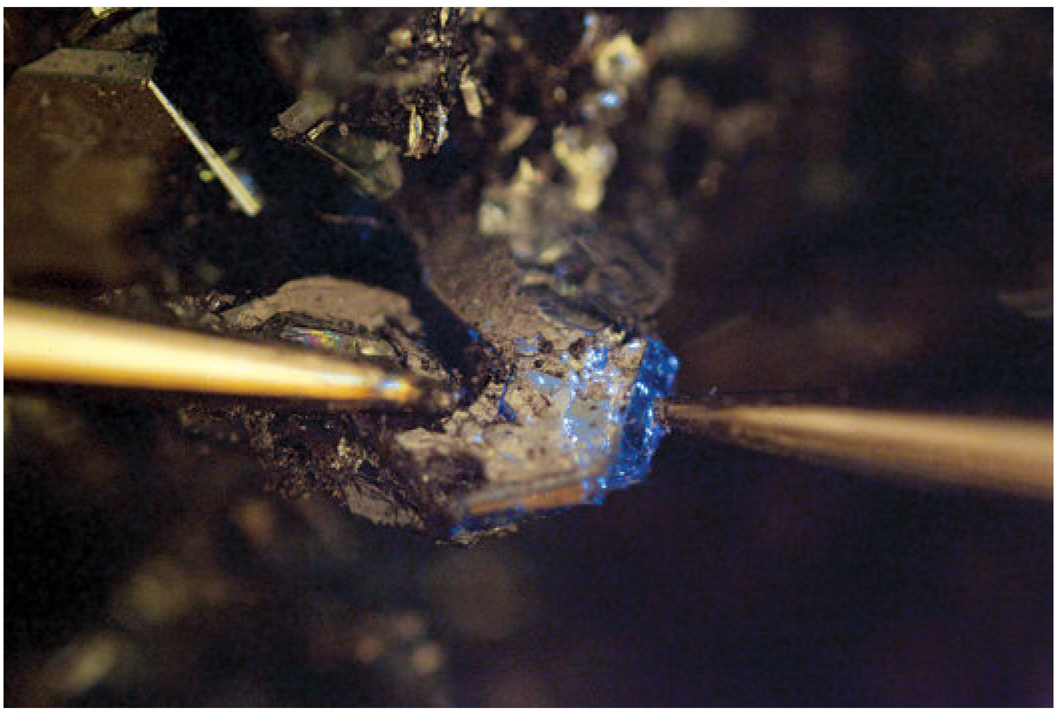
LED Lighting : Newest COB LED technology explained

28 COMMENTSWRITTEN BY **ROB HUSTON**

It all began over100 years ago, when electroluminescent phenomenon was first discovered in 1907 by a British experimenter, H.J. Round, using an electrified probe on a chunk of **silicon carbide crystal**, produced the first visible shafts of light, however Russian scientists credibly reported the first creation of LED in 1927.



After various experimental reports in the 50s, American experimenters **Robert Brady** and**Gary Pittman**, working at **Texas Instruments** in 1961 found that gallium arsenide emitted infrared radiation when electrical current was applied, although this light was not visible to the naked eye is allowed mass adoption of LED for infrared control devices.

General electric company employee; **Nick Holonyak Jr** in 1962 produced the first practical visible red LED and is considered by some as the “grandfather of LED”

in 1968 the **Monsanto** company first organized mass produced visible LEDs using gallium arsenide phosphate. Quickly propelled into mass adoption in handheld devices such as calculators, wristwatches, and digital displays of all types but until around 1995, were not considered bright enough for any replacement of traditional lighting.

The introduction of high brightness blue LEDs, demonstrated by the **Nichia Corporation** and eventually leading to the 2006 millennium technology prize for **Shuji Nakamura**, today's high-tech LED lighting is all based on this research. High output blue LEDs have revolutionized the computer industry with advancements in blue Ray technology.(The first blue LEDs using gallium nitride were made in 1971 by **Jacques Pankove** at **RCA Laboratories**)

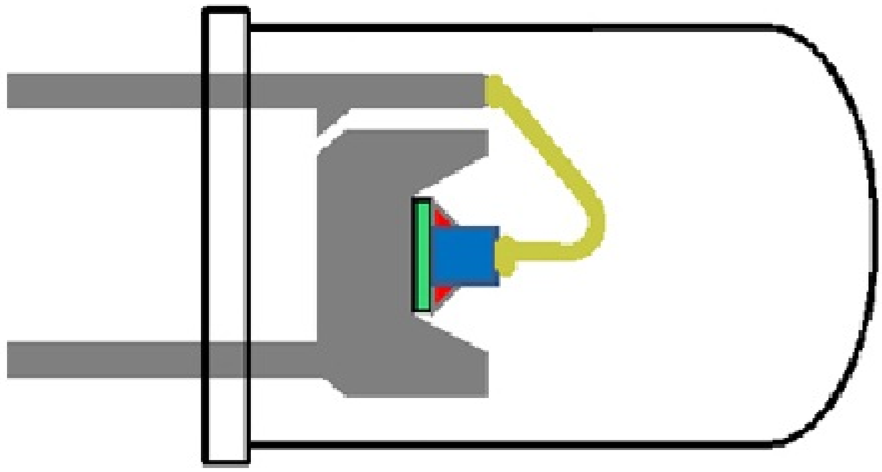
Growing LEDs

Although silicon dioxide or “Quartz” is an abundant compound in the Earth's crust, it must be converted into pure silicum or silicon, through advanced scientific precipitation process. Other processes (**Zohnenschmelz** or **Czochralski** process) are required and then it is pulled or grown into crystals up to 20 cm wide with a length of up to 2 m! These crystal extrudes are now called “wafern” and must go through a further crucial doping procedure in which the wafer in are **bombarded with ions from foreign atoms** in sophisticated accelerator chambers.

LED Lights technology has evolved from the early days of the first generation D.I.P. 5mil LED, with its inherent heat management problems to today's High-output MCCOB LED technology .

DIP LED

The DIP LED adopts “DIP package”, which is short for dual in-line package technology. The solid plastic package of DIP LED can be designed to focus its light instead of an external reflector used in incandescent and fluorescent, the plastic can act as a lens.



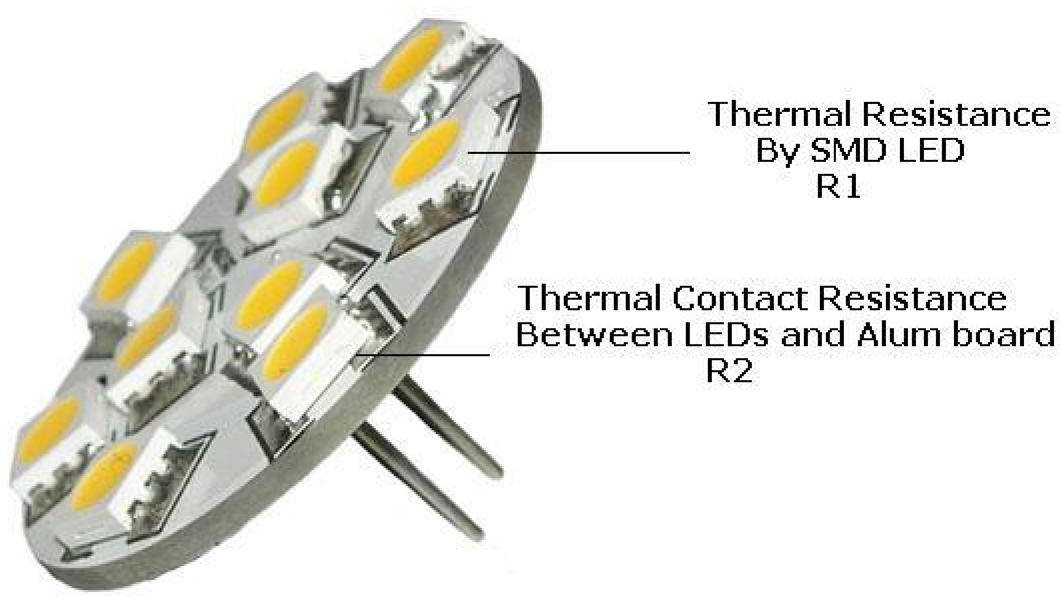
Most everyone is familiar with it, encapsulated in a; 3mm, 5mm and 10mm, (or smaller) colored plastic, bullet shaped case, these early LED designs are the most commonly recognized LED, their long metal connectors protruding for easy solder connections. Far from being outdated, arrays of “Next Generation **superflux LED** (or Spider LEDs)”DIP LEDs are still being used today because of their high brightness and long lifespan


superflux LED

SMD LED (Surface mounted diode)

This recent LED technology is largely responsible for the possibility of, adoption of LED as a viable alternative to incandescent and mercury-based lighting. **SMD** chips allowed manufacturers to automate production, improve quality control and offer a product that features; better heat dispersion, high lumen output (high lumen flux) and longer overall life (low optical decay) than its predecessor the DIP LED .

The **SMD** chip itself is created from layers of man-made nano sapphire and gallium crystal layers that are bonded to a ceramic base that can be easily mounted in various package LEDs.

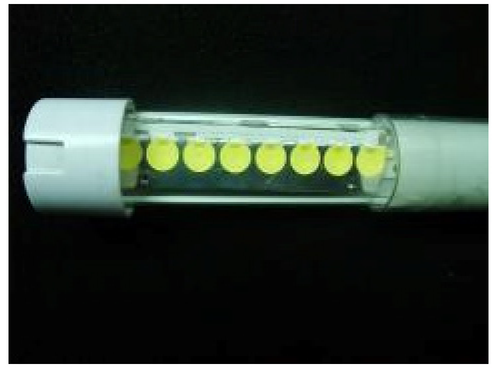


Far from being outdated, **SMD LED** continues to improve in its lumens per watt output, these small, maintenance-free long-lasting solid-state light sources will be around for many years to come.

COB LED "Removing thermal management barriers"

The Next Generation of LED, is without doubt; Multi or integrated Chip, Referred to as MCOB (Multi Chip On Board) or MCCOB (multiple chips and cups on board)

This new LED lighting technology comprises of many small-chips integrated into one large single chip.



COB (Chip on board) LED technology, differs from traditional LED in that instead of individual SMDs soldered to a circuit board and then mounted to a heat sink; the Wafers or “Wafern” are cut into some hundred small chips, with a thickness of only approx. 250 µm. These tiny small and hardly visible pieces of semiconductor crystal are bonded directly to the aluminum substrate (with a proprietary bonding procedure) allowing for optimum heat dissipation, and solderless fabrication.


The yellow discs are simply a phosphor coating, enabling complete control of color temperatures.This type of LED technology makes chip densities up to 70 chips per square centimeter possible, and promises to offer much more flexibility over other LED technologies.

As with all LED products however, the drivers and thermal management are the key to LED product longevity.

COB Exhibits superior Thermal management compared to DIP or SMD, LED technologies

These are becoming more common in floodlights and High bay lights. They are cheaper to assemble than multiple single chips and so make products like high bay and floodlights much more affordable than multiple chips. The more well-known companies working on this technology are **Bridgelux (USA)** and **Edison** and **Epistar** (Taiwan).

CREE and a few others make integrated chips, but are currently prohibitively expensive.
MCOB is also found in LED bulbs and LED tubes, however compared to SMD surface mounted diode technology, MCOB technology is still in its infancy.

Watch for this exciting new technology in new ultra efficient high output LED lighting.

COB———Chips embedded on board
MCOB——Multi-Chips embedded on board
MCCOB—— multiple chips and cups on board

GaN on silicon: A breakthrough technology for LED lighting (MAGAZINE)

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By John Ellis, Plessey Semiconductors

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*With silicon-based LEDs overcoming issues such as lattice-mismatch and refractive-index problems, **JOHN ELLIS**, chief engineer at Plessey Semiconductors, predicts that the LED industry will move to take advantage of the lower-cost substrate used in the broad IC industry.*

Over the last decade, progress in light-emitting diode performance has been nothing less than phenomenal. LEDs today are performing at 50% wall plug efficiency, meaning that 50% of the applied power is emitted as light. Laboratory results are even higher in the high 60s; these results will become standard in due course. In the meantime, LED-based lighting is replacing incandescent, fluorescent, mercury, and sodium lamps in almost all applications. However, the uptake of LED lighting is still limited by the cost of producing LEDs. This one remaining barrier will be addressed by developments in gallium-nitride-on-silicon (GaN-on-Si) technology.

Shuji Nakamura developed a method of growing thin GaN layers on sapphire substrates in the early 1990s, and up to now these have been the foundation of high-brightness blue LEDs. One notable competitor is silicon carbide (SiC), but these substrates are very expensive. While sapphire costs are dropping, silicon is a very common substrate in the semiconductor industry, and the costs are much lower than either sapphire or SiC.

Semiconductors of all types are characterized by the spacing between atoms in the crystal lattice. One difficulty with using silicon as a substrate is that the atoms are not spaced at the same distance as the atoms in a GaN layer. Growing GaN directly on silicon would lead to a mismatch that would cause strain, and this strain would be relieved only through sporadic dislocations that in turn cause leakage currents and general impairment of the performance of the LED.

The breakthrough needed for growing GaN on silicon was to use a buffer layer that offers a better match to the silicon lattice, and then to gradually transpose the buffer layer into GaN. This buffer technology forms the basis of new GaN-on-Si technology. In addition to the buffer layer, considerable optimization has been pursued to reduce residual dislocations, manage the residual strain, and optimize the quantum wells for high-performance LEDs.

GaN-on-Si also requires attention to optical properties. As a substrate, silicon is a good absorber of light — well demonstrated by the number of CMOS imaging chips and photodiodes currently available. The architecture of a highly-efficient LED must eliminate the losses that would occur if the light emitted from the quantum wells in the LED were allowed to enter the silicon.

One method of mitigating the problem is to put a mirror onto the top surface of the LED, transfer the LED and mirror onto a handle wafer, and remove the original substrate. The LED structure is thus turned upside down, and light generated in the junction is reflected upwards.

GaN also has a high refractive index, and as a result has a narrow escape cone with a half-angle of about 23°. Any light that propagates outside of this angle is totally internally reflected. A surface roughening scheme, however, creates a transmissive interface between GaN and air, effectively removing the total internal reflection (TIR) restriction. A lens can further enhance

light extraction, increasing the escape cone and providing a refractive index that is closer to the GaN than air.
The techniques described here can deliver lower-cost, high-performance LEDs. The LED is measured in terms of internal quantum efficiency (IQE).
There are several techniques for measuring IQE. The most relevant measure is the overall electrical efficiency. In terms of current, there is a figure of merit that describes output power in terms of watts per unit of current in (W/A). Wall plug efficiency is another measure. The difference between the two is the forward voltage across the diode. Today we can achieve typical forward voltages of about 3.05V. IQE is approaching 60% and light extraction efficiencies are improving to greater than 70%.
Over the next 12 months GaN-on-Si LEDs will match the performance of GaN-on-sapphire LEDs, and offer a substantial price reduction. The move to a silicon substrate will help broaden and accelerate the market for LED-based lighting.