SID-Bay Area Meeting: Display Week 2013 Recap

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Outline – SID 2013 Recap

Introduction

SID 2013 Highlights

• Keynote Presentations
• Exhibition
• International Symposium

Display Industry Awards

Question & Answer
SID 2013
Keynote Highlights
Dr. Kinam Kim, President and CEO of Samsung Display Co., Ltd. and head of the company’s OLED business spoke of a “Display Evolution” being driven by OLED technology.

He described OLED flexible displays as the coming next (3rd) generation of displays in a succession of display technologies.

He outlined four (4) key attributes of AMOLED technology:

1) Outstanding Performance
2) Optimized for People
3) New Value Creation
4) Solution Convergence
SID 2013
Exhibition Highlights
SID 2013 Exhibition Highlights: Nine Major Themes (Excluding Touch Technology)

- UHD (4K) TV Products
- OLED TV Products
- Super High-Resolution Displays
- Widened Color Gamut LCD Technology
- Glasses-Free 3D Displays
- Next-Generation Flexible Displays
- Advanced Display Designs (Narrow Bezel, Transparent, etc.)
- Reduced Power Consumption
- Metal-Oxide TFT Array Technology
## SID 2013 Exhibition Highlights: Overview of Value-Added Displays

<table>
<thead>
<tr>
<th>Developer</th>
<th>Application</th>
<th>Description</th>
<th>TFT</th>
<th>Size &amp; Format</th>
<th>PPI</th>
</tr>
</thead>
<tbody>
<tr>
<td>Samsung</td>
<td>TV</td>
<td>4K AMLCD</td>
<td>a-Si</td>
<td>85&quot; UHD/4K</td>
<td>51 PPI</td>
</tr>
<tr>
<td>LG</td>
<td>TV</td>
<td>4K AMLCD</td>
<td>IGZO</td>
<td>84&quot; UHD/4K</td>
<td>52 PPI</td>
</tr>
<tr>
<td>LG</td>
<td>TV</td>
<td>AMOLED (conventional, flat)</td>
<td>IGZO</td>
<td>55&quot; FHD</td>
<td>40 PPI</td>
</tr>
<tr>
<td>LG</td>
<td>TV</td>
<td>AMOLED (curved, 3D)</td>
<td>IGZO</td>
<td>55&quot; FHD</td>
<td>40 PPI</td>
</tr>
<tr>
<td>LG</td>
<td>Smartphone</td>
<td>Hi-Res AMOLED (plastic)</td>
<td>LTPS</td>
<td>5&quot; FHD</td>
<td>440 PPI</td>
</tr>
<tr>
<td>Samsung</td>
<td>Smartphone</td>
<td>Hi-Res AMOLED</td>
<td>LTPS</td>
<td>4.99&quot; FHD</td>
<td>441 PPI</td>
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<tr>
<td>JDI</td>
<td>Smartphone</td>
<td>Hi-Res AMOLED</td>
<td>LTPS</td>
<td>5.0&quot; FHD</td>
<td>440 PPI</td>
</tr>
<tr>
<td>Samsung</td>
<td>Tablet</td>
<td>Hi-Res AMLCD</td>
<td>a-Si</td>
<td>10.1&quot; WQXGA</td>
<td>298 PPI</td>
</tr>
<tr>
<td>LG</td>
<td>Tablet</td>
<td>Hi-Res AMLCD</td>
<td>IGZO</td>
<td>7&quot; FHD</td>
<td>314 PPI</td>
</tr>
<tr>
<td>Sharp</td>
<td>Tablet</td>
<td>Hi-Res AMLCD</td>
<td>IGZO</td>
<td>10.1&quot; WQXGA</td>
<td>298 PPI</td>
</tr>
<tr>
<td>Samsung</td>
<td>Notebook PC</td>
<td>Hi-Res AMLCD</td>
<td>a-Si</td>
<td>13.3&quot; WQXGA+</td>
<td>276 PPI</td>
</tr>
<tr>
<td>LG</td>
<td>Notebook PC</td>
<td>Hi-Res AMLCD</td>
<td>a-Si</td>
<td>14&quot; QHD</td>
<td>209 PPI</td>
</tr>
<tr>
<td>Sharp</td>
<td>Notebook PC</td>
<td>Hi-Res AMLCD</td>
<td>IGZO</td>
<td>15.6&quot; QHD</td>
<td>188 PPI</td>
</tr>
<tr>
<td>Sharp</td>
<td>Notebook PC</td>
<td>Hi-Res AMLCD</td>
<td>IGZO</td>
<td>13.3&quot; QHD</td>
<td>220 PPI</td>
</tr>
<tr>
<td>Sharp</td>
<td>Notebook PC</td>
<td>Hi-Res AMLCD</td>
<td>IGZO</td>
<td>11.6&quot; QHD</td>
<td>253 PPI</td>
</tr>
<tr>
<td>LG</td>
<td>Monitor</td>
<td>Hi-Res AMLCD</td>
<td>IGZO</td>
<td>23.8&quot; UHD/4K</td>
<td>185 PPI</td>
</tr>
<tr>
<td>LG</td>
<td>Smartphone</td>
<td>AMLCD (narrow bezel)</td>
<td>IGZO</td>
<td>5&quot; HD</td>
<td>293 PPI</td>
</tr>
<tr>
<td>LG</td>
<td>Notebook PC</td>
<td>AMLCD (narrow bezel)</td>
<td>a-Si</td>
<td>13.3&quot; FHD</td>
<td>165 PPI</td>
</tr>
<tr>
<td>LG</td>
<td>Mobile</td>
<td>AMLCD (narrow bezel)</td>
<td>IGZO</td>
<td>7&quot; HD</td>
<td>209 PPI</td>
</tr>
<tr>
<td>LG</td>
<td>Monitor</td>
<td>AMLCD (narrow bezel, 100% NTSC)</td>
<td>a-Si</td>
<td>23.8&quot; FHD</td>
<td>92 PPI</td>
</tr>
<tr>
<td>LG</td>
<td>Automotive</td>
<td>AMLCD (800 nit, 85% NTSC)</td>
<td>a-Si</td>
<td>12.3&quot; FHD</td>
<td>179 PPI</td>
</tr>
<tr>
<td>LG</td>
<td>Refrigerator</td>
<td>Transparent AMLCD</td>
<td>IGZO</td>
<td>47&quot; FHD</td>
<td>46 PPI</td>
</tr>
</tbody>
</table>
SID 2013 Exhibition Highlights: UHD LCD-TV Products

Samsung Display

85" UHD Panel
“Largest in Mass Production”

- 3840 x 2160 pixels, 500cd/m²
- 5,000:1 contrast, 72% NTSC color
- Direct LED BLU, 240-zone local dimming
- 11.7mm narrow bezel

LG Electronics

84" UHD TV
Currently available in the market

- 3840 x 2160 pixels
- Edge-lit LED BLU
- Price: US$16,000
SID 2013 Exhibition Highlights:
Samsung High-Resolution OLED Display

**Samsung AMOLED**
4.99" FHD OLED Display – 441ppi
Recently introduced in the Galaxy S4 Smartphone

*Uses Super Slim On-Cell Touch to achieve a total display thickness of 1.82mm including cover window*

**Diamond Pixel**
New OLED pixel layout
Better than Stripe layout for diagonal & curved characters

**Green Phosphorescent EL Material**
Provides for ~20% reduction in power consumption
SID 2013 Exhibition Highlights: LG Electronics OLED-TV Products

Conventional 55” OLED-TV
Model 55EM9700
Limited market release in early 2013

- Metal Oxide (IGZO) TFT array
- White-OLED with RGBW color filter
- Full HD: 1920 x 1080 pixels
- Price: ~US$10,000

Curved 55” 3D OLED-TV
Model 55EA9800
Limited release on June 10th, 2013

- Same technology as conventional OLED panel
- Uses Carbon Fiber-Reinforced Plastic frame
- 15 million won (~US$13,285)
- 4.3mm thick, 17kg weight
SID 2013 Exhibition Highlights: High-Resolution AMLCD Displays

**Japan Display**

**LTPS-LCD**  
Smartphone Application  
5” FHD LCD– 443ppi  
0.95mm thick, 1mm bezel

**Japan Display**

**LTPS-LCD**  
Tablet or Auto Applications  
7” FHD LCD– 314ppi

**Sharp**

**IGZO-LCD**  
15.6” QHD, 13.3” WQHD,  
11.6” WQHD, 10.1” WQXGA
SID 2013 Exhibition Highlights:
Quantum Dot – Wide Color Gamut Technology

Nanosys

QDEF™ Technology
Films marketed through 3M in Fall 2013

- Uses 3M’s PET-based barrier film
- Nanosys & 3M will focus initially on mobile display products.
- In a typical LCD smartphone: 68.8% NTSC \( \Rightarrow 98.4\% \) with QDEF™ vs. AMOLED: 103.9% NTSC

QD-Vision

Color IQ™ Component
Commercialization with Sony from May 2013

- Five (5) high-end Sony TVs in the market: Three 2K TVs, Two 4K TVs (55”, 65” models).
- Wide color gamut >100% NTSC (sRGB, Adobe)
SID 2013 Exhibition Highlights:
Glasses-Free 3D Displays

Innolux
11.6” FHD
LTPS AAS Technology
Dual & Multi-View Modes

Japan Display
12.2” Automotive
720 HD (2D), 960x720 (3D)
Head Tracking Capability

LG Display
55” 3D LCD-TV
Fixed Lenticular Lens
Multi-View (20 Zones)
High Luminance
Wide Viewing Angle

55” 3D LCD-TV
Fixed Lenticular Lens
Multi-View (20 Zones)
High Luminance
Wide Viewing Angle

LG Display
4.5” HD (720x1280)
Two Views, 2D-3D

LG Display
55” 3D LCD-TV
Fixed Lenticular Lens
Multi-View (20 Zones)
High Luminance
Wide Viewing Angle
SID 2013 Exhibition: Flexible (Plastic) Display Demonstrators

LG Display
5" Plastic OLED Display
Smartphone Applications

- LTPS TFT array on polyimide substrate with thin-film encapsulation (similar to Samsung process)
- Production planned in late 2013

Sony & E Ink
13.3" Digital Paper Device
Uses EM Induction Digitizer & Stylus

- All plastic display, including TFT array substrate
- 13.3" (A4 size), 6.8mm thick, 358 grams
- UXGA, 1200 x 1600 pixels with 16 levels grayscale
- Announced in May for end of 2013 release in Japan
SID 2013
International Symposium Highlights
SID 2013 International Symposium: Overview of Papers Presented

Number of Papers by Technology
- OLED: 98
- LCD: 97
- Oxide TFT: 48
- 3D: 43
- LED BL, Lighting: 17
- E-Paper: 17
- PDP: 7
- Organic TFT: 6
- Touch: 19
- Projection: 16
- 3D: 43

Number of Papers by Country
- Korea: 79
- US: 80
- Taiwan: 69
- Japan: 84
- China: 53
- Others: 21
- Netherlands: 3
- UK: 4
- Germany: 12

SID 2013 Symposium
254 Oral + 151 Poster = 405 Total Papers
## SID 2013 International Symposium: Notable Flexible Display Papers

<table>
<thead>
<tr>
<th></th>
<th>Panasonic</th>
<th>Toshiba</th>
<th>SEL/Sharp</th>
<th>ASU FDC</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Diagonal (in)</strong></td>
<td>4”</td>
<td>10.2”</td>
<td>3.4”</td>
<td>14.7”</td>
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<tr>
<td><strong>Pixel Format</strong></td>
<td>224 x 224 x RGB</td>
<td>1920 x RGBW x1020</td>
<td>540 x RGBW x 940</td>
<td>960 x 720 x RGB</td>
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<tr>
<td><strong>Resolution</strong></td>
<td>80 ppi</td>
<td>223 ppi</td>
<td>326 ppi</td>
<td>81 ppi</td>
</tr>
<tr>
<td><strong>OLED Device</strong></td>
<td>Top- Emission</td>
<td>Bottom Emission</td>
<td>Top- Emission</td>
<td>Bottom Emission</td>
</tr>
<tr>
<td><strong>OLED Technology</strong></td>
<td>RGB</td>
<td>W-OLED + CF</td>
<td>W-OLED + CF</td>
<td>RGB</td>
</tr>
<tr>
<td><strong>TFT Array Technology</strong></td>
<td>a-IGZO</td>
<td>a-IGZO</td>
<td>CAAC-IGZO</td>
<td>a-IGZO</td>
</tr>
<tr>
<td><strong>Substrate Material</strong></td>
<td>PEN</td>
<td>PI</td>
<td>Transparent plastic</td>
<td>PEN</td>
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<tr>
<td><strong>Bending Radius</strong></td>
<td>R = 10mm</td>
<td>Not reported</td>
<td>R = 4mm</td>
<td>Not reported</td>
</tr>
<tr>
<td><strong>Max. Process Temp</strong></td>
<td>150ºC</td>
<td>Not reported</td>
<td>Not reported</td>
<td>200ºC</td>
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<tr>
<td><strong>SID 2013 Session #</strong></td>
<td>18.4L</td>
<td>70.1L</td>
<td>18.2</td>
<td>70.2L</td>
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<tr>
<td><strong>SID Prototype ?</strong></td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
<td>No</td>
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</table>
## Notable OLED Lighting Papers

<table>
<thead>
<tr>
<th>Description</th>
<th>Panasonic</th>
<th>SEL &amp; Advanced Film Device</th>
</tr>
</thead>
<tbody>
<tr>
<td>Highly Efficient OLED Lamp</td>
<td>Highly Efficient Flexible OLED Lamps</td>
<td></td>
</tr>
<tr>
<td>Lamp Size (mm)</td>
<td>50 mm × 50 mm</td>
<td>56 mm × 42 mm</td>
</tr>
<tr>
<td>Luminous Efficiency</td>
<td>102 lm/W @ 3000cd/m²</td>
<td>131 lm/W @ 1000cd/m²</td>
</tr>
<tr>
<td></td>
<td>114 lm/W @ 1000cd/m²</td>
<td></td>
</tr>
<tr>
<td>CIE Color Coordinates</td>
<td>(not reported)</td>
<td>0.49, 0.50</td>
</tr>
<tr>
<td>Color Reproduction (CRI)</td>
<td>(not reported)</td>
<td>&gt;90%</td>
</tr>
<tr>
<td>Lifetime</td>
<td>~100K hours @ 1000cd/m²</td>
<td>(not reported)</td>
</tr>
<tr>
<td>Featured Technologies</td>
<td>BLES (Built-up Light Extraction Substrate)</td>
<td>Exciplex (hole transport material)</td>
</tr>
<tr>
<td></td>
<td>MLA (Micro-Lens Array)</td>
<td>Three-color white: Orange-Green-Blue</td>
</tr>
<tr>
<td>SID 2013 Session #</td>
<td>Session 66.2</td>
<td>Session 66.4</td>
</tr>
<tr>
<td>SID Prototype?</td>
<td>Yes</td>
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SID 2013
Display Industry Awards
## SID 2013 Display Industry Awards: Silver & Gold Winners

<table>
<thead>
<tr>
<th>Category</th>
<th>Silver Award</th>
<th>Gold Award</th>
</tr>
</thead>
<tbody>
<tr>
<td>Display Application</td>
<td>The Nokia Lumia 920</td>
<td>Apple's iPad with Retina Display</td>
</tr>
<tr>
<td>Component Category</td>
<td>Sharp's Moth-Eye Technology</td>
<td>QD Vision's Color IQ Component</td>
</tr>
<tr>
<td>Display Device Category</td>
<td>CSOT 110-in. 4K × 2K 3-D LCD TV</td>
<td>Sharp and SEL's IGZO LCD</td>
</tr>
</tbody>
</table>
Thank you!