

Global

LEDs/OLEDs

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WHERE ARE LEDS LEADING US?

HIGH BRIGHTNESS LEDS
COLOR CONSISTENCY
LEDs IN SMT PRODUCTION
PEC PROCESS FOR LED INTERCONNECTION
LED BIN VALIDATION & TRACEABILITY



Mark Larson
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High-brightness LEDs: a rising tide lifts many boats

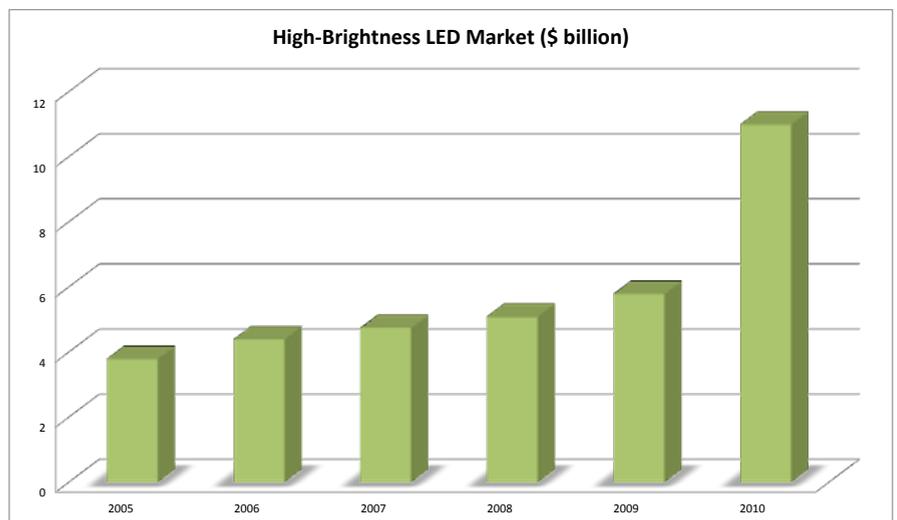
Lisa Bergson, Tiger Optics LLC

If you're engaged in any aspect of the high-brightness light-emitting diode (HB-LED) business, you could set the table for friends and family with your good fortune. Worldwide HB-LED revenues jumped to US\$10.8 billion in 2010, up 93 percent from \$5.6 billion in 2009, according to the latest report from Strategies Unlimited, the oft-cited California market research firm. The 2010 results exceeded, by 32 percent, the firm's year-earlier forecast of US\$8.2 billion.

The rising tide of HB LEDs is lifting a *flotilla* of boats. Here's a story that could hearten anyone who was submerged in the Great Recession, yet it seems that the general public may be unaware of the ramifications of this surging LED industry. Knowing that I was a business journalist in an earlier career, a colleague has urged me to share my observations from the public record and as chief executive of a company that supplies the LED industry at multiple points.

Sales rose 177 percent last year at Tiger Optics LLC, the high-tech company I head in Warrington, Pennsylvania. We sell laser-based trace gas analyzers to HB-LED makers and tool manufacturers, as well as to the gas companies that supply ammonia, the favored source of nitrogen for the production of gallium nitride (GaN) compound semiconductor wafers, a key component of HB LEDs.

There is ample evidence that many companies—private and public—are prospering from their stakes in the HB-LED business. Albeo Technologies Inc., an LED-lighting products company in Boulder, Colorado, said (in August, 2010) that it has expanded twice in two years while averaging annual revenue growth of more than 110 percent for three years. California-based Bridgelux Inc., a pioneer in LED solid-state lighting, recorded US\$30 million in 2010 revenues and expects to triple that amount in 2011, the *New York Times*



recently reported.

At Veeco Instruments Inc., revenues from LED and solar process equipment in 2010 nearly quadrupled the \$205 million reported in 2009. Veeco is a leading producer of the metal-organic chemical vapor deposition (MOCVD) systems used to manufacture HB LEDs.

Strategies Unlimited credits much of the industry's growth in 2010 to the escalating demand for HB LEDs to "backlight" the liquid crystal display (LCD) units of TV screens and computer monitors. Such demand will likely flatten out in 2013, with solid-state lighting becoming the "key market driver" in 2014 due to global demand for energy efficiency and the phase-out of incandescent bulbs, the market research firm predicted in a report presented at the Strategies In Light conference in Santa Clara, California, on February 23rd.

Meanwhile, a number of gas companies are prospering from the sale of ammonia for HB LED applications. At Tiger Optics, we also note some stellar performers among:

The MOCVD system suppliers

Two companies, **Aixtron SE** and **Veeco Instruments**, dominate the market for producing the MOCVD equipment used to create HB LEDs. An HB-LED fabrication plant typically allocates more than 50 percent of its capital expenditures to acquire MOCVD systems, according to Veeco. By the close of 2010, the global MOCVD market was expected to reach US\$1.5 billion in sales, more than trebling the estimated 2009 market value of US\$464 million, according to Aixtron, which cites market research by Gartner Dataquest. Aixtron notes that it also competes with a number of Asian manufacturers, including **Taiyo Nippon Sanso Corp.** Aixtron said it expects that equipment companies from "adjacent" industries will attempt to develop their own MOCVD tools and identified Applied Materials, Inc. as an aspiring competitor.

- **Aixtron SE**, based in Herzogenrath, Germany, reported revenues of EUR 783.8 million for the year ended December 31, 2010, up 159 percent from the same

period in 2009. Aixtron said the increase was driven largely by its deposition equipment revenues, which rose 168 percent in 2010.

- **Veeco Instruments Inc.**, headquartered in Plainview, New York, reported net sales of US\$933 million for the year ended December 31, 2010, up 230 percent from the comparable period in 2009. (For its LED & Solar Process Equipment segment, Veeco's revenues rose 289 percent.)
- **Taiyo Nippon Sanso Corp.**, the global industrial-gas company, serves 80-90 percent of the domestic Japanese market for MOCVD equipment. For the first six months of its fiscal 2011, the Tokyo-based company said operating income jumped nearly 101 percent in its electronics business, which includes MOCVD equipment.

The LED chip and component makers:

- **Nichia Corp.**, headquartered

in Anan-Shi, Japan, was the top-selling LED supplier in 2009 with revenues of US\$2.2 billion, according to IMS Research of the United Kingdom. Nichia's shares are not publicly traded.

- **Philips Lumileds Lighting Company LLC**, a leading LED-component maker, also does not publish financial results, but it ranked fourth – in a tie with Seoul Semiconductor – in 2010 revenue, in the estimate of Strategies Unlimited.
- **Epistar Corp.**, a leading LED chip producer based in Taiwan, reported net revenue of TWD 1.4 billion for the month of December 2010, representing a year-on-year increase of 55.6 percent.
- **Cree Inc.**, based in Durham, N.C., said its net income rose almost 97 percent for the six months ended December 26, 2010, compared to a similar period the preceding year. Cree

makes LED chip products and components.

Capturing the “frontier” spirit of the HB LED industry, Bridgelux Chief Executive Bill Watkins wrote in a Forbes.com commentary last August: “Light bulbs represent the world's last vacuum technology so digital lighting is where the semiconductor, software and disk-drive industries were 40 years ago—on the edge of steep and continuous growth.”

Inevitably, the seas will grow choppy, but in the meantime . . . Hoist the sails!

Lisa Bergson, founder and chief executive of Tiger Optics LLC, pioneered the commercial development of the laser technology called Continuous Wave Cavity Ring-Down Spectroscopy



that is presently used in more than 800 locations at chemical companies, semiconductor fabrication plants, laboratories, and gas productions and distribution facilities around the world.

Where are LEDs leading us?

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the product appearance is poor this probably reflects the approach to its design and manufacturing.

Comparing specifications carefully, particularly with respect to luminous efficacy and claimed operating life expectancy, will give you an indication of quality. If an unfamiliar brand claims to have performance and reliability figures well in excess of the norm, more research should be undertaken into the accuracy of the data.

LED lamp availability, economics and quality

The choice of LED lamps will grow over the next couple of years but most major vendors are producing products for the retrofit market, so are launching products with the most common fittings first. Luminous efficacy has reached the point where replacements for traditional 40W lamps are now available and replacements for incandescent bulbs rated at up to 100W should be on the market before the September 1st, 2012 deadline when all incandescent lamps will be banned by EU legislation.

Early LED lamps were not dimmable but recent products can now be dimmed



Figure 2. LED lamps are now available in a range of common fittings as low-energy retro-fit alternatives to traditional incandescent lamps

using standard dimmers designed for use with incandescent lamps.

The current life expectancy of a high quality LED lamp is typically between 15,000 and 45,000 hours. In general, LED lamps with smaller physical formats, such as candle lamps, will have lower life expectancy because they operate at higher temperatures. If a lamp is operated for 6 hours per day, 35,000 hours equates to 16 years. Few consumers are concerned about life expectancy beyond this time scale and even with such lamps costing 20 to 30 times the price of incandescent types, the economic

argument in favour of LED lamps is compelling. Poor quality LED lamps, which might fail in a much shorter time, do not offer an attractive return on investment because replacement cost needs to be considered.

LED lamps are expected to replace most other forms of domestic and commercial lighting in the next few years. LED lamps not only reduce energy costs, they also cut maintenance requirements and offer new opportunities for creativity in lighting installations.

Jeanine Chrobak-Kando is Verbatim's business development manager for the LED lighting business in Europe, the Middle



East and Africa. Based in Frankfurt, Jeanine previously spent 4 years at OSRAM GmbH as product manager for LED Luminaires. Jeanine began her career as a micro-structure technology researcher. She has a Masters Degree in Electrical Engineering from the University of Karlsruhe, Germany.