LASER COMPONENTS®

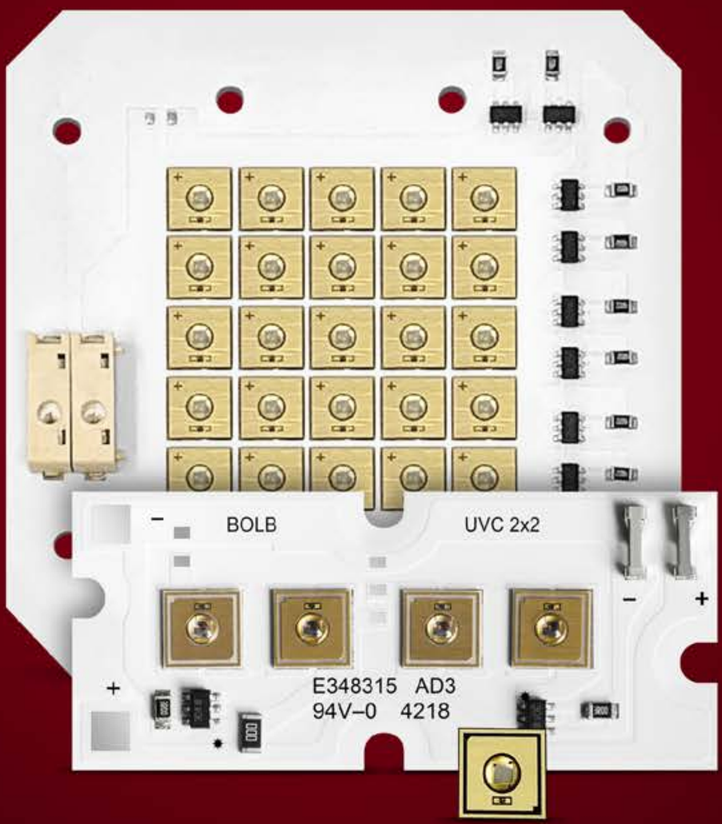
UNDERSTANDING, CHOOSING, AND BUYING **UV LEDS**

beyond borders

Although considerably younger than other in-use light sources, UV-emitting diodes (LEDs) are a rapidly advancing technology at the center of a constantly shifting market.

It has been just over 30 years since the Nobel Prize winner Isamu Akasaki first developed this technology and opened up new areas of application, especially with short UV wavelengths between 320 nm and 100 nm.

This guide is an overview, as well as a practical decision-making aid, to help you find a suitable UV LED no matter your application or need.


BOLB
UVC 2x2
E348315 AD3
94V–0 4218

WHICH WAVELENGTH DO YOU REQUIRE?

When searching for the right UV LED, it is important to focus first on your application and desired LED wavelength. The »UV« in »UV LED« stands for ultraviolet radiation, which is the wavelength range (approximately 400 nm and 100 nm) between the visible spectrum and X-rays. In similar fashion to how visible light is divided into different colors, invisible UV radiation is traditionally segmented by wavelength ranges. This segmentation is applied to the industrial and commercial use of »UV light«.

/ UV-A

The term »UV-A« designates the wavelength range between the end of the visible light wavelength (approximately 400 nm) and 320 nm. Within this range, there are two important everyday uses of UV light for which to be aware.

The first commercial LEDs available at the end of the 1990s were sold in the wavelength range between 420 nm and 390 nm. Today, these »black light« LEDs are primarily used in counterfeit-proofing banknotes, identification cards, and documents. This works due to the low-output power levels these applications require.

UV radiation between 390 nm and 350 nm, on the other hand, is used in various industries to cure adhesives, coatings, ink, and other materials. Due to its high efficiency and compact design (not to mention its low operating costs) these diodes are increasingly replacing other technologies, such as mercury vapor lamps.

/ UV-B

The term »UV-B« designates the wavelength range between 320 nm and 280 nm. We typically find UV-B paired with UV-A in the latest market introduction of LEDs between 340 nm and 300 nm. These LEDs offer great potential for applications such as UV curing, DNA analysis, dermatology, and sensor technology.

/ UV-C

The term »UV-C« designates the wavelength range between 280 nm and 200 nm. Since UV-C light is completely absorbed by the atmosphere, no living creatures on Earth have formed a natural defense against this high-energy radiation. When cells absorb this radiation into their DNA and RNA, their nucleotide sequences »clump together«. This destroys the genetic information of a cell, ensuring that it can no longer reproduce and can, in fact, be killed. This makes UV-C LEDs perfect for germ disinfection.

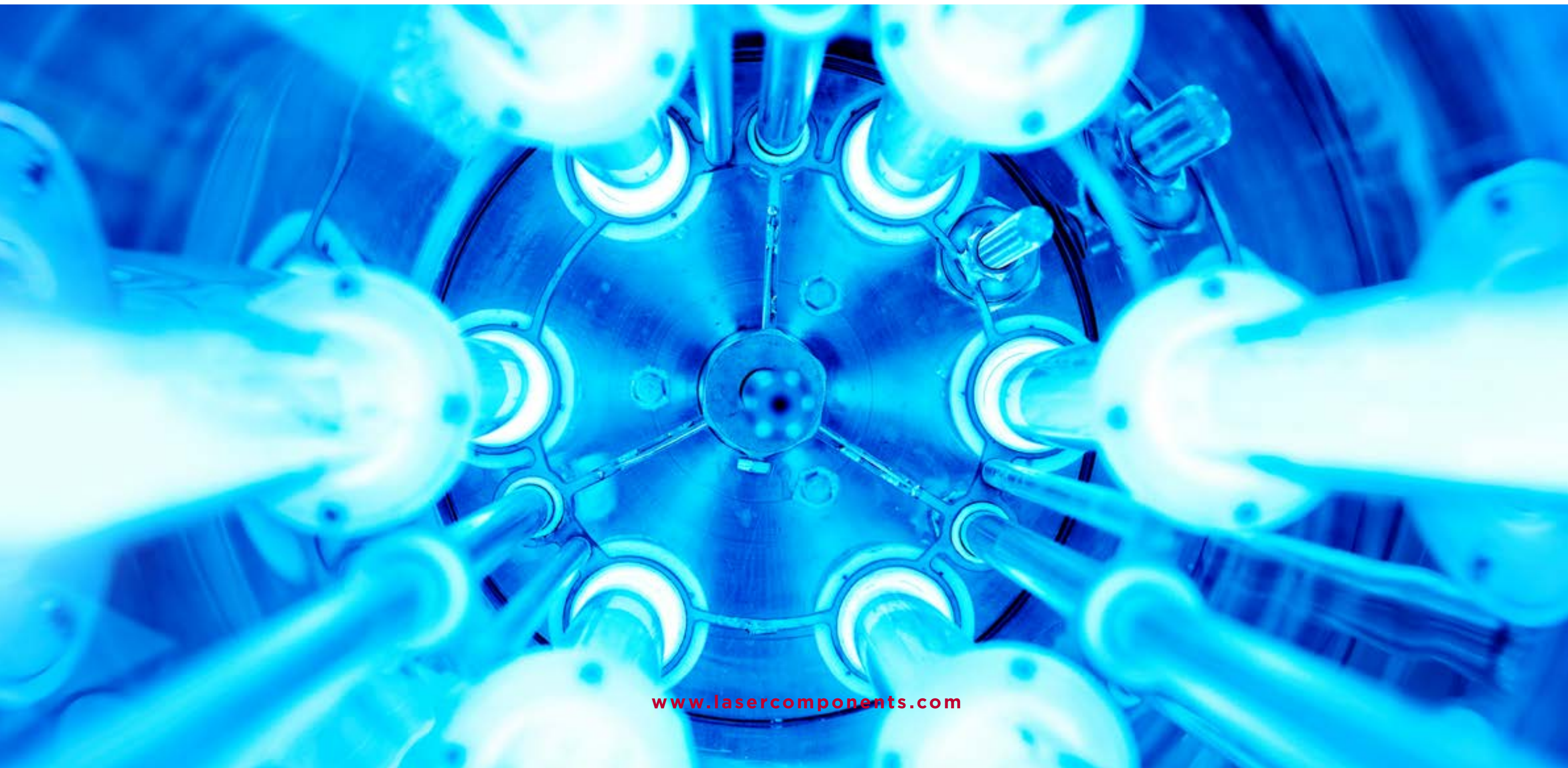
In addition to wavelength and output power, the properties of various germs must be considered with respect to disinfection applications. UV-C LEDs can achieve a sufficient disinfection rate of 99.9999% after longer periods of irradiation.

SMALLER AND MORE EFFICIENT THAN PREVIOUS SOLUTIONS

When it comes to market success, the emitted wavelength and power of an LED each play a crucial role. This is one reason why short-wave UV-C LEDs have made significant market progress in recent years.

One effect of this market success has been the de-emphasis of Mercury vapor lamps, which have been used as radiation sources for decades. This is largely due to the fact that LEDs have several advantages over more traditional technology:

- Whereas previous solutions (such as vapor lamps) require high voltages and generate large amounts of heat, LEDs can operate with low DC voltages and currents – making mobile use possible.
- LEDs emit a negligible amount of heat radiation in the direction of their beam and can, therefore, be used for processing heat-sensitive materials.
- Unlike traditional solutions, LEDs do not require a »warm-up time« and are instead immediately operational. This allows for emitters to pulse in the millisecond and nanosecond range.
- Wavelength, radiation intensity, and beam shape are easily adjustable during production. Whereas solutions like mercury vapor lamps emit specific peak wavelengths, LEDs can be manufactured for a wide range of wavelengths.
- LEDs are small, compact, and can be integrated into most application designs. And perhaps most importantly of all, LEDs are not fragile nor contain toxic substances.



SATURATED MARKETS AND HIGH GROWTH POTENTIAL

The market situation for UV LEDs can be understood via the technical development of each wavelength solution. LED technology cycles begin with technical innovations that open new markets: at this impetus, quantities are low and cost is high. As with all new technology, these solutions become more established on the market over time and demand increases. As a result, quantities rise and prices fall, resulting in a saturated market with industrial mass production, high quantities, and low prices. Accordingly, each UV LED market is at a different point in their development cycle. Currently, the rule of thumb is the shorter the wavelength, the more expensive the LED.

As noted during our section on UV-A, the technology for black light LEDs has been in the public for decades. This had led to low manufacturing costs as well as low-priced products.

On the other end, we have seen the pressure to innovate in the wavelength range between 390 nm and 350 nm recently result in rapid growth. Manufacturing costs are still significantly higher than those in the black light segment; however, increasingly efficient production methods and rising product volume has led to a continuous decline in pricing.

In recent years within the UV-B segment, there has been an increase in the output of individual LEDs. With that said, the quantum efficiency value of these LEDs (i.e., the number of photons that are generated) is increasing continuously and opens up new fields of application, but it will still take some time before UV-B LEDs displace established technologies within the market on a large scale.[1]

Finally, the market for disinfection applications is currently the most exciting and dynamic among LED solutions. Although Mercury vapor lamps dominate the market, there is reason to believe their deficiencies (e.g., their bulk and fragility makes them unsuitable for mobile applications) will allow UV-C LEDs to gain a significant share. This is because these LEDs have been developed to make effective disinfection solutions possible. Accordingly, analysts expect the market for UV-C LEDs to develop rapidly in the coming years.

1 https://onlinelibrary.wiley.com/doi/epdf/10.1002/phvs.201900039

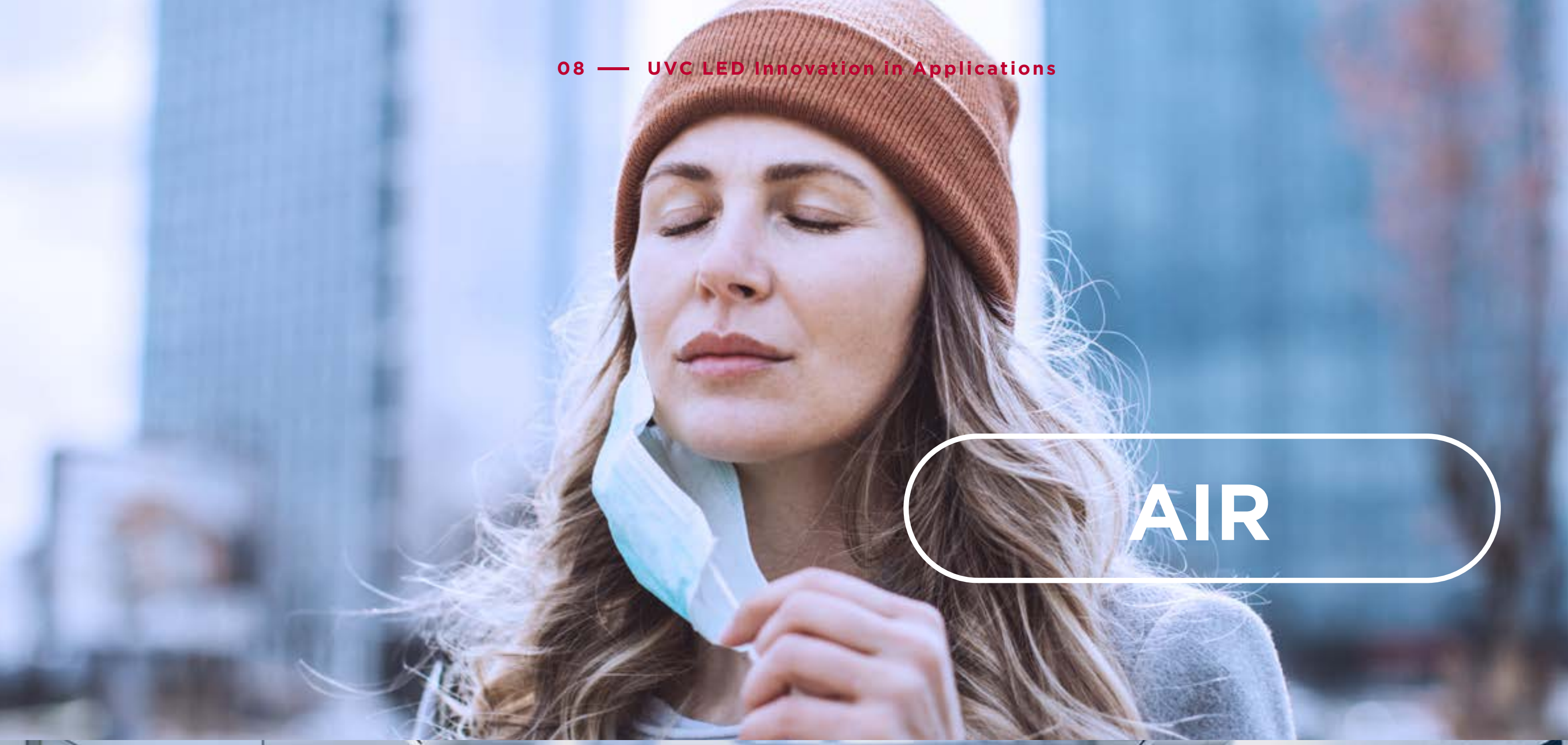
TECHNICAL INNOVATION TRIGGERS NEW GROWTH

A significant technical breakthrough for growth in the UV-C LED market was achieved a few years ago with the development of a p-doped material that is transparent to UV-C wavelengths and offers the desired photon yield. The company, California start-up Bolb, Inc., uses quantum electrical effects to increase the quantum efficiency of the UV-C spectrum to 14% above its own commercial UV-C LED design of 6%. But an 8% increase is just the beginning: Bolb, Inc. believes that a quantum efficiency of 75% will be able to be achieved in the near future[2].

With the technical foundations having been laid, it is now possible to venture a forecast as to the further development of the market. Experts liken the current state of UV-C LEDs to the market for blue LEDs, which were created at the end of the 1980s with a similar technical breakthrough. Furthermore, the COVID-19 crisis has provided a sustained boost to the market as prior to the pandemic, analysts predicted it would take the UV LED market several years to exceed $1 Billion USD. Market giants, such as Nishia or San‘an, are currently investing large sums of money in UV-C LEDs while small, innovative start-up companies work on expanding their technological lead.

With LASER COMPONENTS' UV LED suppliers planning to achieve an output of 400 mW and a quantum yield of 20% in just a few short years, the photon yield could rise to over 50% by 2030 with the price point around $1/optical watt. Meanwhile, leading foreign LED manufacturers, such as Photon Wave distributed by LASER COMPONENTS, are able to offer quality UV-B and UV-C solutions at a competitive price. By focusing on applications for air, water, and surface sterilization, companies like Photon Wave are poised to play a fundamental role in shaping the deep UV industry.

2 https://onlinelibrary.wiley.com/doi/epdf/10.1002/phvs.201900039


AIR


SURFACE


WATER

SHORT WAVES, GREAT EFFECT. UV-BASED EXPERTISE FOR ALL MARKETS.

Furthermore, in analyzing the significant advantages LEDs possess over current market solutions, it is likely that LED market share will occur more rapidly than expected, especially when considering that new market segments are opening that are not covered by conventional technologies (e.g., Bolb's or Photon Wave's solutions for mobile water treatment). The heightened global awareness of hygiene and disinfection that has resulted from the COVID-19 pandemic will continue to drive demand and technical development. For example, several large car manufacturers have already announced plans to invest millions in UV disinfection solutions for vehicle interiors, which can only be implemented with appropriate LEDs. Similar applications are currently being developed for public transportation and patient transport, and we can only expect to see these needs increase over time.

Original source (Photoniques, the magazine of the Société Française d'Optique) and link to the original article:
https://www.photoniques.com/articles/photon/pdf/2021/01/photon2021106p48.pdf

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