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Optical spectrum investigations of LED backlight display panels and the blue light hazard

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Nowadays, display panels use white LEDs backlight to provide thin and lightweight devices with high brightness. The spectrum of white LEDs has an important blue component with a peak wavelength around 450 to 470 nm. The term "blue light hazard" (BLH) refers to the photochemical damage of the retina in the range of 380–550 nm. Blue light retinal injury can result from viewing either an extremely bright light for a short duration or a less bright light for a longer duration. Our studies and measurements focused on usual display panels of desktop and laptop PCs, used many hours a day by the operators who are endangered by the cumulative effect of blue light exposure. The paper will present the results and recommendations in order to order to minimize the risk of blue light exposure.

INTRODUCTION

The spectrum of white LED sources can be obtained in two ways. One approach is by mixing the optical radiation from LEDs with the appropriate colors, each emitting a relatively narrow spectrum of blue, green, or red light to create a spectral power distribution that appears white.

The other approach is by generating the white spectrum by using phosphor materials together with a blue LED. When a phosphor material used in white LEDs is illuminated by blue light, it emits yellow light having a reasonably broad spectral power distribution. The passing through blue light mixed with the phosphor yellow light gives an approximately white light spectrum.

Sophisticated white LEDs are using more than one phosphor material (yellow and red) in order to achieve a better balanced white spectral power distribution. Considering the need for high optical power for LED backlight display panels, the second approach is preferred. So, it is essential to analyze the blue light emission of these LED backlight sources to avoid the BLH.

The Scientific Committee on Health, Environmental and Emerging Risks (SCHEER) of the European Commission released in 2018 an official document regarding the potential risks to human health of LEDs [1] and also the International Commission on Illumination (CIE) presented in 2019 a position statement on the BLH [2].

MEASUREMENT SETUP

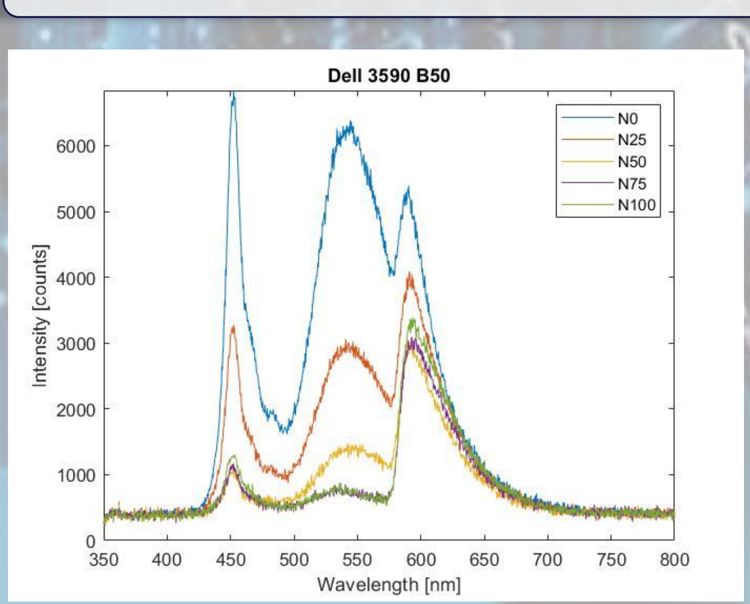
The experimental setup consists of a FLAME miniature spectrometer, a bifurcated fiber optic probe, and the display panel to be measured. The spectrometer was configured to measure wavelengths between 350 and 800 nm. The spectrum was measured using a bifurcated fiber optic probe. The spectrometer was calibrated by measuring the reference spectrum using a Spectralon reflectance standard probe and the dark spectrum by obstructing the fiber optic. The spectrometer software saved both reference spectrums. The software also allows users to save each spectrum measurement for later use.

RESULTS

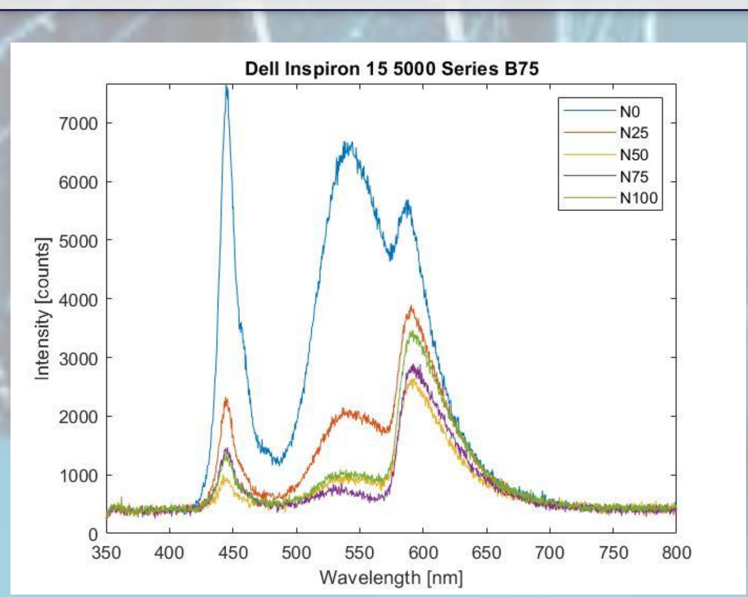
A total of seven display panels were used. The brightness and night light of laptop display panels were changed between 0 and 100 with a step of 25. The brightness and contrast of monitor display panels were changed between 0 and 100, with a step of 25 for brightness and a step of 42 for contrast. All of the spectrums were afterwards processed in MATLAB.

The results show three spectral peaks, one at approximately 450 nm (because of the blue LED included in the white LED structure), and the others at 550-600 nm (as a result of the phosphor emission).

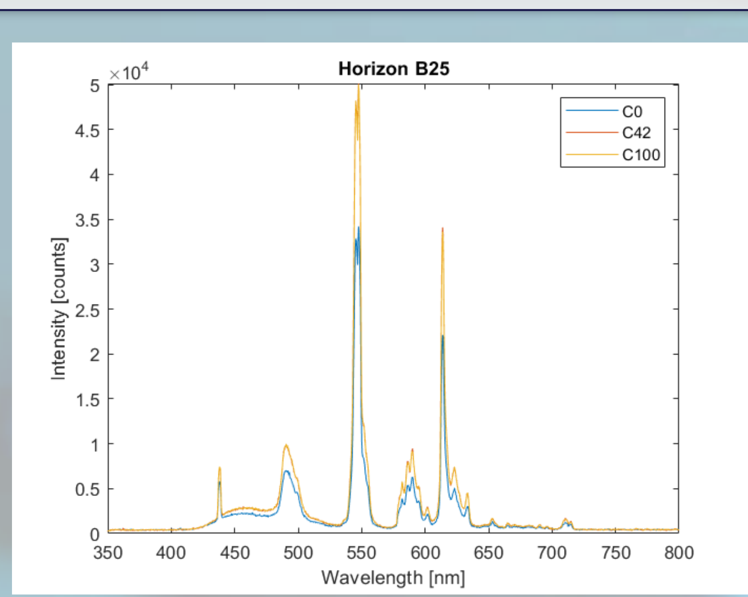
The optical spectrum for various display panels



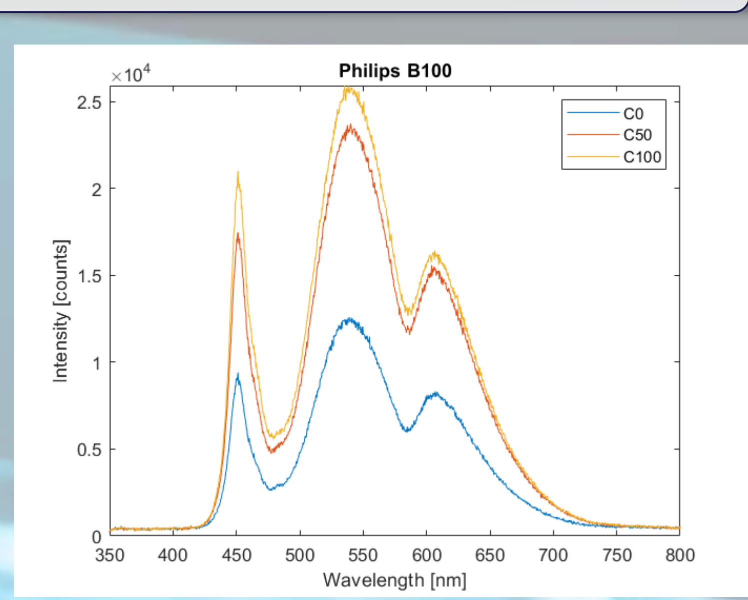
The spectrum for the brightness of 50 and various night light values (laptop display panel)



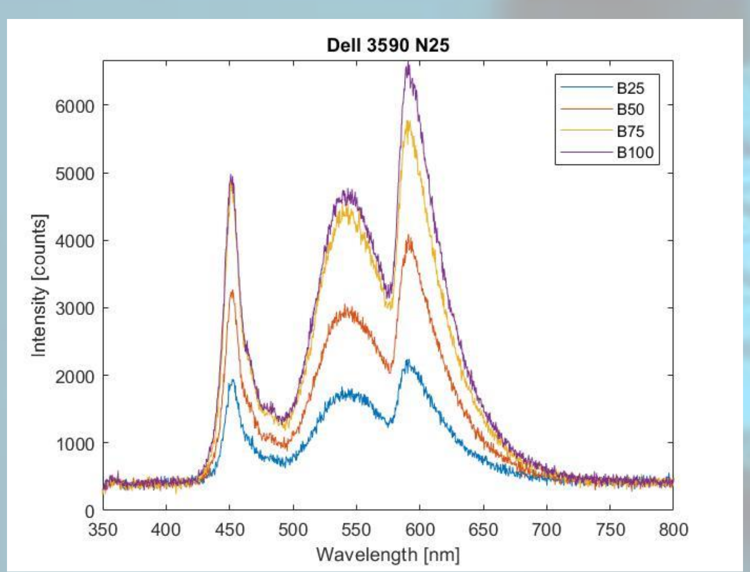
The spectrum for the brightness of 75 and various night light values (laptop display panel)



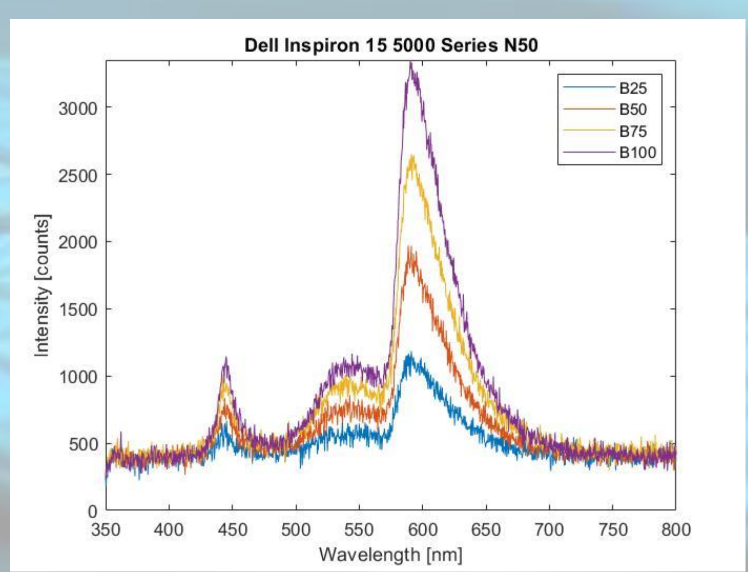
The spectrum for the brightness of 25 and various contrast values (monitor display panel)



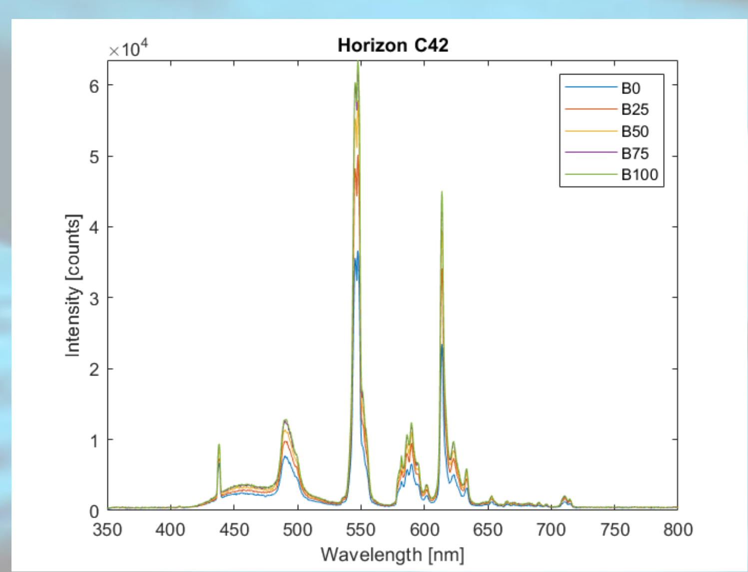
The spectrum for the brightness of 100 and various contrast values (monitor display panel)



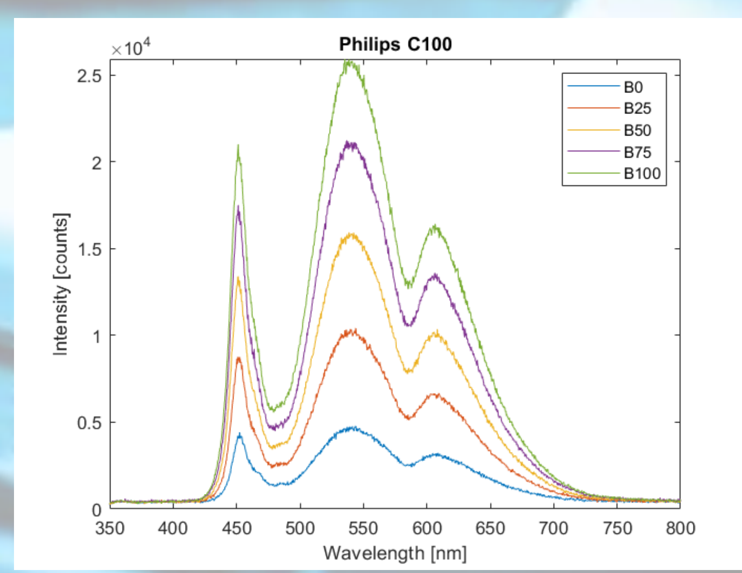
The spectrum for the night light of 25 and various brightness values (laptop display panel)



The spectrum for the night light of 50 and various brightness values (laptop display panel)



The spectrum for the contrast of 42 and various brightness values (monitor display panel)



The spectrum for the contrast of 100 and various brightness values (monitor display panel)

[1] Scientific Committee on Health, Environmental and Emerging Risks (SCHEER), "Opinion on Potential risks to human health of Light Emitting Diodes (LEDs)", SCHEER 9th plenary meeting on 5-6 June 2018.

[2] International Commission on Illumination (CIE), "CIE Position Statement on the Blue Light Hazard", April 2019.