LED TV Market Outlook and Its Impact on LED Supply/Demand

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February 2, 2010
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This week IMS Research has released the first market research report forecasting in detail the supply side of white and RGB LED production used for high brightness (HB) LEDs. Ross Young will be presenting the key findings from this report, “hot off the presses”

The report forecasts the extraordinary growth in large area display backlights by application and shows the capacity, yielded production and in-spec (binned) LED dies on a quarterly basis by LED supplier. By the end of 2009, there were 1,413 reactors at 75 manufacturers with a capacity of 188 billion die/year.

Key findings of the report include:

- **A projected 2010 shortage of 12-14 billion in-spec (binned) die.**
- **2010 MOCVD reactor forecast of 348 units with an additional 195 - 240 reactors necessary to meet demand, resulting in a total potential market of 588 reactors.**
- **This potential shortfall in supply is putting pressure on both the tool suppliers and the LED manufacturers to improve yields (or reduce the binning spec), increase capacity and speed up tool production.**
- **Nichia has a dominant position with a 42% share and over $2B in in-spec (binned) die revenues as shown in Table 1 due to their technical and IP leadership in the white LED market. Cree’s share has surged to 11% due to its strong focus on the rapidly growing solid state lighting market.**
- **34 billion in-spec (binned) die were produced with Nichia again in a leadership position as shown in Table 2. Epistar was #2 followed by Samsung LED Company, which vaulted to #3 as a result of strong demand from Samsung’s TV business, Cree and Show Denko.**
- **By region, aiwan leads in HB LED production with a 37% share followed by Japan and Korea.**

Course instructor

Ross Young is SVP, Displays and PV at IMS Research USA. Prior to joining IMS Research in November 2009, Young co-founded Young Market Research (YMR) with Barry Young in May of 2009 which IMS Research acquired in November.

Prior to forming YMR, Young was VP of New Market Creation at Samsung Electronics’ LCD Business, reporting to the LCD CEO, where he tracked, analyzed and assessed their solar market and supported their market intelligence efforts in notebooks and TVs.

Prior to Samsung, Young was the founder and CEO of DisplaySearch, the leading flat panel display market research, consulting and events firm. Young ran DisplaySearch from 1996 to 2007 and launched most of their product areas and many of their most popular reports on such topics as production equipment, supply/demand, large-area displays, notebooks, monitors and TVs. He sold DisplaySearch to The NPD Group in Sept. 2005.

Prior to DisplaySearch, Young served in marketing positions at OWL Displays, Brooks Automation, Fusion Semiconductor and GCA in the driver IC, automation, resist removal and lithography markets respectively for flat panels and semiconductors.

Young also authored a book published by the University of Texas on US-Japan competition in the semiconductor and semiconductor equipment industries entitled Silicon Sumo, has appeared as a display analyst on NBC’s The Today Show and other news programs and has been quoted in most business publications.

Young has spoken at over 40 different conferences around the world and keynoted more than a dozen. He won NPD’s prestigious John Byington award for outstanding creativity and innovation in 2006 and made VLSI Research’s Executive All-Star Team in 1993. Young was educated at UCSD, Australia’s University of New South Wales, UCSD’s Graduate School of International Relations and Pacific Studies and Japan’s Tohoku University.

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The content of this presentation handout has been kept in its original format as requested by the course presenter.
Outline

- My Bio and About IMS Research
- LED TV Market History and Development
- LED TV Demand Forecast
- LED Demand Forecast
- LED Supply/Demand Forecast
- Summary
About Ross Young


- Founded DisplaySearch in 1996.
  - Developed and authored their most popular quarterly reports in:
  - Notebook PCs, LCD Monitors, TVs, FPD Equipment and LCD Supply/Demand
  - Sold DisplaySearch to NPD in 2005


- Started Young Market Research in June 2009.

- Sold YMR to IMS in November 2009

- Also serve on Board of Directors of Uni-Pixel Displays, Advisory Board of Illumitex and as a consultant to the SID Executive Committee.

- email address: ross.young@imsresearch-usa.com
About IMS Research

- Founded in 1989 by former TI UK semiconductor executives.
- Focused on all electronics markets
- Reports, consulting and conferences
- ~ 100 employees, 80 analysts.
- Publish >200 reports per year.
- Headquartered in Wellingborough, UK with US office in Austin, Texas and China office in Shanghai.
- Sales into Asia grew 10-fold in last 3 years.
- Opening Korea and Taiwan offices in Q1’10.
- Annual average revenue growth of 30% for last 5 years.
- Continued healthy growth through recession.
12 Major Research Groups

- Automotive & Transportation
- Displays
- Medical Devices
- Communications
- Financial & ID Technologies
- Power & Energy
- Computer & Office Equipment
- Industrial
- Security & Fire
- Consumer Electronics
- Lighting & LEDs
- Semiconductors & Components
Lighting and LEDs Group

Reports

- Annual LED Report
- Annual Lighting Report
- Quarterly LED Supply Report
- Quarterly LED Backlighting Report
- Weekly Advertising and Next Generation TV Report
- 6 other new reports in development

Resources:

- LED Chip Analyst – Jamie Fox (UK)
- LED Supply – Barry Young (USA)
- OLEDs - Barry Young (USA)
- Backlighting – Ross Young (USA)
- Lighting – Kevin Furr (USA)
- Regional Shipments/Supply:
  - China – Jackey Wang
  - Taiwan – TBD, March
  - Korea – TBD, March

For more information on any of these products, please send me an email at ross.young@imsresearch-usa.com.
LED TV Market History and Development
History of LED TVs

- **2004**
  - Sony introduced the first LED-backlit LCD TV in 2004, the 40” and 46” Qualia 005 at ~$7500 and $10,000 respectively. It used RGB and LEDs and was 5” thick.

- **2005 – 2008**
  - Other manufacturers also introduced direct RGB and white LED backlighting at the high end.
  - Luminus and Global Lighting began actively promoting edge-lighting with a small number of Luminus’ large photonic lattice LEDs per edge and Global Lighting’s lightguide. 37”, 7 RGB modules. 52”, 10 RGB modules, <10mm thickness. However, thermal issues could not be overcome.
  - LED TV volumes remain limited due to high costs of direct LED backlighting.

- **2008**
  - LED costs fall significantly as a result of build up for mobile demand.
  - Lower LED prices lead to Apple’s LED Macbook Pro, higher volumes and even lower prices.
  - Samsung puts edge-lit LEDs on its LCD TV panel roadmap for production in Q1’09.
  - Sony, its JV partner in S-LCD, opts for HCFLs.
History of LED TVs...

- **2009**
  - Samsung launches edge-lit LCD TVs into retail in April.
  - Due to the nature of product cycles which are refreshed in April, no other brand got edge-lit into major US national chains in 2009.
  - LG units, SL90 series, started showing up in regional retailers in September 2009.

- **Why edge?**
  - It was a surprise to me and other analysts as the mindset at the time was the industry would move to direct LED backlighting when costs fell. Nobody was thinking about edge lighting after the Luminus/GLT approach failed.

- **While I was at Samsung, one major display research firm lowered its LED TV penetration forecast in Q4’08 from**
  - 2.0% to 1.5% for 2009
  - 5.1% to 4.6% for 2010
History of LED TVs...

- **Edge vs. Direct**
  - Relative to direct LED backlighting, edge-lit contrast, brightness and power consumption performance was not as good, but form factor was significantly improved. In addition, edge-lit cost 30% less, due to around half as many LEDs, and thermal concerns were reduced.

- **Edge vs. CCFLs**
  - LED edge-lighting offered significant contrast, power and form factor improvements which Samsung correctly believed would interest consumers.

- **LED TVs**
  - Samsung’s move to LED edge-lighting blindsided the rest of the industry. Having a highly differentiated product in such a competitive market is quite unusual. Samsung took advantage of this situation through a multi-million dollar LED TV advertising campaign which really cemented Samsung’s leadership position in the TV market.

- **According to Samsung US, LED TVs accounted for around 7% of the 40”+ market in 2009. Given the economic climate, there was quite a bit of discounting (scandowns) of LED units up to 25% from the initial MAP.**
LED TV Demand Forecast
2010 CES Show Highlights

- **LG**
  - 41 new models, 19 or 46% were LED. 4 were direct.

- **Panasonic**
  - 9 new LCD models, 2 were LED edge.

- **Samsung**
  - All edge. Around 1/3 of its TVs to be LED in 2010. In the US at 40”+, >40% to be LED.

- **Sharp**
  - 21 new models, 11 are LED. LEDs are all edge.

- **Sony**
  - 36 new models, 22 are LED. 2 are direct.

- **Vizio**
  - 20 new models, 100% were LED, down to 16”. 6 were direct.

- **6 Backlighting Configurations in the market:**
  - CCFL
  - HCFL
  - LED Edge-lit, LED Edge-lit with dimming
  - LED Backlit, LED Backlit with dimming
LED TV Penetration

- For performance, form factor and power consumption reasons, LED penetration to surge from 2.5% in 2009 to 22.2% in 2010 and 45% in 2011.

- Penetration to be 2X higher at 40”+ than <40” in 2010.

Source: IMS Research
Initial products were direct, edge took over in 2009, but the market will increasingly adopt direct due to the performance and power consumption benefits from 2D dimming as LED prices fall.

Source: IMS Research
LED TV Demand in LED Die

- LEDs in TVs are projected to grow at a 99% CAGR.
- Direct should overtake edge in LED die demand in 2012.

Source: IMS Research
NB Market Demand

- NB PCs jumped from 6% to 46% penetration in 2009 and should reach 80% in 2011 and full penetration from 2011.

Source: IMS Research
LED demand to grow at a 37% CAGR from 2009 – 2015 to 162.5B die.

Backlighting to grow at a 47% CAGR over this period

TVs to overtake all small/medium applications in 2010.

Source: IMS Research
HB LED Demand by Application

- Backlighting rising from 53% of 2009 demand to ~75% of 2011-2014 demand.
- TVs to grow from 4% of 2009 demand to 51% of 2014 demand.

Source: IMS Research
LED Supply Forecast
LED Supply

- IMS has recently introduced a breakthrough QUARTERLY report quantifying LED supply developed in partnership with a leading financial analyst who has been tracking the LED market for 10 years.

- Our LED supply database indicates how many MOCVD reactors each LED manufacturer has by brand and model #s.

- This allows us to determine LED supply in wafers, die and binned die by LED manufacturer and by MOCVD supplier.
Capacity Calculation

Capacity = Reactors x Die/Reactor

Yielded Die = Capacity * Process Yield* Utilization(%)* Packaging Yield

Binned Die = Yielded Die* Bin Ratio

Revenue = Binned Die* ASP
1413 reactors in production at the end of 2009.

Nippon Sanso builds exclusively for Nichia, tools are low capacity, 2” and 3”, 1-3 wafers per reactor.

Thomas Swan is part of Aixtron, all tools are 2”.

Most of the market buys from Aixtron and Veeco.

AMAT has multiple systems in the field. Jusung, SEMES, others rumored to be getting in.

<table>
<thead>
<tr>
<th>Company Name</th>
<th>2009</th>
<th>2009 Share</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 Nippon Sanso</td>
<td>501</td>
<td>35.5%</td>
</tr>
<tr>
<td>2 Thomas Swan*</td>
<td>329</td>
<td>23.3%</td>
</tr>
<tr>
<td>3 Aixtron</td>
<td>323</td>
<td>22.9%</td>
</tr>
<tr>
<td>4 Veeco</td>
<td>254</td>
<td>18.0%</td>
</tr>
<tr>
<td>5 Other</td>
<td>6</td>
<td>0.4%</td>
</tr>
</tbody>
</table>

**Total Installed Base** 1413 100%

Source: IMS Research
Veeco leads in installed die capacity at 33% on both a yielded and unyielded basis.

Nippon Sanso takes share from Thomas Swan on a yielded basis.

Unyielded Die Capacity

- Nippon Sanso, 12%
- Aixtron, 26%
- Thomas Swan, 29%
- Other, 0%

Yielded Die Capacity

- Nippon Sanso, 16%
- Thomas Swan, 24%
- Aixtron, 26%
- Other, 0%

Source: IMS Research
Nichia has the highest share followed by Epistar, Samsung LED, Cree and Showa Denko.

34B Binned die and 42B off spec die were produced.

Source: IMS Research
2009 Binned Die Revenue Share

- Revenues from binned HB LED die reached $5.2B in 2009.

- When off-spec die are included, the revenues were $5.7B.

- Nichia had the highest share due to its pricing premium derived from its IP position and tier 1 performance along with high penetration of high volume segments like NBs and mobile.

- Cree was #2 due to its significant position in lighting which warrants a premium.

Source: IMS Research
Regional Share

- Japan has the highest reactor and revenue share.
- Taiwan has the highest binned die share.

![Reactor Share Diagram](chart1)

- Japan: 38%
- Taiwan: 27%
- Korea: 17%
- USA: 8%
- Europe: 2%
- China: 8%

![Binned Die Share Diagram](chart2)

- Japan: 24%
- Taiwan: 37%
- Korea: 11%
- USA: 11%
- Europe: 2%
- China: 2%

![Revenues Share Diagram](chart3)

- Japan: 52%
- Taiwan: 21%
- Korea: 11%
- USA: 12%
- Europe: 2%
- China: 2%

Source: IMS Research
LED Supply/Demand

- We expect the LED industry to operate under a significant shortage from 2010 to 2014 despite supply growth of 28% CAGR.

- Suppliers will not be able to match the dramatic growth in TV demand unless significantly more tools are ordered. If this does not happen, demand forecasts will need to be scaled back.

- We are currently projecting a shortage of nearly 12B binned die in 2010.

Source: IMS Research
How LED and MOCVD Suppliers Are Reacting

- **MOCVD Suppliers**
  - Expanding their tool production capacity.
  - Outsourcing more of their tool production.
  - Boosting throughput, developing 6” tools.
  - New entrants

- **LED Suppliers**
  - New entrants
  - Boosting yields
  - Maximizing utilization, minimizing downtime.
  - Increasing wafer sizes
  - Increasing luminous efficiency
  - Customers relaxing binning specs...
Additional Reactors Needed to Meet Demand

- Large number of reactors needed relative to traditional annual shipments.
- MOCVD companies are well positioned for multiple years of high revenues.

![Chart showing additional reactors needed and reactor forecast for 2010 to 2013.]

Source: IMS Research
30%-70% more money needs to be spent per year to meet LED demand, led by LED TVs.

Source: IMS Research
Summary

- Sony developed the first LED TV in 2004, but it wasn’t until 2009 when Samsung successfully commercialized them with an edge-lighting solution first proposed by Luminus/GLT in 2005.
- At CES 2010, all major TV brands introduced a large number of edge-lit LED TV solutions.
- With LED prices declining and efficiencies improving, direct LED backlighting should grab a reasonable share in 2010 with over a dozen SKUs introduced at CES.
- LED TV panel penetration is projected to jump from 2.5% in 2009 to 22% in 2010 and 45% in 2011 for form factor, performance and power consumption reasons.
- LED TV panel demand is expected to grow at a 99% CAGR with direct overtaking edge in LED die demand in 2012.
- TVs are expected to become the single largest LED application from 2010 overtaking small/medium.
- IMS has recently launched a breakthrough quarterly LED supply report that tracks wafer, die and binned die and also compares supply with demand.
- A significant LED shortage is predicted for 2010 – 2013 that will lead to rapid growth in MOCVD reactor shipments.
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