Light Emitting Diode

Nichia Lighting LED for Disinfection

Table of contents

NF2W585AR-P8 refers to Nichia part number. The Nichia part number within this document is merely Nichia's part number for the Nichia product and is not related nor bear resemblance to any other company's product that might bear a trademark.

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1. Overview

In recent years, it has been found that the light in the wavelength range from 380nm to 420nm has a disinfection effect. Since the light in this wavelength range has less energy than ultraviolet light, it is less effective for disinfection but it is less harmful to human health; therefore, it is thought that the light in the wavelength range from 380nm to 420nm can be utilized for disinfection in situations where ultraviolet light cannot be used.

Nichia's NF2W585AR-P8 LED is a white LED where the light emitting device has a peak wavelength within the wavelength range from 380nm to 420nm. Nichia has achieved the dual function of illuminating and disinfecting objects by converting the light into white light with Nichia's original phosphor technology without losing the disinfection effect. This application note provides information on Nichia's NF2W585AR-P8 LED and precautions when using the LED.

Figure 1. Appearance of Nichia's NF2W585AR-P8 LED

Figure 2. Reference Images of Situations using LEDs for Disinfection

2. NF2W585AR-P8 LEDs

2.1 Properties of NF2W585AR-P8 LEDs

Figure 3 shows the emission spectra of a typical white LED[1] and a NF2W585AR-P8 LED. The typical white LED uses an LED chip that emits blue light at a wavelength of 450nm and has a peak wavelength at 450nm. This typical white LED hardly emits light in the wavelengths below 420nm that is effective for disinfection. On the other hand, the NF2W585AR-P8 LED uses an LED chip that has a peak wavelength at 405nm and emits light in the wavelengths mainly between 380nm and 420nm that is effective for disinfection.

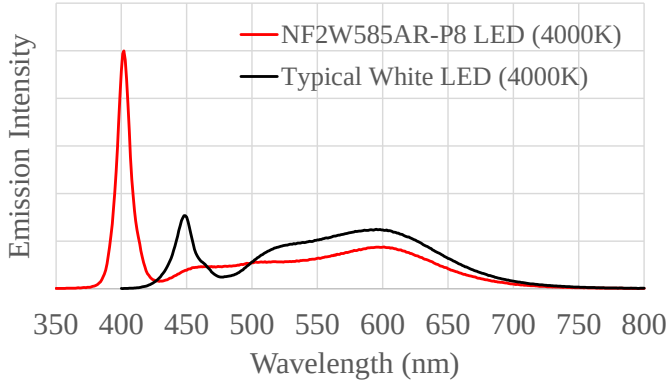

Figure 3. Emission Spectrum Comparison

[1] In this document, "a typical white LED" is defined as a white LED that uses blue chips that have a peak wavelength near 450nm and yellow phosphors.

Ultraviolet light with a wavelength around 260nm (UV-C light) is often used to damage and inactivate bacteria effectively. However, ultraviolet light with a short wavelength has a high energy and can damage not only bacteria but also the human body. On the other hand, the NF2W585AR-P8 LED emits light with the peak wavelength of 405nm that is classified as visible light, and its energy is much lower than ultraviolet light (UV-C light). For the classification of the peak wavelengths of LEDs, refer to Figure 4. Although the light of the NF2W585AR-P8 LED is less effective for disinfection of bacteria than ultraviolet light, it can significantly reduce damage to the human body. In addition, the NF2W585AR-P8 LED emits white light and its color rendering index Ra, which indicates color reproducibility, is over 80; therefore, this LED can fulfill the function as a white light source for a typical luminaire. In places where human activities take place, it is possible to maintain environments where bacteria cannot actively proliferate by continuously illuminating the places with the white light of the NF2W585AR-P8 LED.

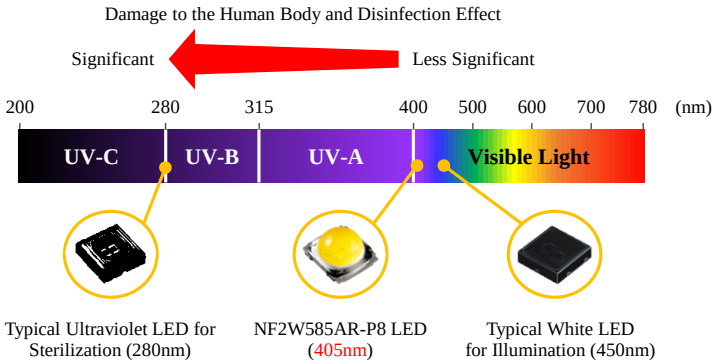

Figure 4. Peak Wavelengths of LEDs

2.2 Precautions when Using the NF2W585AR-P8 LED

The NF2W585AR-P8 LED emits light containing light of a shorter wavelength (higher energy) than that of a typical white LED. For safe and effective use, the following precautions should be taken into consideration when designing and handling the luminaire.

i. Disinfection Effect against Bacteria

The disinfection effect of the NF2W585AR-P8 LED is not effective against all bacteria. The disinfection effect varies depending on the structure of the luminaire and/or the environment where the luminaire is used. Verifications should be done against the target bacteria under the condition where the luminaire is actually used.

ii. Light Absorption of Optical Components assembled in Luminaries

The optical components assembled in the luminaire may absorb the light between 380nm and 420nm and the disinfection effect may not be fully achieved. When selecting optical components, verifications should be done to ensure that the light between 380nm and 420nm sufficiently passes through the optical components.
For reference, Nichia's light transmittance measurement results are shown in Section 3.

iii. Effects on the Human Body

The NF2W585AR-P8 LED contains a small amount of UV-A ultraviolet light (315nm to 400nm). Operating multiple LEDs at a high output at the same time or directly viewing or being exposed to the light condensed by the optical components for a long period of time may affect the eyes or health. Since the harmfulness of ultraviolet rays varies depending on the wavelength, irradiance, and exposure time during use, verifications should be done prior to use. In addition, it is necessary to provide users with sufficient precautions depending on the intended use.

iv. Effects on the Materials/Components used with the NF2W585AR-P8 LED

Depending on the materials/components used with the NF2W585AR-P8 LED, UV-A ultraviolet light (315nm to 400nm) may accelerate their degradation. Verifications should be done prior to use when selecting materials/components used for the luminaire. The degradation of the objects irradiated with UV-A ultraviolet light may also be accelerated; therefore, sufficient precautions should be taken. In addition, it is necessary to provide users with sufficient precautions depending on the intended use.

v. Estimated Lifetime of the NF2W585AR-P8 LED

Since the NF2W585AR-P8 LED emits light containing light of a higher energy than that of a typical white LED, the degradation of the materials used in the NF2W585AR-P8 LED is more accelerated than that of a typical white LED. Therefore, the lifetime of the NF2W585AR-P8 LED is shorter than that of a typical white LED. For this reason, limiting the operating conditions such as the input current may be required. If customers require the details of the lifetime of NF2W585AR-P8 LED, contact a local sales representative.

3. Light Transmittance of the Optical Components

The light transmittance of an object depends not only on its material but also on the wavelength of the incident light. The shorter the wavelength is, the more light is absorbed inside the object, resulting in a decrease in the light transmittance. The NF2W585AR-P8 LED has a peak wavelength of 405nm, which is the shortest wavelength of visible light, and its light is easily absorbed by the optical components such as lenses and covers. For this reason, the disinfection effect may not be achieved sufficiently. The following section shows the measurement results of the light transmittance for different materials. Use these results for reference when selecting optical components.

3.1 Measurement Method

Measurement Samples:

See Table 1 for the materials and thickness of the samples.

The color is transparent (colorless) for all the samples.

Table 1. Measurement Samples

Material	Thickness (mm)			
	1.0	1.5	2.0	3.0
Optical Grade Polycarbonate	✔	✔	✔	
General Grade Polycarbonate			✔	✔
Acrylic	✔	✔	✔	✔
Soda Glass	✔		✔	✔

Measurement Device:

UV-Visible Spectrophotometer U-3900 Manufactured by Hitachi High-Tech Corporation

Measurement Method:

Measure the total amount of the light that is transmitted through a sample (sum of the light that passes straight through the sample and the light that diffuses through the sample). The percentage of the light that is transmitted through the sample to the incident light is defined as a light transmittance. Then, measure the light transmittance for each wavelength.

3.2 Measurement Results

Figures 5 to 7 show the measurement results.

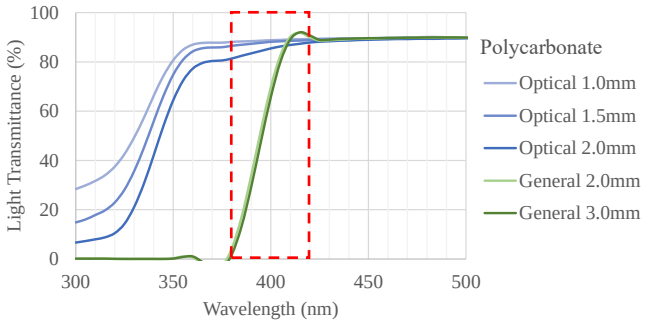

Figure 5. Light Transmittance Measurement Result (Polycarbonate)

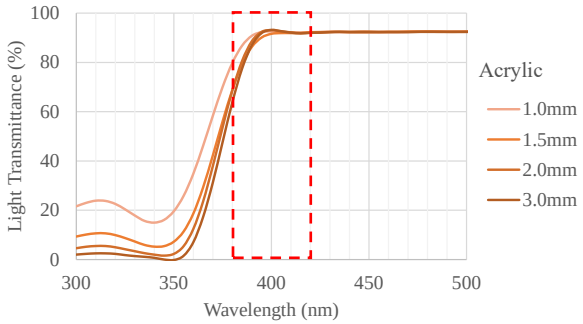

Figure 6. Light Transmittance Measurement Result (Acrylic)

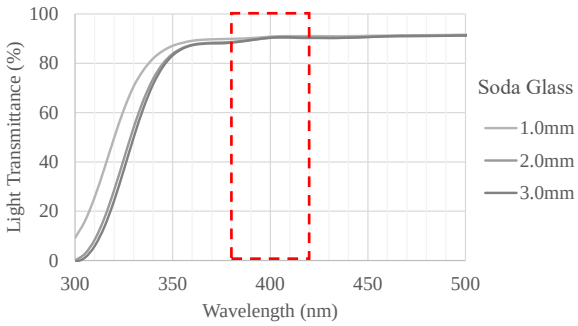

Figure 7. Light Transmittance Measurement Result (Soda Glass)

The comparison of the light transmittance between 380nm and 420nm, which is effective for disinfection, indicates the following:

- General grade polycarbonate has a low light transmittance, and the light intensity is significantly reduced accordingly, resulting in a significant decrease in the disinfection effect.
- Optical grade polycarbonate has a high light transmittance and the decrease in the disinfection effect can be minimized. The light transmittance slightly decreases when the polycarbonate plate thickness increases.
- Acrylic also has a high light transmittance; however, the light transmittance slightly decreases at the shorter wavelength (380nm).
- Glass has a high light transmittance at all thicknesses.

These results were obtained from measurements using certain materials. Even if the same material is used in the optical components, their properties may be significantly different depending on the grade of the material and/or the specifications of the optical component that is actually used. General luminaries usually use light diffusion covers with diffusion materials added or with surface processing to reduce the glare of the light sources. For those cases, the light transmittance may become even lower than these results.

4. Summary

The NF2W585AR-P8 LED is a product that has the characteristics of both a white LED for lighting and an ultraviolet LED for disinfection. This LED is assumed to be used for a luminaire with a disinfecting effect; precautions are required since this LED needs to be used in a different manner from a typical LED for a luminaire. When designing a luminaire using this LED, make sure that light with a wavelength between 380nm and 420nm, which is effective for disinfection, is sufficiently emitted through the luminaire. In addition, verifications should be done against the target bacteria under the conditions/environments where the luminaire is actually used. If customers have any questions regarding this product, contact a local sales representative.

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