SMD Vs COB LED Lights

1. What are LED's

The first reports of diodes emitting light were discovered in 1907 by the British Experimenter H. J. Round of Marconi Labs. Since then many attempts were made to bring the LED to the world, but prevented this until allied technologies were far more mature. Later the first visible-spectrum (red) LED was developed in the early 1960's.

A light emitting diode (LED) is a semiconductor device that emits light when an electric current is passed through it.

Light is produced when the particles that carry the current (known as electrons and holes) combine together within the semiconductor material.

Inside the semiconductor material of the LED, the electrons and holes are contained within energy bands. The separation of the bands (i.e. the bandgap) determines the energy of the photons (light particles) that are emitted by the LED.

The photon energy determines the wavelength of the emitted light, and hence its color. Different semiconductor materials with different bandgaps produce different colors of light.

The precise wavelength (color) can be tuned by altering the composition of the light-emitting, or active, region.

LEDs are comprised of compound semiconductor materials, which are made up of elements from group III and group V of the periodic table (these are known as III-V materials). Examples of III-V materials commonly used to make LEDs are gallium arsenide (GaAs) and gallium phosphide (GaP).

Until the mid-90s LEDs had a limited range of colors, and in particular commercial blue and white LEDs did not exist. The development of LEDs based on the gallium nitride (GaN) material system completed the palette of colors and opened up many new applications.

- Bright Blue is made with Gallium Nitride (GaN)
- White LEDs are made with Yttrium Aluminum Garnet (YAG)
- Red and Infrared LEDs are made with Gallium Arsenide (GaAs)

The Phosphor white method (Image 1.1) produces white light in a single LED by combining a short wavelength LED such as blue or UV, and a yellow phosphor coating. The blue or UV photons generated in the LED either travels through the phosphor layer without alteration, or they are converted into yellow photons in the phosphor layer. The combinations of the blue and yellow photons combine to generate white light.

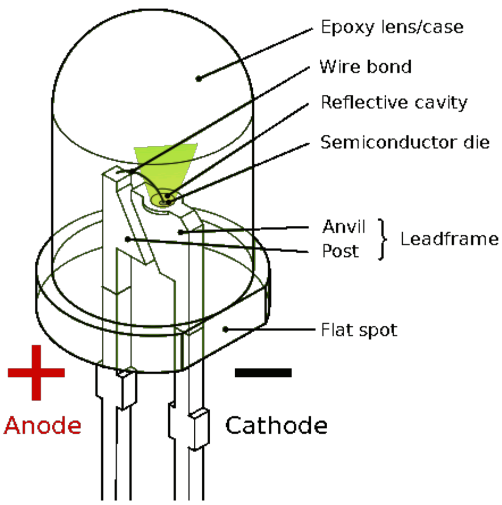

Image 1.0 – Parts of a LED.

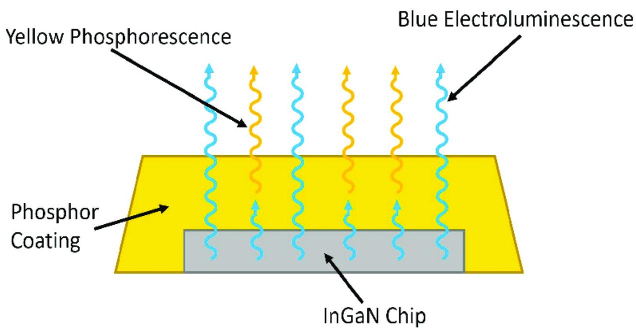

Image 1.1 – Phosphor White Method Schematic.

2. Advantages of LED's

- Efficiency: LEDs emit more lumens per watt than incandescent / Fluorescent / Halogen and CFL light bulbs.
- Color: LEDs can emit light of an intended color without using any color filters as traditional lighting methods need. This is more efficient and can lower initial costs. The colors provided by LED's can be much more precise than the traditional methods as well.
- Size: LEDs can be very small (smaller than $2mm^2$) and are easily attached to printed circuit boards.
- Warmup time: LEDs light up very quickly. A typical red indicator LED achieves full brightness in under a microsecond. LEDs used in communications devices can have even faster response times.
- Cycling: LEDs are ideal for uses subject to frequent on-off cycling, unlike incandescent and fluorescent lamps that fail faster when cycled often, or high-intensity discharge lamps (HID lamps) that require a long time before restarting.
- Dimming: LEDs can very easily be dimmed either by pulse-width modulation or lowering the forward current.
- Cool light: In contrast to most light sources, LEDs radiate very little heat in the form of IR that can cause damage to sensitive objects or fabrics. Wasted energy is dispersed as heat through the base of the LED.
- Slow failure: LEDs mainly fail by dimming over time, rather than the abrupt failure of incandescent bulbs.
- Lifetime: LEDs can have a relatively long useful life. One report estimates 35,000 to 50,000 hours of useful life, though time to complete failure may be shorter or longer
- Shock resistance: LEDs, being solid-state components, are difficult to damage with external shock, unlike fluorescent and incandescent bulbs, which are fragile.
- Focus: The solid package of the LED can be designed to focus its light. Incandescent and fluorescent sources often require an external reflector to collect light and direct it in a usable manner. For larger LED packages total internal reflection (TIR) lenses are often used to the same effect.

3. Disadvantages of LED's

- Temperature dependence: LED performance largely depends on the ambient temperature of the operating environment – or thermal management properties. Overdriving an LED in high ambient temperatures may result in overheating the LED package, eventually leading to device failure. An adequate heat sink is needed to maintain long life.
- Voltage sensitivity: LEDs must be supplied with a voltage above their threshold voltage and a current below their rating. Current and lifetime change greatly with a small change in applied voltage.
- Color rendition: Most cool-white LEDs have spectra that differ significantly from a black body radiator like the sun or an incandescent light. The spike at 460 nm and dip at 500 nm can make the color of objects appear differently under cool-white LED illumination than sunlight or incandescent sources, due to metamerism, red surfaces being rendered particularly poorly by typical phosphor-based cool-white LEDs. The same is true with green surfaces.
- Area light source: Single LEDs do not approximate a point source of light giving a spherical light distribution, but rather a lambertian distribution. So, LEDs are difficult to apply to uses needing a spherical light field
- Light pollution: Because white LEDs emit more short wavelength light than sources such as high-pressure sodium vapor lamps, the increased blue and green sensitivity of scotopic vision means that white LEDs used in outdoor lighting cause substantially more sky glow.
- Efficiency droop: The efficiency of LEDs decreases as the electric current increases. Heating also increases with higher currents, which compromises LED lifetime. These effects put practical limits on the current through an LED in high power applications.
- Impact on insects: LEDs are much more attractive to insects than sodium-vapor lights, so much so that there has been speculative concern about the possibility of disruption to food webs.

4. Main Types of LED's

There are 3 main types of LED's in general

1. Dual in-line Package (DIP) LED's. Also known as through hole LED's.

2. Surface Mounted Diode (SMD) LED's.

3. Chip on Board (COB) LED's.

4.1. Dual in-line Package (DIP) LED's

DIP LED's contain two connecting pins which are mounted through-hole to printed circuit boards (PCBs). DIP LED's have higher optical decay, lower CRI, and lower efficiency than the more recent SMD LED's. However, many DIP LED's are used in larger pixel pitch outdoor LED screens to achieve higher brightness. These are not used in architectural lighting products.

Image 4.1.1 – Dual in-line Package (DIP) LED.

4.2. Surface Mounted Diode (SMD) LED's.

SMD LED's are the more recent, resilient, efficient, and long lasting technology for mass production. SMD parts can be made smaller and thinner because the part is only soldered to the "surface" of one side of the circuit board. SMD chips have become very important for the development of the LED industry as 3 diodes are able to be put on the same chip. As well as the brightness being significantly better, they have the capacity to change colour. Some of the chips are made small in order to be used in high end electronics such as laptop computer indicator lights. They are also standalone chips predominantly used LED strips or LED recessed downlights. These SMD chips can produce between 50 to 100 lumens per watt. Which is significantly better than the DIP chip.

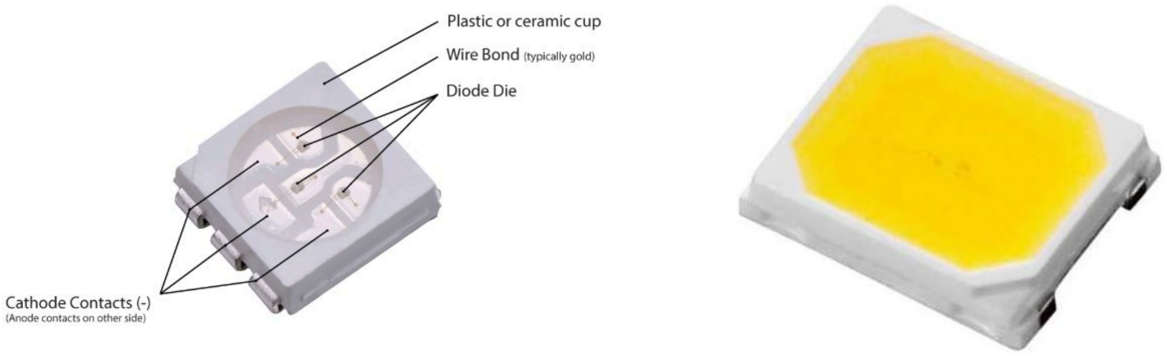

Image 4.2.1 – Surface Mounted Device LED.

4.3 Chip on Board (COB) LED's.

COB LED is a high powered chip which is the most recent development in LED lighting. Similarly to SMD chips, the COB LED has multiple diodes.

COB chips are being used in an array of different devices. Typically, in small devices such as cameras and smartphones, this is due to a high amount of lumens created for a very small amount of energy.

Although there are different forms of the COB chip, they can offer a much higher amount of lumens per watt which can often be well over 100.

Newer COB technology presents many advantages: wide viewing angle, solid dustproof, shockproof, and often waterproof surface which is rigid and prevents damage to LED elements.

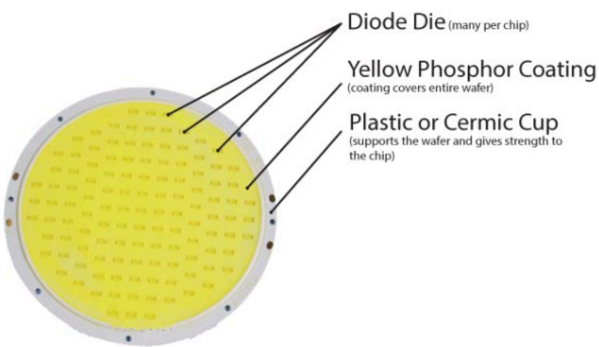

Image 4.3.1 – Chip on Board LED.

5. Difference between SMD and COB LED lights

Like the SMD, COB chips also have multiple diodes on the same surface. But the difference between COB and SMD is that COB LED's have more diodes.

COB chips typically have 9 or more diodes. COB chips also only have 1 circuit and 2 contacts, regardless of the number of the diodes. This simple circuit design is the reason for the panel-like appearance of COB LED light (SMD light, on the other hand, appears like a collection of smaller lights). But unlike SMD's, COB LED lights can't be used to create colour changing bulbs or lights. This is because there are only 2 contacts and 1 circuit. Multiple channels for adjustment are required to create the colour changing effect. Because of this, COB LED lights are efficient in single-color applications.

Another aspect of the COB vs SMD LED Lights difference is in the use of energy. COB is known for better lumen-per-watt ratios and heat efficiency. This has a lot to do with the design of COB LEDs, and the cooling ceramic substrate of the chips. Before, heavy duty technology like spot lights and flood lights made with LED were non-standard, because you'd need multiple LED sources to produce that kind of high lumen output.

But now, COB chips can produce a large amount of lumens with less energy. You can find it in all kinds of bulbs and applications

In architectural lighting, COB chips are used in more sophisticated lighting applications to gain better beam angles and for much aesthetically appealing fixtures (Image 5.1). SMD's are used for more general lighting fixtures such as diffused panel lights (Image 5.2) where the light source is covered with a frosted diffuser. SMDs are hidden by a frosted acrylic lens. The face is usually bigger. COBs faces are exposed to show the one chip. In most cases, they are designed to look like traditional dichroic halogen globes.

Image 5.1 – A COB LED fixture.

Image 5.2 – A SMD LED fixture.

COB fixtures are mostly used in high end applications such as star hotels (Image 5.3) whilst the SMD fixtures are more commonly used for general lighting applications such as offices spaces (Image 5.4) to get an even lighting along the work area.

This is because, COB downlights provide a better light source. It achieves a more focused light and with the use of reflectors, the light beam can be controlled. Chrome reflectors surrounding the diode can be replaced and set at different angles to make the light beam narrower or wider. Due to the narrow beam and with the use of reflectors that are usually clear, COB lights generate crisper and cleaner as there is no frosting on the lenses like the SMD fixtures. which cuts down the clarity of the LED light.

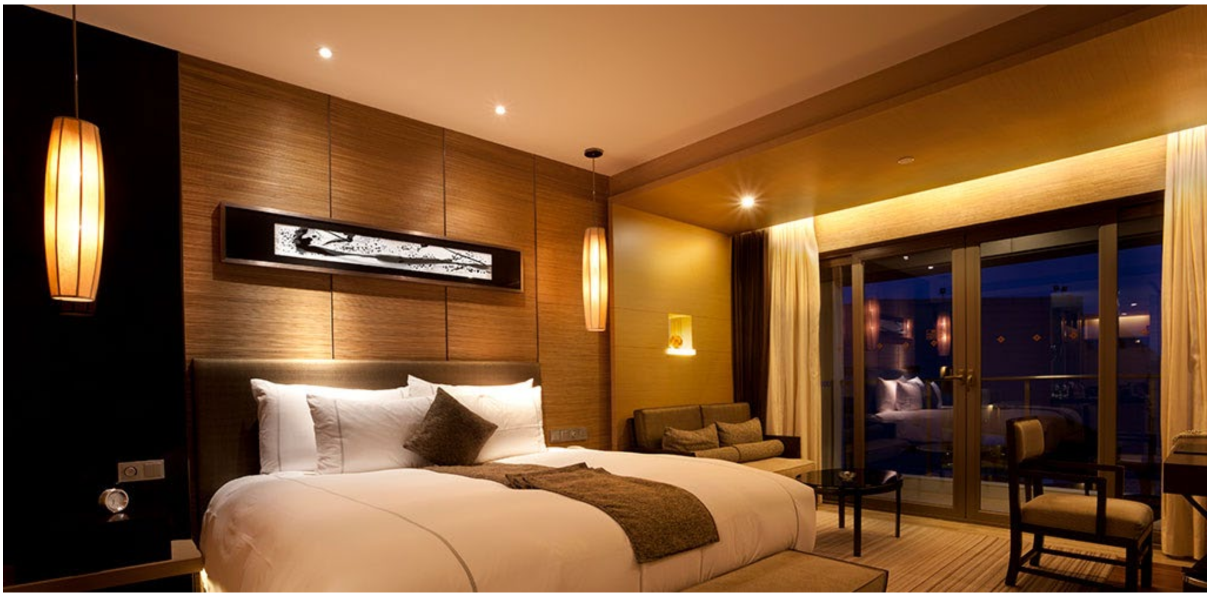

Image 5.3 – A COB-fixture lighting application of a star rated hotel.

Image 5.4 – A SMD-fixture lighting application of an office building.

6. References

En.wikipedia.org. (2019). *Light-emitting diode*. [online] Available at: https://en.wikipedia.org/wiki/Light-emitting_diode [Accessed 14 Nov. 2019].

LEDSINO. (2019). *LED Package | DIP LEDs | LED Chips - LEDSINO*. [online] Available at: https://www.ledsino.com/led-package-chips-technology/ [Accessed 14 Nov. 2019].

Razorlux.com. (2019). *What is the Difference between SMD and COB LED Lights? | Razorlux Lighting*. [online] Available at: https://www.razorlux.com/what-is-the-difference-between-smd-and-cob-led-lights.html [Accessed 14 Nov. 2019].

Jdlighting.com.au. (2019). *What are the Differences Between SMD and COB LED Downlights? | JDLighting*. [online] Available at: https://www.jdlighting.com.au/blog/blog/smd-cob-downlights-comparison.html [Accessed 14 Nov. 2019].