Seeing the light: new standards for quantifying specifications of low level light sources

Dirk Poelman, Koen Van den Eeckhout, Philippe F. Smet

Since many years, standards for measuring the brightness and color of artificial light sources such as lamps and displays have been well established. The units involved are photometric: they take into account the average human eye sensitivity and color perception. The same photometric quantities are used for specifying low level light sources such as persistent luminescent materials (long afterglow phosphors), while it is realized these are not valid at low light levels. Using the usual photometric standard, a luminance of 0.32 mcd/m2 is taken as the visibility threshold for applications and – by definition – any source with this luminance should look equally bright, irrespective of its emission spectrum. However, this is not the case, as the human eye sensitivity shifts from photopic vision at high light levels (corresponding to cone vision) to scotopic vision at low levels (rod vision). During this transition, the spectral sensitivity gradually shifts to shorter wavelengths – the so-called Purkinje effect – and it is a real challenge to describe the eye sensitivity in the intermediate (mesopic) region. Efforts are currently undertaken to describe the actually perceived brightness by means of a unified luminance concept [1]. The same effect is also responsible for the fact that it is notoriously difficult to produce a red-emitting persistent luminescent material, as the human eye is not red-sensitive at low light levels.

The present work aims at a better understanding of human eye behavior in the mesopic region, and focuses on persistent luminescent materials as model systems with a high application value. Specifically, it is the aim to find the optimum emission spectrum of persistent luminescent materials, combining a reddish color, needed for emergency signage, and sufficient visibility at low light levels.

[1] D. Poelman, N. Avci, P.F. Smet, Measured luminance and visual appearance of multi-color persistent phosphors, Optics Express **17**, 358-364 (2009)