Where Do OLEDs Fit In?

DOE SSL Workshop
Portland, OR

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OLEDWorks
Naturally Illuminating

OLEDWorks.com
Where do OLEDs fit in?

- A solid-state lighting solution that complements LED
- With the SSL advantages you’ve come to expect:
  - control, efficiency, environmental
- And evolutionary performance trajectory that mirrors LED
  - Efficacy, lifetime, CRI, cost

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Where do OLEDs fit in?

- OLED is a different experience
  - Light quality
  - Thinness (<1mm)
  - “something about the light”
  - Cool to the touch
  - Direct view
- Enable new designs
Global View: OLED light engines

<table>
<thead>
<tr>
<th></th>
<th>Philips</th>
<th>Osram</th>
<th>Kaneka</th>
<th>Konica Minolta</th>
<th>LG</th>
<th>OW</th>
</tr>
</thead>
<tbody>
<tr>
<td>Efficiency lm/W</td>
<td>45</td>
<td>40</td>
<td>40</td>
<td>45</td>
<td>60 (80)</td>
<td>50 (80)</td>
</tr>
<tr>
<td>L70 Khrs</td>
<td>10 @ 9000nits</td>
<td>20@3000nits</td>
<td>50 @ 3000nits</td>
<td>8 @ 1000nits</td>
<td>40 @ 3000nits</td>
<td>30 @ 3000nits</td>
</tr>
<tr>
<td>CRI</td>
<td>&gt;80</td>
<td>&gt;80</td>
<td>&gt;80</td>
<td>&gt;75</td>
<td>&gt;90</td>
<td>&gt;84</td>
</tr>
<tr>
<td>Notable</td>
<td>High brightness</td>
<td>Transportation</td>
<td>Architectural</td>
<td>Flexible</td>
<td>Broad Portfolio</td>
<td>Versatile Mfg</td>
</tr>
</tbody>
</table>

- Are OLED lighting panels positioned for market adoption?
- Yes, surpass threshold for many applications
OLED Application Evolution

- > 80 LPW
- > 60 LPW
- > 40 LPW
- > 25 LPW

2013  2014  2015  2016  2017

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Efficiency Forecast – Is it real?

- Higher performance materials including blue phosphorescent emitters being developed
- Harnessing all the trapped light – new substrates and extraction techniques
- Big improvements in drivers

- Yes: OLEDs offer an efficient lighting solution for current and future applications
OLED Designs – An opportunity and a challenge

- OLED lighting industry infrastructure
  - Drivers – more challenging as panels get more efficient
  - Cost effective supply
  - Standards

- Design paradigm
  - The very attributes that enable new designs also challenge existing paradigms – no shades, reflectors, etc.
  - Showcase thinness
  - Connectivity – needs to be easy
  - Area source – not competing for the Edison socket

- The 80/20 rule
OLED Designs – An opportunity and a challenge

- OLED can build on LED, solid-state lighting, expertise including drivers and controls
  - Simpler assembly
  - Fast development time, low development cost
- **Blurs the line between light engine and fixture**

The OLED Way

Creative Vision + Fixture Design Channel = Fixture Design Channel
OLED Cost Reduction

OLED Panel Cost Scenario

Executive Summary, 2014 SSL R&D Manufacturing Roadmap: www.ssl.energy.gov/techroadmaps.html

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Cost Forecast – Is it real?

- Cost decrease with volume increase – efficiency in production
  - OLED as lamp, building material, electronic component...
- Higher yields
- Material costs – display and lighting demand drives efficiency in supply
- Device and finishing engineering improvements

- Yes: OLEDs offer an affordable lighting solution for current and future applications
### OLED Luminaire Layout Comparisons

#### ("Standard" vs. "Application Efficient" Layouts)

**9’ Ceiling Height; 80-50-20 Reflectance**

<table>
<thead>
<tr>
<th>Comparison</th>
<th>Standard Layout</th>
<th>Application Efficient Layout</th>
</tr>
</thead>
<tbody>
<tr>
<td>Luminaire Quantity / Mounting Height</td>
<td>112 (Surface-Mounted)</td>
<td>88 (15 Surface; 73 Pendant)</td>
</tr>
<tr>
<td>Total System Watts</td>
<td>849 W</td>
<td>685 W</td>
</tr>
<tr>
<td>Luminaire Spacing</td>
<td>6’ x 6’ o.c.</td>
<td>VARIES</td>
</tr>
<tr>
<td>Average Initial Work Zone Illuminance at 30’ AFF (FC)</td>
<td>34 FC</td>
<td>35 FC</td>
</tr>
<tr>
<td>Average Initial Circulation Area Illuminance at 30’ AFF (FC)</td>
<td>22 FC</td>
<td>16 FC</td>
</tr>
<tr>
<td>Avg. Horizontal Uniformity (Max/Min; Avg/Min) – Work Zone</td>
<td>1.5 (Max/Min); 1.3 (Avg/Min)</td>
<td>2 (Max/Min); 1.6 (Avg/Min)</td>
</tr>
<tr>
<td>Avg. Horizontal Uniformity (Max/Min; Avg/Min) – Circulation</td>
<td>2.5 (Max/Min); 1.7 (Avg/Min)</td>
<td>2.7 (Max/Min); 1.7 (Avg/Min)</td>
</tr>
<tr>
<td>Average Initial Wall Illuminance (FC)</td>
<td>16 FC</td>
<td>11 FC</td>
</tr>
<tr>
<td>Lighting Power Density (W/sq.ft)</td>
<td>0.8 W/sq.ft</td>
<td>0.65 W/sq.ft</td>
</tr>
</tbody>
</table>

P. Ngai, Acuity Brand Lighting
Real World Application: OLED World Summit 2014 Panel Discussion; Road to Commercialization

OLED LUMINAIRE LAYOUT COMPARISONS
("STANDARD" VS. "APPLICATION EFFICIENT" LAYOUTS)

But you have to Experience It!

P. Ngai, Acuity Brand Lighting
Where do OLEDs fit in?

- Expanding design space while embracing the SSL imperatives of efficient, affordable, high light quality lighting solutions.

A superb lighting experience.