Positioning OLED Lighting for Success

A NanoMarkets White Paper

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NanoMarkets believes that Organic light-emitting diodes (OLEDs) will play a major role in lighting applications in the future, but how soon this future arrives and how deeply the devices penetrate will depend on a number of factors. In a recent report titled, Emerging Markets for OLED and Printed Lighting, we predicted that in the long term, the economies of roll-to-roll manufacturing will establish OLED and other printable technologies as major players in mainstream lighting applications. In the short term, innovative designers will have find ways to put their unique characteristics to clever use in niche and specialty applications.

The report predicts that the modest $135.8 million OLED and printed lighting market of 2007 will grow to almost $174 million in 2008 before leaping ahead in 2009 and 2010 to $304 million and about $619 million, respectively. The OLED share of the overall market is virtually nothing in 2007, but OLED lamps are expected to capture about 20% of the printed lighting market within one year and, by 2009, OLEDs will represent almost 50% of the total market. NanoMarkets predicts, further, that OLEDs will represent about $443 million of the overall $619 million lighting market in 2010--a share of over 70%.

Early Positioning Against ILED Technology: Familiarity Breeds Sales

That's not to say that OLED lamps do not have a hard row to hoe. They not only have to cope with the usual technical maturation and infrastructure development issues that accompany any startup technology, but they also have to contend with a highly fragmented lighting market that has already begun a long-term evolution towards different technologies. Examples of these include compact fluorescent lamps (CFLs) in general-purpose residential lighting, and traditional inorganic LEDs (ILEDs) in a number of applications including traffic signals, automotive lighting, and LCD backlighting.

In this scenario, NanoMarkets believes that market positioning vis a vis the alternatives, especially ILEDs, could be critical to the success or failure of OLED lighting.

With decades of technology evolution under its belt as the de facto standard technology for electronic indicators, ILED technology is quite mature, and the pace of advancement over the past handful of years here has been fast--delivering more efficient blues, brighter whites and far greater bang for the buck. Moreover, ILED R&D is being carried out at a feverish pace today to advance the state of the art even farther, as current-generation products pour forth at ever higher volumes for an ever expanding range of applications. Volume manufacturing has reduced ILED prices radically although the semiconductor manufacturing processes used are inherently expensive ones.

OLEDs for lighting are also advancing on a number of fronts, as described in the report, but as the new kids on the block, they're playing catch up with ILEDs and will continue to do so for some time to come. In the long run, OLEDs are likely to surpass ILEDs in important metrics such as efficiency, but trying to sell technology based on future potential would seem to demonstrate suicidal tendencies.

NanoMarkets believes that initially lighting integrators are likely to be more amenable to the OLED that is positioned as a fellow traveler of the ILED on the road to solid state lighting, the next generation of technology that will raise the lighting plateau in performance, efficiency and lifetime. They are unlikely to find much appeal in an alternative that's less familiar, lower performing and more expensive, no matter what its advantageous differences.

ILED strikes back: What are these differences? All begin with the fact that the ILED is a point of light and the OLED is a sheet of light. The ILED excels in delivering focused light while the photons emerging
from an OLED are naturally diffused. ILEDs are small, rigid semiconductors and multiples of them are usually required to light an area. An external interconnect between them is also required. OLEDs, in contrast, can be manufactured over large areas and are conducive to flexible implementations. Another difference is that ILEDs provide only a very small area for dissipating heat, while the OLED’s dissipation area is as big as the lamp itself.

These advantages will help OLEDs win a big share of the solid-state lighting market eventually, but ILEDs have ways of emulating some of the intrinsic advantages of OLEDs which will help them to leverage the sheer familiarity of ILED technology to retain market share for years to come. ILEDs can emulate flexibility, for example, by being built into a curved mechanical frame, for example, or packaged in “chains” of light embedded in a flex circuit type substrate. ILED light can be effectively diffused by adding the appropriate optical components. And, to a certain degree, the heat emerging from an ILED can be handled with a thermal management subsystem. The ILED can in fact compensate in areas where OLEDs appear to have a natural advantage, although it always requires some extra effort. The edge goes to the OLED in terms of simplified packaging.

But in these, the early days of OLED lighting, the older, established, well understood, widely available ILED will have the edge. Better to piggyback on the ILED bandwagon than attempt unsuccessfully to upset the apple cart.

**Leveraging Sheets of Light**

As OLED technology becomes more familiar and integrators are more willing to take a chance with it, NanoMarkets believes that OLED makers will be able to leverage the sheet-of-light differences that give OLEDs an advantage over ILEDs in mass markets such as LCD backlighting and general-purpose illumination.

**Freedom to design:** Sheets of light are conducive to being built *into* things rather than *onto* things, a characteristic that will certainly not escape designers’ attention. For example, whereas a conventional fluorescent ceiling fixture hangs down from a ceiling, an OLED lamp could have the same form factor as the ceiling tiles themselves and mount flush with the ceiling. Flexible sheets of light are also conducive to irregular shapes, curved surfaces and other novel aspects that will characterize next-generation lighting technology.

We anticipate that there will be significant opportunities for OLED lighting in architectural lighting, since this is something that should greatly interest the architectural community for the sake of freedom to innovate. The vision of large, low-cost R2R-manufactured OLED lamps enabling walls of multicolored light, of course, intrigues architects.

According to NanoMarkets analysis, specialty architectural and industrial lighting will represent the second largest market for OLED lighting over the next few years, according to NanoMarkets figures, capturing between a 15 and 20% share. By 2010, general-purpose lighting will take over second place, representing about $119 million, roughly 27% of the $443-million pie.

**Backlighting:** OLED lamps face an altogether different competitive situation when it comes to backlighting applications for switches, keypads, instrument panels and, to some extent, automotive dashboards and advertising displays. Backlighting in all its many forms will be the largest application for OLED lighting, until 2011, at which point general-purpose lighting will take the primary position.

The thick-film electroluminescent (EL) lamp is king in the backlighting space. Designers here are, thus, already familiar with the benefits of using very thin, highly flexible sheets of light, and will be attracted to
OLEDs. EL is vulnerable in these arenas. Of a lighting technology’s four key parameters--brightness, efficiency, lifetime and cost--the OLED lamp outshines the EL lamp in all but cost, but there it’s at a serious disadvantage for the time being. However, as prices for OLEDs go down, OLEDs reputation in the backlighting space will be enhanced by the fact that the OLED lamp combines the best of EL and ILED, delivering ILED-class performance in an EL-like sheet of light.

**Emerging Markets for OLED and Printed Lighting** predicts that OLEDs will break EL’s stranglehold on the backlighting market in 2008. The entire backlighting market is expected to grow to around $2 billion in 2014. From a 0% market share in 2007, OLEDs will grow to a dominant 88% share in 2014.

In vehicular applications - long dominated by EL lighting, OLEDs will intrude initially accounting for $4.7 million or so of a $43.9 million market. OLED use will grow, however, reaching near parity with EL in this application in 2011 and spiking significantly at several stages of the projection period. NanoMarkets predicts that by in 2014, OLEDs will account for $172.3 million of a $207.3 million market for printed vehicular lighting--achieving a commanding 83% share. In the display sector, OLEDs will offer much needed packaging simplification and cost reduction to the process of assembling an LCD and its backlight. Industry estimates place the cost of a backlight at 30 to 38% of the total cost of the display today. Obviously, the opportunity exists here for radical cost improvements to be introduced.

**General-Purpose Lighting: Eyes on the Prize**

The granddaddy of all lighting applications is, of course, is general-purpose illumination for residential, commercial, industrial and other environments. In the long-term, OLED makers have their eyes set on this market, but OLEDs have a long way to go before they can compete in this market in any significant way.

The drive toward energy-saving SSL is a clear OLED motivator, but the extremely low price of the entrenched competition is a major OLED disincentive. Incandescent is the king of the hill in residential buildings, while fluorescent has a huge presence in the commercial sector, and ILEDs are just beginning to intrude a bit.

Nonetheless, OLED progress on important technical parameters that might make a difference here has been fairly impressive recently:

- An incandescent bulb lives 1 Khr, fluorescents live 10 to 20 Khrs, and ILEDs last for 50 Khrs or more. OLED lights have already been reported with lives up to 100 Khrs, although figures under 10 Khrs are more common.

- Incandescent provide roughly 15 lm/W in efficiency; and fluorescents, which vary widely, come in roughly at 40 – 100 lm/W--an efficiency range that ILEDs have entered within the past year. Some high-brightness fluorescents and HID (high-energy discharge) lights, in turn, provide over 100 lm/W in efficiency. OLED lights are now in the range of 20-30 lm/W, with demonstrators as high as 64 lm/W. Ongoing work on more efficient outcoupling of OLED-generated light promises far higher efficiencies in the future.

The bottom line is that incandescent and fluorescent lights are destined for the trash heap of lighting history, with halogen and others also eventually going the way of the dinosaur. In the short term, fluorescent should enjoy a healthy surge in residential installations, as better educated consumers adopt its more energy efficient technology.

But long term, the general-purpose lighting market will eventually belongs to SSL, first ILEDs alone, and then in the company of OLEDs. NanoMarkets predicts that from a near dead stop in 2008, the general-
purpose market for printed lighting will grow to about $119 million in 2010 and to over $1.5 billion in 2014, consisting mainly of OLEDs.

To obtain a copy of the NanoMarkets report, *Emerging Markets for OLED and Printed Lighting*, please visit our website at [www.nanomarkets.net](http://www.nanomarkets.net) or contact us at sales@nanomarkets.net or by calling our offices at (804) 270-7010.