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ON THE PARAMETERS AFFECTING THE COLOR OF PHOSPHOR CONVERTED WHITE LED LIGHT SOURCES

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Solid-state lighting offers many new prospects for tomorrow's customized lighting solutions, including sophisticated lighting effects and lower energy consumption. This technology is on its way to supersede incandescent and fluorescent lamps nowadays used for general lighting and automotive applications. In order to successfully compete with the performance of those traditional lighting systems, design and development of LED light sources are still faced with the necessity to enhance the lumen output and to improve the white light quality. Also, the adjustment of specific radiation characteristics and the temporal modulation of precisely defined color temperatures still need to be addressed.

Present concepts of phosphor-converted white LEDs provide a mixture of blue light (a fraction of which is exciting green, yellow or red phosphors) and the phosphor emission to generate a broad white light spectrum. Although this concept seems to be rather trivial, the device performance and the quality of the white light, especially in terms of angular homogeneity, critically depend on the appropriate geometry, the arrangement and the composition (with respect to phosphor concentration and phosphor particle size) of the color conversion element (CCE).

In this paper, we present numerical calculations, which include a) the set-up of a model for the blue LED die, b) the implementation of individual CCEs configurations and compositions (varying in their lateral and vertical dimensions, their arrangement with respect to the LED die, as well as the concentration and the particles sizes of the phosphor particles in the matrix material) into the model for the white light source and the simulation of the color conversion process therein, and finally c) the inspection of the white light for angular homogeneity by converting the irradiance distributions for the blue LED and the yellow converted light as determined for a photo-detector centrally surrounding the white LED light source into a single matrix of the corresponding CIE x color coordinates (CIE 1931) we discuss the impact of the CCEs configuration and composition on the achieved correlated colour temperature and the intrinsic angular homogeneity of phosphor converted white light sources.

The performance of suchlike predicted CCEs which are compared with real device set-ups in order to verify the accuracy of the model.