

# Material shortages take the edge off LED boom

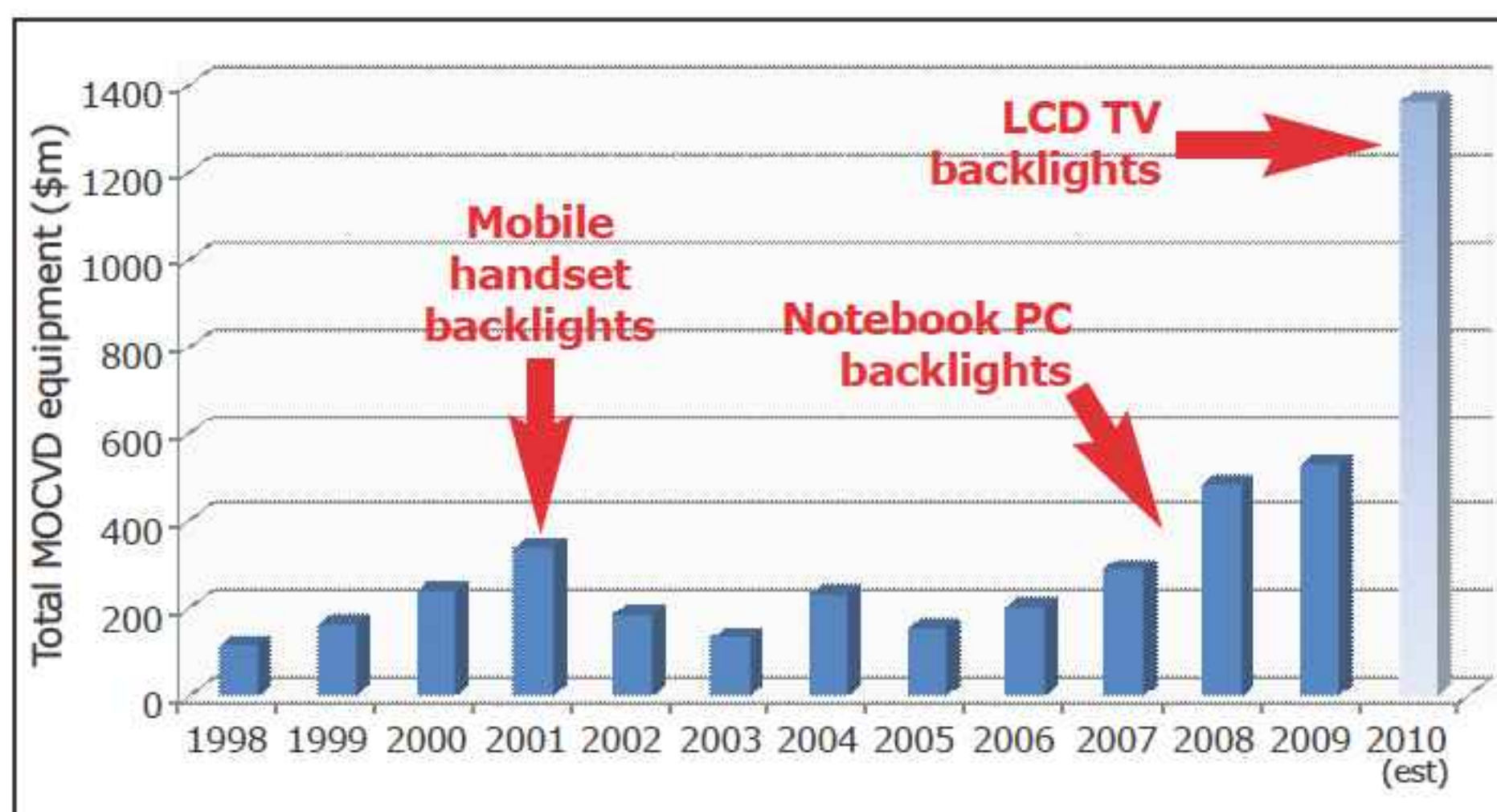
**It's boom-time in the LED industry. But while the unexpectedly sharp upturn in demand will mean a shortage of key materials during 2010, in the longer term there will be greater competition among MOCVD equipment vendors, and an acceleration of the emerging solid-state lighting market, writes Michael Hatcher.**

**T**he year 2010 will go down in compound semiconductor history as one of the great 'boom' years. Upwards of 250 new MOCVD reactors are likely to come on-stream in the LED manufacturing hot-beds of Taiwan and Korea — the two centers of the LCD TV backlighting industry that is primarily driving the current ramp.

Sales staff at Aixtron and Veeco Instruments have never had it so good: every quarter sees new records set for MOCVD-related orders, and with those deliveries now being fulfilled revenues are heading in the same, sharply upward, direction. With new fabs under construction and the likes of TSMC now entering the LED market, it's a situation that is set to continue.

But the boom presents its own challenges, and one trend that we are already starting to see is increased competition for the incumbent MOCVD equipment suppliers. For more than a decade now, Aixtron, Veeco and Taiyo Nippon Sanso have dominated the scene, with a combined market share consistently in excess of 95% in the past five years. Smaller suppliers such as EMF and Structured Materials have found a market in niche applications and customized equipment, but they do not supply the mass-production systems that are required for volume LED epiwafer fabrication.

The incumbents already face a stiff challenge in meeting the unprecedented and rising demand. Both Veeco and Aixtron exploit largely out-sourced production models that allow them to scale volumes rapidly up and down as demand requires. The two companies have stepped up capacity recently. Right now Aixtron is able to assemble 100 MOCVD systems each quarter, and is aiming to increase this to 150 by the end of 2010 — should such demand arise. Veeco's capacity target has been lifted to 120 systems per quarter, which it should be able to support by late 2010, suggesting a combined annual capacity in excess of 1000 systems in 2011.



**Fig 1: The spike in MOCVD reactor sales prompted by the LCD backlight unit boom dwarfs previous spikes seen for mobile handset and notebook PC backlights, as so many more LEDs are required to produce high-quality TV images. Source: Aixtron/Strategy Analytics.**

Can they achieve that capacity increase and meet the surging demand? Possibly. But they will certainly have more competition as we move out of 2010 and into 2011. Korea's Jusung Engineering and Integrated Process Systems (IPS) Ltd, along with China's Jason Qingdao and the lurking giant Applied Materials, have all made moves into the MOCVD sector. The sudden expansion of the TV backlighting market for LEDs (expected to comprise half the HB-LED market by 2013) may have caught those new entrants by surprise — within two years the capacity required to service that market will have been largely deployed, as LED backlight units become a standard technology in LCD TVs, and the present window of opportunity will have closed.

Consolidating their lead positions, first Veeco and then Aixtron updated their MOCVD equipment offerings in early 2010. A new flow design from Veeco improves cross-wafer deposition uniformity, enabling less waste of high-performance LED die through the binning stage. Aixtron's update to the 'IC' platform adds significant capacity to each reactor, with a susceptor arrangement providing room for up to 56 2" wafers or 14 4" wafers.



The potential challengers have been taken by surprise by the LCD TV ramp, and although they do have an opportunity to enter the market as supply tightens, they will be looking more realistically to the future investment cycle of solid-state lighting to make their mark. Those challengers are taking significantly different approaches. Applied Materials is working on a hybrid HVPE and MOCVD tool and, in general, equipment that emphasizes rapid throughput, while Jusung has fielded a tool to Korea's Epi-valley with room for more than 100

2" wafers. As always, refining new technologies to provide the required level of uniformity and consistency will take time, and industry talk suggests that the tools fielded by Applied are not yet ready for the task.

While the LCD TV investment cycle will come and go at the MOCVD equipment level, that will not be true of the materials required to make LEDs, which will need to step up significantly. Demand for trimethylgallium (TMG) in particular has picked up strongly (40–50%) as the slew of new MOCVD chambers is switched on for volume production, and there is now a big gap between demand for MO materials and the amounts that suppliers are able to provide. This capacity squeeze is likely to prove more of a drag on the LED market in the short term than any limits on the supply of epitaxy equipment. In fact, demand for TMG already outstrips supply by as much as 40%, with prices rising quickly. Some LED epiwafer producers, and in particular those based in Taiwan, are struggling to retain sufficient supply.

To a significant degree, this is the fault of the market itself, and in particular those who have battered down the price of MO materials over the years. As a result, suppliers have been unable — or unwilling — to risk making an investment in additional MO capacity. After many a false dawn in LCD backlighting applications and years of diminishing profit margins, this position should not be surprising. Now that the dawn of LED TV backlights has arrived for real, those suppliers are unable to ramp up to meet demand with immediate effect.

Manufacturers in Taiwan, where prices have historically been under the greatest pressure and supply contracts have typically been short-term in nature, have to adjust to a new reality. Unlike the first major ramp in LED production, for mobile handset backlights, the Taiwanese are not the dominant customers and cannot call the shots as before. This time, it is the Korean giants Samsung and LG, along with Seoul Semiconductor,

**Table. LED LCD TV backlight expansion (inches).**

	2009	2010
BenQ	None	21.5, 23.6
LG	42, 47, 55	19, 22, 26, 32, 37, 42, 47, 55, 60
Panasonic	None	37, 42
Philips	42, 46	40, 42, 46
Samsung	32, 40, 46, 55	19, 22, 26, 32, 40, 46, 55, 60, 65
Sharp	32, 40, 46, 52	19, 22, 32, 40, 46, 52, 60, 63
Sony	46, 52, 55	32, 40, 46, 52, 55, 60
Vizio	47, 55	16, 19, 22, 23, 26, 32, 37, 42, 47, 55, 72

Source: Aixtron, Strategy Analytics

who are calling the tune. With deep pockets, they are able to absorb the increased MO costs and now appear to be favored by suppliers of critical materials.

Such a position does of course raise the possibility of additional competition at the MO level. After all, the need for materials continues long after the MOCVD reactors have been shipped and installed, and there is an opportunity for long-term growth. But MOs are notoriously hazardous products and entering this specialist market is not a decision to be taken lightly. As a result, LED epiwafer manufacturers will likely have to take the increased MO prices on board until suppliers are able to scale up their production facilities.

The LCD TV boom is also now impacting sapphire wafer suppliers, with a shortage likely in second-half 2010. In Asia, prices have already risen 20% and, although sapphire producers aim to add crystal growth equipment, much of this extra capacity will not come on stream for many months. With LED producers increasingly looking to larger-diameter wafers, the shortage is likely to extend across all sapphire wafer sizes.

Clearly there will be some short-term pain, likely for the next 12 months, to go with the record gains, and materials supply constraints will limit LED market growth in 2010. But the extra capacity will ultimately provide greater economies of scale, just as extra competition among equipment suppliers will deliver performance improvements to impact LED yields in a positive way.

These trends will be crucial to cutting the cost of high-performance LED production to a level that pushes the cost per lumen figure for solid-state lighting significantly lower. The LED industry is embarking on a 2–3 year period of rapid growth and faces a new set of challenges as outlined above. When it emerges from that period, solid-state lighting will quickly provide the next cycle of investment among what is likely to be a more diverse range of device, equipment and materials companies. ■

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