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Solid State Lightening Component LED: Role in Modern Lightening Technology

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Abstract: *An understanding of Light-Emitting Diode (LED) technology is an investment in future prosperity. This article tries to explain the development of LED and how the development of LED lightening technology became a superior business judgment for industrial lightening.*
Keywords: Electroluminescence, Contact Fluorescent Lamps, Lightening Technology.

1. INTRODUCTION:

A light-emitting diode (LED) is a two-lead semiconductor light source. It is a p-n junction diode, which emits light when activated. When a suitable potential is applied to the leads, electrons are able to recombine with electron holes within the device, releasing energy in the form of photon. This effect is called electroluminescence, and the color of the light (corresponding to the energy of the photon) is determined by the energy band gap of the semiconductor. This semiconductor light-emitting diode, or LED, is a key component of today's lightening technology. Modern households have numerous tiny glowing indicators provided by LEDs that are used for reading CD and DVD disks in computer and games-console drives, or for transmitting signals to electronic equipment from remote controls. Increasingly, cars are equipped with LED indicator and brake lights. Most crucially, however, the LED is a vital link between electronics and photonics. Semiconductor lasers based on LEDs send modulated optical signals into telecom fibers, serving the ever-growing demand for broadband communication and Internet.

2.DEVELOPMENT OF LED TECHNOLOGY:

Like every scientific discovery, the development of light emitting diodes happened over time, gaining progress in fits and starts. Early pioneers like H.J. Round, Oleg Losev, and Rubin Braunstein laid the foundation in the first half of the 20th century, experimenting with crystals and gallium arsenide to produce the first examples of electroluminescence. The semiconductor laser, which has an LED at its core, was revealed shortly after the demonstration of the first ruby laser.

When it came to finding practical uses for their breakthroughs, however, the field was left wanting. That started to change in the fall of 1961 when a couple of Taxas Instrumentation (TI) researchers discovered that gallium arsenide emitted infrared light when exposed to an electrical current. James R. Biard and Gary Pittman earned their place in history as the fathers of LED light when TI introduced the SNX-100 the following year. The first example of an infrared LED bulb, the SNX-100 produced a 900 nanometer wavelength of invisible light and used a pure GaAs crystal as its sole source of illumination. The next decades saw LEDs move beyond their humble beginnings. One of the most important advances, however, took place almost simultaneously. In 1962 four research groups in the USA simultaneously reported a functioning LED semiconductor laser based on gallium arsenide crystals. Three of these papers were published in the same volume of Applied Physics Letters. Those involved were Robert Hall and Nick Holonyak from two different General Electric Company laboratories, Marshall Nathan of IBM and Robert Rediker of MIT, and their co-authors. These names now rightly belong in the optoelectronics hall of fame.

In 1962, Nick Holonyak, Jr. of General Electric developed the first visible-spectrum LED. Holonyak's red LED was later followed by yellow light in 1972, invented by M. George Craford, a former student of Holonyak's. Low light output from these LEDs limited their usefulness to anything more than indicators. For LEDs to become a legitimate source of light, researchers would have to figure out how to boost their output.

In the 1990s, Isamu Akasaki, Hiroshi Amano, and Shuji Nakamura did just that. With breakthrough development that earned the trio the Nobel Prize in 2014, they invented the first blue light beams, creating a revolutionary step forward in commercial lightening technology. With the blue LED, bright white light was now a possibility. More energy efficient and environmentally responsible than incandescent bulbs, the new LED lights could move worldwide power consumption into a brave new age.

3. APPLICATION OF LED IN LIGHTENING:

LED used in lightening now a days is not really new technology. It has been around for over 100 years. In the year 1962, the first commercial LEDs were sold to IBM. They replaced tungsten bulbs in punch card readers. The earliest LEDs emitted low-intensity infrared light. Infrared LEDs are still frequently used as transmitting elements in remote-control circuits, such as those in remote controls for a wide variety of consumer electronics. The first visible-light LEDs were also of low intensity and limited to red. Modern LEDs are available across the visible, ultraviolet and infrared, wavelengths, with very high brightness.

Early LEDs were used as indicator lamps for electronic devices, replacing small incandescent bulbs. They were soon packaged into numeric readouts in the form of seven-segment displays and were commonly seen in digital clocks. Recent developments in LEDs permit them to be used in environmental and task lightening. Now a day its applications as diverse as aviation lightening, automotive headlamps, advertising, general lightening, traffic signals, camera flashes, and lighted wallpaper. Scientist believe that as of 2016, LEDs are powerful enough for room lightening remains somewhat more expensive, and require more precise current and heat management, than compact fluorescent lamp sources of comparable output. They are, however, significantly more energy efficient and, arguably, have fewer environmental concerns linked to their disposal.

If we compare the today's lightening technology, it has been seen that incandescent bulbs have terribly wasteful. Almost 90 percent of energy is produced as heat rather than light. CFLs ("Contact Fluorescent Lamps") aren't much better, releasing approximately 60 percent of energy as heat. LEDs are more efficient, using up to 80 percent energy in the form of light. LEDs have many advantages over incandescent light sources including lower energy consumption, longer lifetime, improved physical robustness, smaller size, and faster switching.

4. PROBLEMS ASSOCIATED WITH LED IN LIGHTENING

A LED will theoretically last forever. LEDs will always produce light when power is properly applied. Over time, the amount of light will decrease. Eventually, the amount of light may be so low that the human eye cannot see it. When an LED reaches this point it is still not "dead," it is just producing light that is not visible to our eye. However, this state of unperceivable light is often not the fate of LEDs. Instead, the driver or other controls behind the LED fail first. It is in this area that technological developments have most benefited commercial LEDs. In order for an LED to be commercially viable, it must be reliable. Better technology in the drivers and controllers is the best way to build a more reliable LED lamp.

Early commercial LEDs had countless problems related to the technology around them. In many instances, materials that bond circuits failed and the LEDs stopped working. Another problem was from materials used to encapsulate the diode. The diodes started to change color as they aged. This material aging resulted in diminished output or color changing. These changes to the light output or color were seen as a failure of the LED, not a failure of the supporting hardware.

4.1 Not a White Light

Another, more visible problem with LEDs must be mentioned. The light that many of the early, commercial LEDs produced were not pleasing to people. The light was often bluish-white and lacked "warmth."

It is a little known fact that no LEDs are white. You can make LEDs in almost color but white. This is hard to believe because most of us have seen LED lamps that are white light. However, just one color LED cannot produce this white light. There are two common ways to make white light from LEDs. The first is to mix red, green, and blue LEDs to create white light. The other option is to use phosphor in the LED module. The LED light reacts to the phosphor, similar to the reaction in a fluorescent tube light, and the light that is output appears white. Both of these methods have their pros and cons but the use of phosphor became the more common method.

The use of phosphor proved to be easier, cheaper, and more reliable. This is not to say that it was perfect. In early commercial LED manufacturing, the color rendering of the LEDs was not closely monitored. This resulted in LED lamps that were manufactured in the same place around the same time but did not put off the same color of light. This inconsistency further hindered the widespread acceptance of LEDs.

4.2 Expensive Technology

Lastly, it is important to address the most obvious of all obstacles that LEDs have faced. This is of course: COST. The driver or controller needed to provide the correct power to these lights made the early costs of LED production expensive. In essence, every LED is backed by a tiny computer.

Initial high manufacturing costs made it difficult to see a practical return on investment for most applications. The good news is that advances in LED production, driver design, heat management, and new guidelines or standards have brought the consistent quality of all LEDs up to a higher level, while at the same time reducing production costs. Organizations focused on lightening efficiency have stepped in to offer structure and standards for the industry. The Design Lights Consortium (DLC) has become an industry leader for verifying efficient lightening solutions. The DLC tests the color rendering and life expectancy claims of countless lightening products.

Their objective is to bring facts and test data to the public so that consumers may make an informed decision. Organizations like the Underwriters Laboratory or ETL already perform tests to ensure product safety but there was no one testing the actual performance. The DLC continues to work toward a universal set of standards that will guide manufacturers to produce higher quality LEDs and help the consumers to make educated decisions. Regulating this industry or creating guidelines is no easy feat considering how fast it is advancing and how quickly practices in manufacturing and design can change.

LED technology has progressed at an amazing pace and today's solid state lightening solutions are better and brighter than ever. LEDs became commercially valuable in just the past few decades. Advances in production improved efficiency and light output of commercial LED lights, while lowering costs. The LEDs produced today are over twice as efficient as some produced only five years ago. This trend will continue and LED efficacy will go up as production costs go down. This rapidly developing field not only brings new technology to consumers but also brings new producers to the technology. Today, it is estimated that 200 new companies per month begin manufacturing LED products. This number will continue as technology advances and LED lightening becomes more mainstream.

5. THE FUTURE OF LED:

The LEDs are changing the way of the world lightening. As costs come down, experts predict we'll start seeing LEDs used everywhere we currently see CFLs and incandescent lightening. With their improved brightness, reduced energy usage, and better lifespan, LED lights are winning over consumers in both the commercial and private sectors. Right now, LEDs account for about 20 percent of the lightening market, but industry observers believe that number could grow to as much as 70 percent by 2020.

The future of solid state lightening is wide open. Within the next three years, we should see commercial LED efficacy pass the 200 lumens per watt mark. This level of efficiency, especially when compared to the 35 lumens per watt attained with incandescent bulbs, shows us that the future for solid state lightening is certainly bright and efficient.

6. THE NEXT GENERATION LED:

Beyond the promise of better efficiency, the promise of better products is in the near future for LEDs. One very exciting, new technology is OLED (Organic Light Emitting Diodes) technology . This will allow LEDs to be manufactured on flexible surfaces. This could revolutionize the way that we think about and design lightening and electronics. Imagine a display that could be folded in half like a piece of paper or imagine a material that could be rolled onto a wall or floor and turn that surface into an OLED display. A few manufacturers have already started using OLEDs in their products. Things like curved television screens and Smartphone screens utilize OLED technology. This technology is new and the costs are still high but we can safely assume that we will see more applications and lowers costs in the very near future.

Then there is the laser, which some scientists think it will provide us with illumination long after LEDs have come and gone. When using a laser diode instead of a traditional LED, you can pump about 2,000 times more electricity into the diode. While this has yet to be tested in practical terms, it could mean that laser diodes are capable of providing 2,000 times as much light. That alone could mark a substantial revolution in worldwide power consumption.

7. CONCLUSIONS

Increased efficiencies, improved light output, and lower production costs will help to pave the road for the commercial success of all LEDs. This success will in turn relieve stress from our burdened electrical infrastructure and enable renewable energy resources to more easily fit into our daily lives by reducing the overall demand.

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