprivation during the short light days in wintertime.

### LED-TECHNOLOGIES IN BRIGHT LIGHT THERAPY

The bright light therapy can be conducted as a “light therapy room”. In this room, the light panels able to produce the necessary light intensity (between 2500 – 10000 lux) are used as a light source. The modern technical achievements allow using the co-called light boxes where the light panels with the total light intensity of 10 000 lux are used. It provides an opportunity to reduce dramatically the bright light exposure time (up to 15 – 60 minutes compared to 2 – 4 hours a day at the light intensity of 2000-2500 lux). The recent study showed a good efficiency of more compact equipment during the affective disorder therapy. The operating principle of this equipment is based on LED-technology (5000 lux, the 464 nm wave length light – medium blue band – dominates in the radiated light spectrum. It is thought that the light waves of this spectrum completely inhibit the chromatophoretropic hormone secretion and influence in the optimal way the non-visual photoreceptors in special purpose retinal ganglion cells containing melanopsin that play an important role in light flux data communication from retina to the hypothalamus suprachiasmatic nucleus. Nevertheless, the leading experts in the light therapy of affective disorders think that they do not have enough data to advocate for certain such super compact devices and light devices

that integrate the medium blue light spectrum in emission, for general consumption. It is related to the fact that when the light device size is minimized, the minor head or eye rotation sideways or the distance from the device can dramatically change the luminosity that lands in the eye retina of the corresponding patient, and the biological effect of the medium blue part of the light spectrum is not obvious yet.

Thus, it is still a relevant objective to develop some safe and efficient equipment to conduct the bright light therapy and the operating principle of this equipment should be based on LED-technology. The use of cost-effective, physiologically friendly, chronobiology-oriented therapy and preventive measures in case of seasonal depressions can be beneficent in areas of severe weather conditions that place strong demands on the human coping.

### LED MATRIX PARAMETERS

The light panel design was based on LED-technology that is used when the light-emitting devices are developed. Compared to the standard incandescent-filament lamp that emits in wide spectrum, the led light initially belongs to a narrow spectrum band and depends on materials used for semiconductor p-n-junctions. The possibility to simulate the solar spectrum by the semiconductor selection provided the basis for the bright light therapy that allows solving an important issue of treatment and preventives measures of seasonal depressions by means of illuminating devices simulating the sunshine.

The main task of light panels is to provide the interior comfort that becomes possible due to the simulation of the natural diffuse sunlight (the most convenient for people). The light panel spectrum is maximum close to the solar one and that provides the required solar exposure level measured by the amount of energy units that impinge on the area unit in a unit time.

To solve the solar energy shortfall problem, the special purpose lamps with the emission close to the solar one by brightness and spectral content are offered. The color rendering index shows to what extent other colors are seen in the lamp light. It is measured percentagewise from 0% to 100%. The color-rendering index comfortable for people must be higher than 80%.

The use of LED-technology allows solving the problem of brightness and light spectral content.

LED-lamps with the required brightness level allow simulating the natural sun light and are suitable for the

bright light therapy. To create the illuminated area we suggest using the LED matrix.

The luminous density at the operating distance (0,6m) from the device without any secondary optical components is calculated with DIALux program and is shown in fig.1.

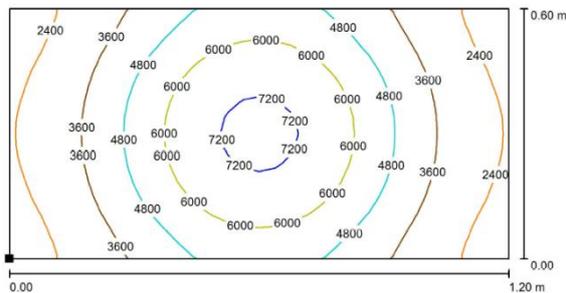


Fig. 1 Luminous density

The light flux of the mock-up specimen has a color temperature of 3057K, the luminous density at the distance of 0,6m with the secondary optical components of 13000 lux.

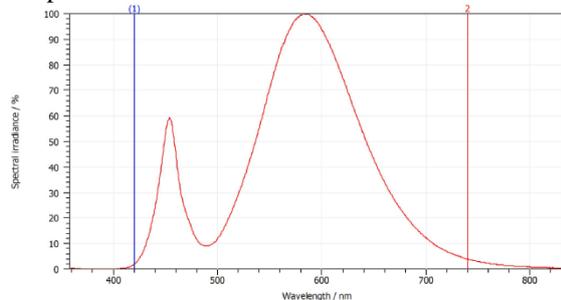


Fig. 2 Spectral-response characteristic of the mock-up specimen

The spectral-response characteristic displayed in fig.2 allows concluding based on studies that these characteristics of LED spectrum are optimum for the bright light therapy.

### DESIGN OF THE LED MATRIX –BASED LIGHT PANEL

The LED-based light panel case was designed with the following technical characteristics that allow providing the line supply of 220V, 50Hz, the power input of 35 Watt, the luminous density of 5000-10000 lux. The panel case is made of plastic.

The necessity of the light panel design is connected to the necessity to develop the visually comfortable environments that are provided with conditions mentioned in studies.

Fig. 3 shows the light panel case design for the bright light therapy in two options: table layout option and wall layout option. The characteristic of the light panel case design make it possible to supply the day light douche, simulate the sun light (10 000 lux at the distance of 0,6m), and provide the bright and uniform emission.



Fig. 3 Light panel case design

### FINDINGS

To solve the sunshine shortfall issue and to improve the human biological rhythm synchronization, the authors suggest the light panels the emission of which is very close by its spectrum content to the sunlight. The use of LED-technologies allows solving the problem of the necessary brightness level as well as the light spectrum content. The article studies the technical possibilities of the bright light therapy that reduce the total economic expenses related to the affective disorder therapy and autumn-winter depressions.

The significance of the study is in the light panel design that boosts the medical procedure efficiency in the medical treatment existing system and takes into account the up-to-date social circumstances on the make of the person-centered system of values in various therapy areas.

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