Brainstorm: LEDs

What do you see as some of the leading developments or differentiating technologies that have helped insulate LEDs from being viewed as a commodity type of component?

 **Peter B. Green, International Rectifier,** www.irf.com **[1]**

Although LED lighting is still in the early adoption phase, high brightness lighting class LED devices are currently used in a wide variety of different applications due to the many advantages they offer over traditional light sources such as incandescent light bulbs and fluorescent tubes. The development of ever more efficient LED devices is ongoing as device technology continues to be improved. Unlike the indicator LEDs that have been around since the 1960s, high brightness LEDs have not yet become a commodity type of component. This is partly due to the greater complexity of LED devices involving, device physics, development of phosphors, optics and thermal management.

LED based lights are much more efficient than incandescent light bulbs and equivalent to fluorescent lamps while lasting much longer than either of these. Additional benefits include durability, very rapid response, ability to operate at low temperatures and small size. LED lights are recognized as far more environmentally friendly alternatives to traditional alternatives. Conversion to LED lighting is encouraged through government programs such as Energy Star through the DOE, while wasteful incandescent light bulbs are being phased out through legislation. LEDs have already surpassed compact fluorescent replacement light bulbs in performance and energy savings and unlike CFLs some can also be dimmed. However as relatively new technology they remain expensive.

The greater reliability of LED lighting has also made it an attractive alternative in areas where high reliability and long life are important, for example airport lighting, medical equipment, street lighting, traffic lights and emergency lights. This along with energy savings justifies the additional cost.

For now LED manufacturers are able to offset some of their ongoing development

costs as the cost of high quality LEDs remains high. Within the next few years highly efficient and reliable parts will be produced in very high volumes, which will be able to drive the price down dramatically. This is inevitable if as predicted, by 2020 LED lighting is to replace a significant portion of the lighting used in the world.

Jim Hunter, Luminus, www.luminus.com **[2]**

LEDs consume less energy, are longer lasting, and are more environmentally friendly than traditional lighting technologies. Despite these facts, they have historically been treated as a specialty or niche product that was not useful for mainstream lighting needs. Over the last several years, new technology has been developed that has allowed LEDs to become more integrated into our everyday lives. We are set to see large-scale adoption in the next few years.

The single most important aspect of the LED is that it's much more versatile than traditional lighting sources – thanks in large part to the chip technology that's behind it. The ability to design a LED light for a specific product – and not the other way around – means that emerging technologies aren't forced to wait for the LED market to catch up.

When you combine this versatility with additional features that allow complete control over the light source -- like an instant on/off switch and the ability to warm and cool the light as needed -- you realize how far the lighting industry has come with developing the LED, and that it is far too advanced to ever be thought of as a commodity.

Russ Dahl, Opto Diode Corporation, www.optodiode.com **[3]**

The expanding wavelength range into the near UV and UV regions will keep LED's from being viewed only as a commodity product. One example of this is the commercialization of UV cured printing inks, in combination with the availability of efficient LEDs that operate in the 370-400nm ultraviolet (UV) wavelength region, is an area of LED technology that helps insulate LEDs and LED systems from being considered commodity types of components. The highly specialized use of light-emitting diodes in this particular UV-curable ink printing application, makes it is also likely that LEDs will not be prone to becoming a commodity component in this area for quite some time.

Utilizing LEDs rather than UV lamps saves money in several ways. The LEDs do not create ozone, thereby eliminating the need for exhausting, as is currently necessary when utilizing UV lamps. The LED lifetime is longer than lamps and reduces the maintenance required. Lamps are broad-spectrum-based and quite inefficient when compared to LEDs which have a relatively narrow spectrum. By formulating inks that cure primarily within a narrow spectrum and utilizing LEDs for curing, less total optical power and less heat are generated, making the curing process much more energy-efficient.

 **Dr. Joachim Frank, Osram Opto Semiconductors GmbH, www.osram-os.com [4]**

LEDs are not yet positioned as commodity articles in the industrial sector as a whole. Only in individual fields of application, such as display backlighting, has this technology achieved some degree of exchangeability. At the same time, however, some specific LED solutions are being adapted to other fields: for example, products developed specifically for backlighting are now also in demand in general lighting.

In most other fields, it is the application-specific design of LEDs that is important. For us, that means, for instance, that we use one and the same chip in different housings with different thermal, mechanical and optical properties. These LEDs, in turn, are used in a variety of different applications: from display backlighting and mobile telephone flashes, to streetlamps and automotive headlamps.

But each application is associated with its own specific LED requirements and, indeed, even within a single product, such as an automotive headlamp, the differently designed LEDs used must fulfill a variety of different requirements. Because no international standards exist as of yet, LEDs made by different manufacturers for the same application can still display significant differences in everything from light-radiating characteristics to solder pad design.

Current standardization activities are mainly focusing on the LED modules or light engines. On the component level, there also are efforts to define industry standards. Naturally, standardization helps to achieve exchangeability in LEDs. At present, however, a general standard for all applications would not appear to be feasible for the above reasons.

Daniel Slupik, Texas Instruments, www.ti.com **[5]**

Several LED manufacturers are doing quite a bit to ensure that they offer unique products that are differentiated, specifically for the solid-state general illumination market. By focusing on the system challenges that face fixture and lamp designers, LED suppliers are able to launch products unique to solid-state general illumination that resist commoditization forces.

Coming from the power electronics world, one example that stands out to me is the recent proliferation of high voltage / lower current LEDs. These types of devices pack a higher forward voltage device into a much smaller footprint than a traditional array. This enables overall system to potentially be much more efficient.

To put it simply, it is more efficient from a power conversion standpoint to step down from line voltage to an LED array with a higher forward voltage than a lower one. Additionally, by giving fixture and lamp designers access to a high-voltage solution with such a small footprint, they are being given greater flexibility in their mechanical design. When a lamp or fixture designer has differentiated components at their disposal, it enables them to be more creative in their product decisions, leading to even further differentiation in the downstream market.

Roland Chapa, TT electronics Optoelectronics Business Unit, www.ttelectronics.com **[6]**

Largely due to the energy efficiency of solid state lighting (SSL), there is no question in my mind that LEDs will become a commodity component. However, the commoditization of SSL is a few years out, and will coincide with the advent of low-

cost retrofit solutions to fill the market need for energy efficient lighting with the phase out of incandescent bulbs.

In the meantime, we are seeing innovation on many fronts. There have been tremendous strides in the quality of light that can be achieved with LEDs, and manufacturers are now able to mass produce components with excellent lumen output, color temperature and CRIs. Production efficiencies have led to a decline in price for LEDs, even while the market is growing at a significant pace. Earlier this year, market firm Strategies Unlimited released a study indicating that the market for LED components used in lighting grew 44% from $1.2 billion in 2010 to $1.8 billion in 2011.

The growth in the market continues to be centered on commercial and government applications, where the initial investment to install a solid-state lighting solution is returned many times over during the lifetime of the product. Currently, LEDs are widely used in applications including street lighting, billboards, malls or hotels, retail displays and even surgical suite lighting – essentially, in locations where constant use requires an energy efficient solution.

As the market continues to grow and LEDs are added to more consumer products, we will see LEDs become a commodity component.

Jy Bhardwaj, Philips Lumileds, www.philipslumileds.com **[7]**

High-Power and Mid-Power high performance LEDs has avoided commoditization due to substantial fabrication differences versus Si ICs as well as the scale of the industry. To set expectations, LEDs manufacturing scale is much smaller than Si ICs. Indeed, today’s global LED demand represents only a fraction of the capacity of a single 50K WSPM 8” CMOS line. Compared to the Si ICs, LED fabrication differs significantly in the fundamental processing: high quality epitaxial GaN material is grown at very high temperatures presenting CTE and lattice match challenges; phosphors down convert blue wavelength pump into red and green; refractive index mismatch presents light extraction challenges; specific output radiation patterns are required.

Some of the LED specific fabrication steps have not yet benefitted from the production maturity that accompanies scale through high volume, low COO, highly automated manufacturing equipment, processing, monitoring which enabled the commoditization of the Si IC industry. The LED device is best described as a quantum analogue transducer and performance improvement remains iterative as there is no integrated model that predicts the white light output from electrical input, this presents another barrier. Lastly, there are little to no universally adopted industry standards in terms of form factors and packages for end products to drive down stream commonality. These barriers allow the very few companies with deep know-how, IP and scale to succeed in the lighting LED sector.

Links:
[1] http://www.irf.com
[2] http://www.luminus.com
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