# Scientific Facts for You

All light sources make photons in specific ways. How each type of luminaire physically works determines how useful it is in any application. The physics controls the output. That spectral output in visible light impacts the presentation (what beauty is seen or hidden) and preservation (the damage rate).

Fast facts are brief articles designed to arm you with information.

There is a great deal of confusing science taught about LEDs. Please read the pdf paper "How a LED Works," Below is just a brief excerpt. If you do not know how light is made in the semiconductor and converted into white light by phosphors, this discussion about lamp life is too brief to give you the facts.

## LED = Blue Pump Phosphor Lamp

Remember, all **light emitting diode** lamps (LEDs) that produce white light instead of a single indicator color (but a white light that is not tristimulus RGB) are "blue pump phosphor" sources. **All of them.** The lamp takes electricity, flows it through a diode, pairs electrons into photons which are blue wavelength photons…really, really it-hurts-your-eyes **blue** light…and then uses phosphors to convert that blue light into white light.

## Diode Lamp Life Verses Phosphor Lamp Life

How a LED works also changes over time. LEDs have the marketing luxury to claim predicted or calculated lamp life. Predictions are long. But, in less than twenty years, LED predicted lamp life has shrunk from 100,000 hours to 80,000 hours to 65.000…you get the idea. Today the predicted lamp life is 35,000 hours to 24,000 hours depending upon the manufacturer. However, you will find LEDs in the field that have failed in just a few years and some with shorter lamp life than a typical halogen lamp life of 2,000 hours.

Blue light is directed by the slot and "pumped" through the phosphor. This slot erodes. It gets bigger. The blue light has less aim. The LED is less effective.

That inefficiency converts into infrared photons. The LEDs operating temperature climbs. The lamp gets hotter. The circuits controlling the semiconductor or the semiconductor itself fails.

This is why LEDs use heat sinks, fans and can requirer free air operation. But it is also why manufacturers state the LED's lamp life is high. The LED never fails in a few thousand hours. The LED works. It is the circuitry that failed. And the circuit does not count in lamp life calculation even if the lamp emits no light.

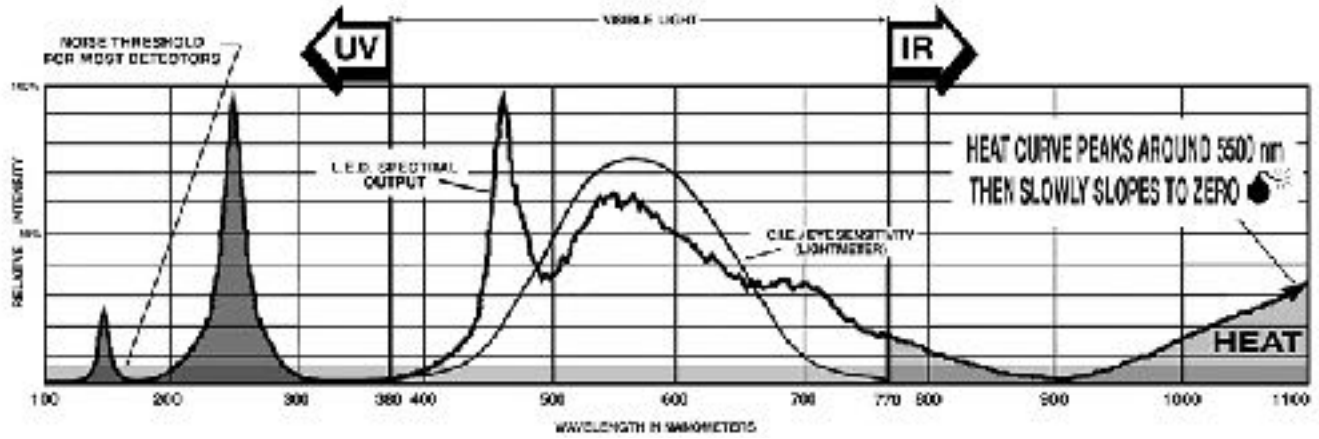
The point is, over time, the phosphors always degrade. They literally get consumed by the photochemical processes. So LEDs grow dimmer. The circuitry grows hotter.

n older LED is half as bright. Good quality LEDs offer long lamp life. The diode survives. But the light output in footcandles can drop by 1/3 or 1/2 in less than two to three years. That is a 33% to 50% loss in light.

The slot growing in size as it wears away its sides helps as the blue light is spread over a wider area of phosphor. So the lamp tends to stabilize at the half footcandle level and then ever so

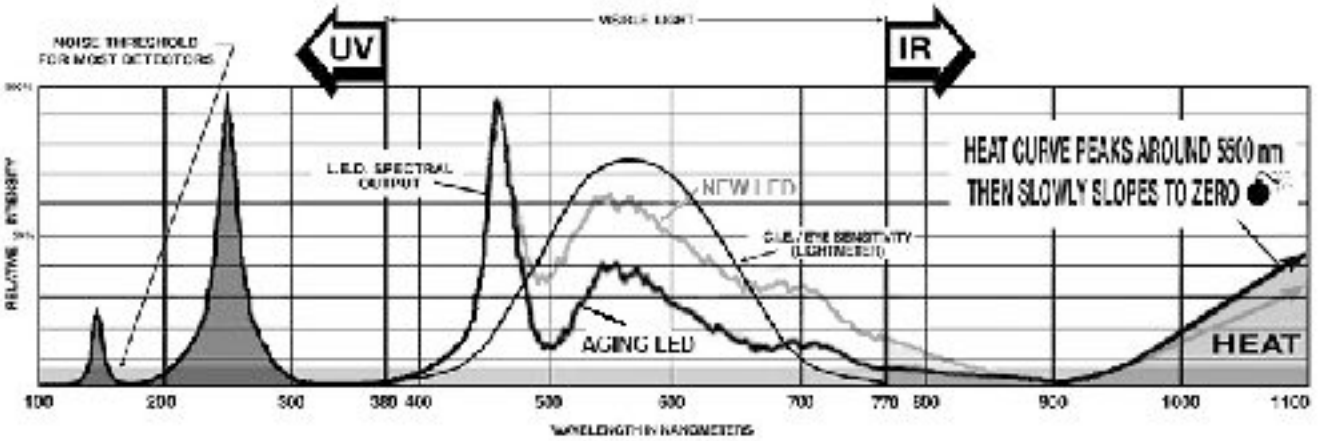
slowly gets dimmer over the remaining operating life.  That is, if the heat does not get too intense to destroy the LED's circuit.

A brand new, out-of-the-box, good-quality LED's output looks like this.




Pay attention to the stipulation. This is the performance of a very good-quality LED. There is a lot of marginal and poor product on the market. This is top performance.

A few years later that same good-quality LED's output changes to this.




Comparatively, the blue output hasn't changed much, because more of the LED's photons created at the PN junction make it through the phosphors without converting to other colors of light. The ultraviolet is not really effected. The best LEDs filter the UV. So the UV should be no concern. Of course, the infrared output rises and so does the lamp failure caused by internal heat.

If the lighting design takes this degradation into consideration, beginning installations are overly bright. They are full of glare. This is why dimming LEDs has become so important.  But the design has a harder time passing the energy saving calculations for the building. More lights and controllers are used.

If the lighting design ignores the fact that LEDs loose footcandles in a short few years, the light levels may not be high enough over time. The degrading happens. It is inevitable. Once the

phosphors are gone, it does not matter if the diode still works. The LED needs to be replaced. Technically the lamp has many more years of lamp life left. But practically, the lamp is just as worthless as if it produced no light at all.  The installation is too dark.

Our papers are full of how-to help.  For a discussion about OLED lamp life and dead pixels, please read the pdf paper “How a LED Works.”  LEDs, OLEDs and PLEDs are extensively covered. The paper also will help you decide when LEDs are a good choice in lighting and when they are a really bad decision.