Simulation and Design of Light Illuminating Systems Based on LED

V. Sokolov (1), A. Garbul (1), D. Zhdanov (2), V. Mayorov (1), K.Tsuchiya (3), A.Voloboy (1), V.Galaktionov (1)
1 : The Keldysh Institute of Applied Mathematics RAS, Moscow, Russia
2 : NRU ITMO, St.Petersburg, Russia
3 : Integra Inc., Tokyo, Japan
E-mail: tsuchiya@integra.jp

Abstract: The work is devoted to investigation of an application of LED (Light Emitting Devices) in indoor and outdoor luminaries. The suggested software allows simulation and design both spatial and angular light distributions of LED based luminaries.

Keywords: LED, luminaire, indoor illumination, outdoor illumination, microstructure

1. Introduction

LED have a lot of advantages over traditional light sources like incandescent, halogen and luminescent lamps. Among them are highest efficiency, cheapness, excellent color uniformity, expanded life time. However small emitting area and low power restrict application of LED as sources for illumination of large areas and on remote distances. To suppress these drawbacks a special device models should be elaborated. In this article we consider possible variants of such models, aspects of simulation and design of similar kind of systems.

2. LED luminaries for indoor illumination

Typically main requirements to luminaries used for indoor illumination are high power and degree of uniformity of output light emitting: as spatial as well angular. The scheme presented in Fig.1 solves these problems. It is similar to backlight system used in LCD displays.

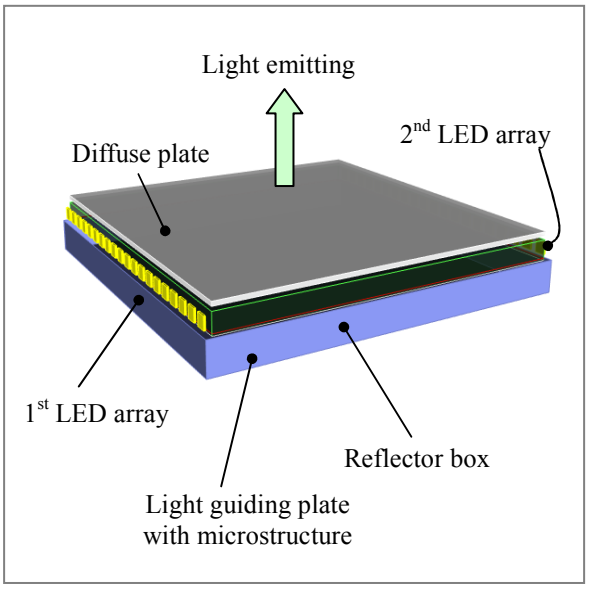

Fig. 1. Scheme of luminaire for indoor illumination

As primary light sources LED array is used. It is placed near to one or several side Light Guiding Plate faces. Big number of LED provides high power of whole device. Light emitted by LED propagates inside light guiding plate having micro-structure (dimples or painted dots) on the bottom part of it. Uniform light emitting is provided with specially designed distribution of microstructure [1]. In the example the shape of the device is rectangular; however it can be arbitrary one. The simulation and design of similar kind of schemes is not trivial task because of complexity of light propagation in presence of microstructures through rather big (up to meters) overall dimensions of luminaries [2, 3]. Fig 2 shows example of output characteristics of designed device.

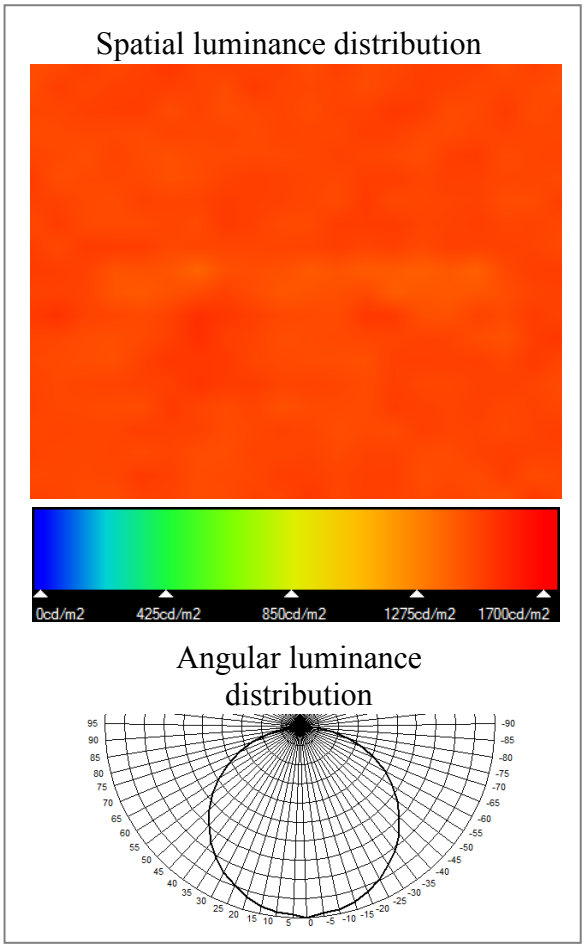

Fig. 2. Examples of output results

We can see high degree of spatial luminance uniformity achieved after design of luminary. Angular intensity distribution is also close to required: Lambertian one. Distribution of imprinted diffuse dots with variable density obtained after design is shown in Fig. 3. In the example the dots have diffuse properties and complex spatial density.

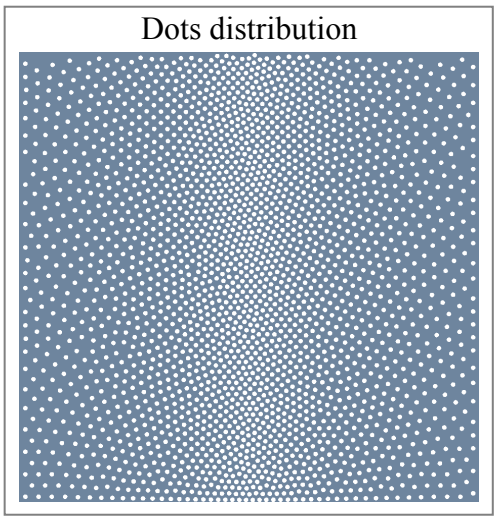

Fig. 3. Dots distribution

3. LED luminaries for outdoor illumination

An example of road illumination with LED street luminary is presented in Fig. 4. A construction of luminary consists of LED and lens arrays. Road sizes, maximal overall dimensions of luminaries and their placement are fixed.

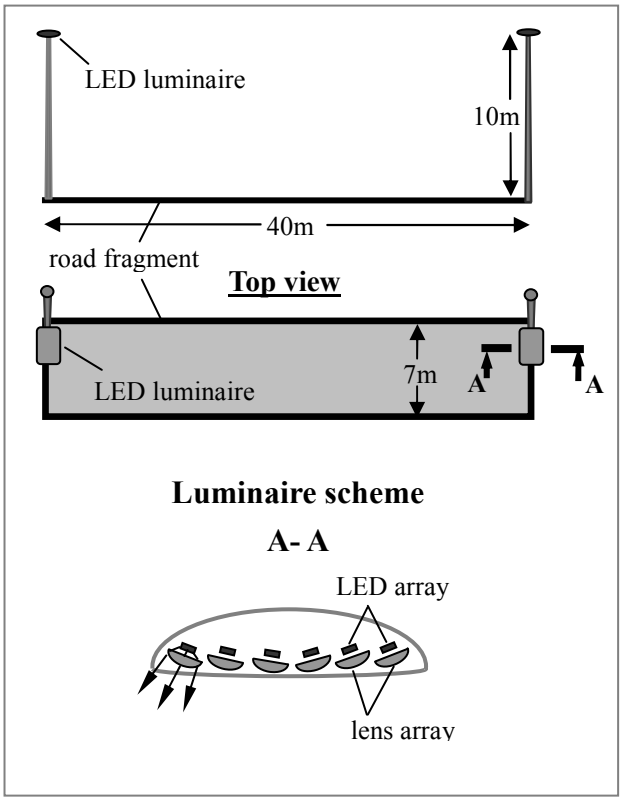

Fig. 4. Scheme of outdoor illumination

The aim of simulation is to provide minimal level of illumination no less than 8 lx on road area presented as rectangle 40x7 meters in our example.

Inclinations of LED and lens parameters are calculated as a result of design. Comparison of the initial variant of simulation and the final designed variant are shown in Fig. 5. In the initial variant the luminaire has no lens raster and all LED are not inclined (placed parallel to road surface). We can see that the final simulation aim (minimal luminance should be no less than 8 lx) is provided.

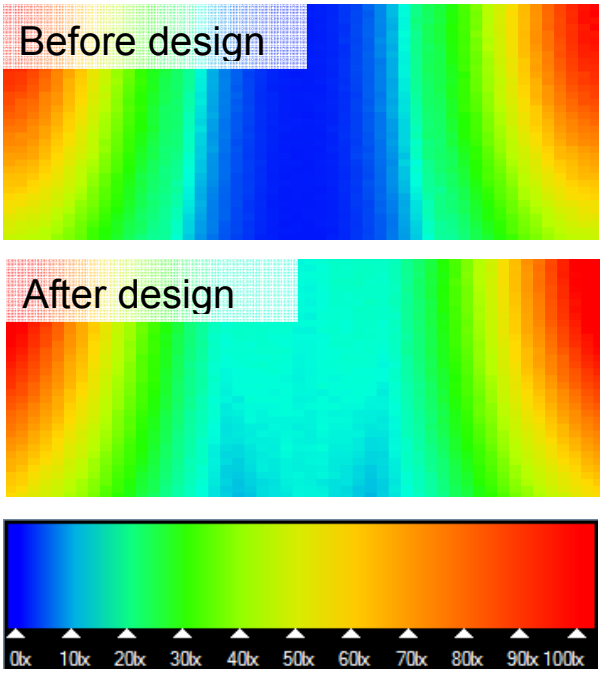

Fig. 5. Comparison of initial and final simulations

4. Conclusion

The above examples demonstrate that LED is applicable to construct luminaries for indoor and outdoor illumination. Simulation and design was made on SPECTER software [4].

5. References

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