HauntMaven.com - Wolfstone's Haunted Halloween Site

http://wolfstone.halloweenhost.com/Lighting/bltled_BlackLightLED.html

Black Light LEDs

Light Emitting Diodes (LEDs) that emit black light are now available. They seem to be good sources of strong, pure black light. They are also tiny, and use little power.

There has been a lot of interest in UV "black light" LEDs, largely kicked off by the glowing creature eyes that Jim Kadel sells through Haunt Master Products. Jim gets points for offering the first commercial haunt products using black light LEDs and has suggested many haunt uses for this technology.

Safety

First Impressions

[This missive on safety of UV LEDs is adapted from a posting to Halloween-L that I made on the subject, August 2002. I have added some stuff since then.]

Let's start with the basics, quoting myself at black light basics:

"Ultraviolet light" generally refers to electromagnetic radiation with wavelengths in the range of 10 to 400 nanometers. This is subdivided into:

- UV-A = 315 to 400 nm.
  345 to 400 nm = used for "Black light" effects.
  315 to 345 nm = are used for suntanning.

- UV-B = 280 to 315 nanometers. Hazardous! Largely responsible for sunburn.
- UV-C = 200 to 280 nm. Dangerous! Used to kill germs.
- Vacuum Ultraviolet - 10 to 200 nm

Since we have no desire to sun tan our eyeballs, I suggest sticking to the 345 to 400 nm range. But just because a light source is UV-A does not mean that it is completely safe. It just means that it is safer than the really nasty flavors of UV. UV-A can still cause damage and must be used judiciously.

Also, be aware that intense light of any wavelength can damage your eyes, and since UV is not visible, you might be getting a damaging dose and not even know it.

Next stop: the Virtual LED Museum, an excellent resource for LED info. Their page at http://ledmuseum.home.att.net/leduv.htm is dedicated to UV LEDs.

The author states "Roithner Lasertechnik # RLT350-30 ... With a peak wavelength of 350nm, this is the shortest wavelength UV LED I've heard of in current production." I find this statement comforting because it implies that none of the UV LEDs go outside the relatively safe "black light" range.

It seems that LED museum lists these in chronological order, with oldest entries at the bottom of the page.

- Roithner Lasertechnik # RLT350-30 - peak wavelength of 350nm
- Roithner Lasertechnik # 380D30 - 380nm
- Roithner Lasertechnik # HUUV-5102L - 393-395nm
- LEDTronics # L200CUV395-12D - 395nm
- Wilycon # WUV503-C395-C - 390nm minimum, 395nm typical, 400nm max
- Nichia America, NSHU550E - 370nm

Now I have a problem: The museum's cautions are displayed with the Nichia LED, and warn:

Thankfully here, the LED's UV emission is all long-wave, and not the even nastier medium and shortwave kind. If you need to view this LED directly for any reason (studying it, curious, etc.), obtain a UV filter and place it between your eyes and the LED's window before you try feeding this LED any power.

Don't let the sickly, weak whitish glow fool you. This comprises only a few percent of the LED's actual energy output - the rest, a whopping 1 milliwatt of radiant output, is in that nasty UV range.

Now, scroll back to "LEDTronics # L200CUV395-12D" "high powered 395nm LED", which states the following:

preliminary test showed this LED has an optical power output in the 5-8mW range

Um, so we got a warning for the 370nm 1mW, and none for the 395nm 5-8mW, though both fall into the relatively safe "black light" part of the UV-A range.

Theory:

- The LED museum's warning was put up when the original Nichia UV LED was posted, and as new LEDs were added at the top, the warning is intended to serve for all of them.
- The wavelength of all these LEDs falls into the relatively safe UV-A region, but their invisible intensity is what makes them dangerous.

I did some more searching, and found no UV LEDs emitting shorter wavelengths than those discussed on the museum page. But I am still concerned about the intensity.

My concerns about black light LEDs are not that their wavelength is dangerously short. I am concerned that they are extremely bright and often narrow-angle, and so near to invisible that their brightness would not be noticed ... until it is too late.

That's it - the problem is that UV LEDs are "invisibly bright!"

Reader Feedback

Since writing First Impressions on safety, I got a friendly note from Craig Johnson, curator of the Virtual LED Museum. He was kind enough to amplify on the subject of UV LED safety:

The theory you put on the page is correct: it [the warning] was added when I first evaluated the Nichia NSHU590E, and should cover all the LEDs on the page. I'll add text to the UV warning that it is indeed for all LEDs on that page, so there is no more confusion. Even better, I'll also place a copy of that text on the top of the page, so it cannot be missed by any visitor.

I also received the following from electrical engineer Michael Holman:

The fact that the light is UV-A does not make it inherently safe. Even looking into a visible-light high intensity LED can cause eye damage. However, with visible light one has a negative feedback system; the discomfort tells you to stop. In contrast, UV LEDs appear quite dim and don't provoke discomfort. Thus, one is much more likely to expose oneself to the light for excessive periods. The company selling them as "eyes" is likely to get into some trouble, especially if they claim that they are safe because they are UV-A. The fact that UV-A provokes the tanning response in skin and is worthy of being blocked by sunscreens and UV-blocking sunglasses should provide ample cause for caution. These concerns were not such a problem with the old black-lights since the light was diffuse and produced over a relatively wide area. LEDs produce a much more focused beam.

As you state, indirect usage - illuminating fluorescent materials - is the correct and safe usage. In such cases, the UV is converted to visible light and any reflected UV is diffused and greatly diminished in intensity.

More Black Light Safety

Our black light page has more safety info.

Current Feelings

At the time of this update (Aug 2004), my feelings about UV LEDs have changed a bit.

Improving technology has produced UV LEDs with wavelengths short enough to be dangerous, but these are uncommon and expensive. The commonly found UV LEDs tend to be "near UV" and their danger is not so much in their wavelength as that they are "invisibly bright".

I still consider UV LEDs to be a solution in search of a problem, but I have seen some impressive ways to use them. UV LEDs are no longer amazing curiosities, but really useful things.

I am still a little worried about aiming UV LEDs at people, but there are many other ways that UV LEDs can be safely and effectively used. Even as LED creature eyes.

Haunt uses

Black light LEDs are a wonderful technical breakthrough. They are a solution looking for a problem that needs solving.

Creature eyes

Jim Kadel's Haunt Master Products has long offered glowing LED eyes, available in numerous colors. With the advent of black light LEDs, Jim added them to his creature eye offerings. Some other vendors of commercial LED creature eyes have followed suit.

At first, I was skeptical of LED creature eyes emitting black light for several reasons:

- Usually, we can't get enough black light in haunts. But in every case where I have used black light or seen it used, it was *pointed at a prop.* Only a little reflected black light made it to the eyes of the guests. When pointed at a prop, more is better, and fairly safe. But in this case, the UV eyes are assumed to be embedded in some creature that is looking at the haunt patron. So the patron is getting the LED output straight.
- It is said that UV LEDs are UV-A and therefor safe. I have come to doubt that any form of UV is really safe. It's just that the shorter the wavelength, the worse.
- Users of this product often line the eye sockets of their creatures with fluorescent paint, converting the black light to colorful visible light. Why not just use a colored LED?

Since then, I have seen a safe, effective, and impressive way of using LED creature eyes by using the UV LED eye to backlight uranium glass marbles. This is another of Jim Kadel's ideas, and I like it very much.

FCG illumination

Halloween 2002 saw a small commercial Flying Crank Ghost, I think by Gemmy, for sale at various outlets including Spencer. Black light LEDs in the top housing illuminated the ghost puppet hanging below.

Fire flies

On one of the Halloween e-mail lists, it was suggested (I think by Jim Kadel himself) to paint a black light LED with luminous paint and regularly blink it, giving the greenish light and slow decay of a firefly.

UV Strobe

Some haunters have built solid-state black light strobes out of UV LED arrays with appropriate driver circuits.

Miniature illumination

My wife and I have a miniature Halloween town decoration, using spooky town buildings from Michael's. In 2004, they offered a couple of items decorated with fluorescent paint and illuminated by a black light LED.

The LED is the scale-model equivalent of a spotlight.

Fluorescent on the LED

GrimShady posted an idea to Helloween-L...

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> From: Halloween-L@lists.wildrice.com On Behalf Of (The Real) GrimShady
> Sent: Saturday, September 25, 2004 10:43 AM
> Subject: Hall: UV LED for eyes
>
> Yes I did it...I stuck a couple UV leds into my FCG and turned the
> intensity way down (about 20ma).
> The eyes look very unique and the lower intensity will be fine for a dark
> cemetery.    Then I thought...I really need something for the UV to react
> with.   So I took some reactive PINK and just place a big DOT of
> pink over the front of the LED.  What I ended up with is really Kool.
> From off the sides you see a violet color but when you get directly in
> front you get a bright blaze of PINK that overcomes the violet.  As you
> pass you get violet again.
>
> I have seen this on car tail lights where, from a distance you see violet
> but up close you see red.
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I like the two-tone idea, but the best part is that in the front, where the UV is strongest (and you don't want it shining straight into human eyes), the UV hits a dot of paint that transforms it into visible light - making it safer.

How about you?

Got a killer use for these neat black light LEDs? Let us know!

UV LED Lifetime Problems

Wolfstone reader Leigh Ellert wrote to me with some comments about the lifetime of UV LEDs. To cut to the chase, Leigh says that "They don't last very long."

- seven different LED types were tested, each from a different ebay seller
- test LEDs are run 24/7, at 20 mA
    - At two weeks, the output of *all* LEDs was down by 30%.
    - At three weeks, they were down by 50%.
    - At six weeks the output was down by 70%.
    - At twelve weeks the output was down by 90%, and roughly stayed there.
- Visible light output appears undiminished, but the UV part of the output decreases.

Leigh's full e-mails include testing methodology. It may not be lab-grade, but the setup sounds good to me. Details, posted by permission, are here: UV LED lifetime issues. 

According to industry rule of thumb, when LED output is reduced to half the original output, consider it dead. At that rate, Leigh's experiments suggest a working life of only three weeks for UV LEDs.

When working with UV LEDs, I suggest:

- Don't use maximum current from the spec sheet.
- Use very conservative designs.
- Avoid wiring LEDs in parallel.
- When not actively in use, turn them off!

Failure To Stimulate Some Fluorescent Materials

The Theory

As of this writing [30 September 2004], all of the common and inexpensive UV LEDs have a peak emission in the long side of the UV-A band. The specs usually say between 395nm and 400nm.

Light in this range barely qualifies as ultraviolet. In fact, some definitions put the start of UV at 390nm, and these LEDs don't qualify as UV at all. I still consider these LEDs to be putting out UV, but don't fool yourself into thinking that the current crop of UV LEDs are just like a fluorescent black light, only smaller. They're not. Fluorescent black light can be anywhere between 345nm to 400nm. In general, fluorescent black lights used for fluorescent effects produce shorter wavelengths than the common UV LEDs.

Different fluorescent materials respond to different UV wavelengths. Some materials, although they respond to "UV", require shorter wavelengths, and respond poorly (or not at all) to UV LEDs.

User Reports

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> From: Halloween-L@lists.wildrice.com On Behalf Of DeanMackey
> Sent: Monday, September 27, 2004 5:24 PM
> Subject: Re: Hall: Glowing Runes
>
> I bought wildfire uv paints, the kind that are white unless they
> have uv shown upon them, then they turn colors. I also bought a
> uv led flashlight from them. it doesn't make them glow though...
> only a true uv flouresent bulb makes that paint I got work. So
> I don't know if anyone else has had better luck with uv leds?
> From: Halloween-L@lists.wildrice.com On Behalf Of Barry Schieferstein
> Sent: Wednesday, September 29, 2004 4:24 AM
> Subject: Re: Hall: short lifetime of UV LEDs
>
> I have found that it depends on the color of the UV paint.  I have
> paint from Gecko and the LEDS work great on the yellow, marginal with
> the orange, and almost non-existant with the pink.
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Exceptions

There are currently some exceptions to this trend. There do exist UV LEDs that emit shorter wavelength UV. They just cost a lot more money and are harder to find. But you can get them.

As technology improves, shorter wavelength UV LEDs will become plentiful and cheap. Just make sure that, if you use them for entertainment purposes, they remain within the range of 345nm to 400 nm.

Here are some Virtual LED Museum, as of 30 September 2004 (most recent entries first):

- Roithner Lasertechnik #RLT365-525, 365nm, 850uW (0.85mW) at 20mA.
- Roithner Lasertechnik #385D15, 385nm, 2-4mW
- Roithner Lasertechnik, #5P4FCA, 395nm, 26mA
- Roithner Lasertechnik, #RLT350-30, 350nm
- Roithner Lasertechnik, #380D30, $6, 380nm, not much over 1mW
- Nichia 375nm UV LED
- Roithner Lasertechnik, #HUUV-5102L, 393-395nm, somewhere in the 2-4 milliwatt range
- Digi-Key 5mm 380nm UV LED (Lumex #SSL-LX5093SUVC), 380nm, 2mW - 4mW
- Chi Wing 5mm 395nm near-UV LED
- Sandia (experimental), wavelengths as short as 275nm
- ETG #ETG-5UV395-30, available from ETG, 395nm, 10mW at 30mA
- LEDTronics #L200CUV395-12D, 395nm, 5-8mW range at 20mA
- Wilycon #WUV503-C395-C, $0.65, 395nm, 10-12mW at 20mA
- Nichia America #NSHU550E, estimated $33.00 apiece, 370nm, 1000 uW @10mA

The shortest wavelength commercially available UV LED emits at 350nm. Those particular LEDs probably stimulate as wide a range of fluorescent materials as fluorescent black lights.