Philips Lumiblade
The World of OLED Lighting
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OLEDs

What is OLED?

OLED stands for “organic light emitting diode”.

Name is misleading: has nothing to do with animals or plants.

“Organic” because materials used in the production of OLEDs come from the field of organic chemistry (carbon based compounds).
OLEDs

Some basics about the technology

Chemical substances in the OLED emit light when current is applied. This principle is called electroluminescence.

Not to be mistaken with phosphorescence.


Today, OLEDs are made with small-molecules structures. Polymers will be the future of OLEDs.
OLEDs
Known for displays, new for lighting

OLEDs are used as displays in smart phones and mobile gaming devices.

First commercial available large OLED TVs announced at CES 2013 – screen size of 55”, price of £8,000.

However: First prototypes were shown already in 2004. 9 years+ to the market.

Relatively new on the market:
Lighting applications based on OLED.
# OLEDs

## Differences between OLED displays and OLED lighting

<table>
<thead>
<tr>
<th></th>
<th>Passive matrix display</th>
<th>Active matrix display</th>
<th>Lighting</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Substrate</strong></td>
<td>Glass/ITO pixelated</td>
<td>LTPSilicon TFT</td>
<td>Glass/ITO large area</td>
</tr>
<tr>
<td><strong>Emission</strong></td>
<td>R,G,B saturated</td>
<td></td>
<td>All, especially white</td>
</tr>
<tr>
<td><strong>Brightness (cd/m²)</strong></td>
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<td>4,400</td>
</tr>
<tr>
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<td>&gt; 5cm x 5cm</td>
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<td><strong>Defect tolerance</strong></td>
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<td></td>
<td>0</td>
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<tr>
<td><strong>Value enabler</strong></td>
<td>OLED/Driver IC</td>
<td>TFT backplane</td>
<td>OLED</td>
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<td><strong>Applications</strong></td>
<td>Sub-display, MP3</td>
<td>Mobile phone display/TV</td>
<td>Any lighting</td>
</tr>
<tr>
<td><strong>Market development</strong></td>
<td>Declining</td>
<td>Strong growth</td>
<td>Embryonic</td>
</tr>
<tr>
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# OLEDs

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OLEDs
Why are OLEDs a revolution to lighting?

Point source

Linear sources
OLEDs

A new perception of light

Rather than a beam emerging from a single light-emitting point, light coming from the larger surface provides pleasant, uniform illumination.

The OLED produces a soft light, casting no shadows and no glare: It is about purity and subtle beauty.
OLEDs
Instant on and dimmable

All actions of staging the light between instant on and smooth dimming are possible.
OLEDs
Ultra-flat and ultra-light

OLEDs are only between 1.8 mm and 0.7 mm thin and a lightweight.

A high-tech light source at its best.
OLEDs
High tech at its best

Layers that emit the light are just 400 nm – that is a 400th of the thickness of human hair.

The relation between the size of the Organic layers and the thickness of the total OLED is the same like a human hair in front of the Paris’ Eiffel Tower.

During production process, atom by atom is sprayed onto the glass plate.
How OLEDs work

A layer of light

OLED works by passing electricity through nanometer thin layers of organic semiconductors sandwiched between two electrodes. The electric current travels from the positive to the negative electrode through the organic film, causing the film to emit light. To protect the organic layers, the OLED is completely sealed between two glass plates.
OLEDs
All shades of white

The OLED is able to produce the cool white emitted by an LED as well as the warm white radiated by an incandescent bulb.
OLEDs
All colors

The colours emitted are produced by mixing the Red, Green and Blue OLED compounds in specific amounts and combinations, this way exact colour shades can be created.
OLEDs
All shapes

As well as symmetric forms like e.g. ovals or rounds, all kinds of free shapes are possible.
OLEDs
Light as a material

OLEDs opens up a whole new world of opportunities for working with light. Functional as well as decorative, and surprisingly easy to use, organic lighting represents a new raw material.
OLEDs
Long-living and highly efficient

Lifetime (L70): 15,000 hours

Already far more efficient than halogen, with no losses due to secondary optics.

Made from glass – easy to recycle.

Philips Lumiblade OLEDs meet European Union’s RoHS and REACH directives.

No drawbacks of conventional lighting like harmful substances and heat dissipation.
OLEDs
A green light source

20 percent of the worldwide energy is used for lighting.

Energy for lighting accounts for six percent of the world’s greenhouse gases (1.9 billion tons of carbon dioxide).

By using energy-saving lighting these figures can be reduced. UN says even halving them.

Source: United Nations Environment Program
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Today's performance

up to 45 lm/W in different shades of white and RGB
up to 4,400 cd/m² brightness
up to 15,000 hours lifetime (at 70% initial brightness)
between 1.8 mm and 0.7 mm thin
<120 cm² surface
OLEDs
Application in architecture, interior- and product-design

The thin, flat nature of the OLED makes it possible to use and integrate light in ways that are impossible with LEDs – or any other lighting source for that matter.
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Realised projects
Mimosa
Jason Bruges Studio
Engulfing the Aston Martin One-77
Jason Bruges Studio
Philips LivingShapes interactive wall
Light installation the easy way
Philips LivingSculpture 3D module system
Adding the third dimension to OLED
Suspended OLED luminaire
Board room in Berlin
LivingSculpture kinetic installation
Shaping light in the air
Moorea
Daniel Lorch Industrial Design
Edge
Amanda Levete
Established & Sons
Flat Lamp
Tom Dixon
smart forvision
Letting the sun thru the roof
Audi light concept
The backside of the near future
Black Eyed Peas
Lighting up Fergie
Philips LivingShapes interactive mirror
Feel the aura of OLED light
The Lumiblade Creative Lab
Open Innovation at its best

More than just an abstract design concept, our Lumiblade Creative Lab is a real workshop in Aachen (Germany), where experts in the fields of lighting, electronics and materials are on hand to advise you how to integrate light and add a new dimension to your projects.

The Lumiblade Creative Lab team offers advice and guidance as well as practical support, helping your project to progress beyond the design stage into a prototype or even entering production as a small series.
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What happens next?
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Color tunability
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Color tunability
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Color tunability

OLEDs will be color tunable in about 5 years from now.
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Transparency

Transparency in the off-state is perceived as a very attractive product feature, because no other material can make glass glow – without being visible in the off-state.
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Transparency

Transparency in the off-state is perceived as a very attractive product feature, because no other material can make glass glow – without being visible in the off-state.

Transparent OLEDs will be available as of mid 2013.
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Flexibility

The next thing we are working on, are flexible OLEDs.

Flexible OLED displays are already on the market, but if it comes to small molecule OLEDs in lighting applications, it is still in a research phase.

OLEDs will be flexible in 5 years from now.
OLEDs
Making the impossible possible
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### Philips Lumiblade

#### Roadmap - Decorative Line

<table>
<thead>
<tr>
<th>Year</th>
<th>2014</th>
<th>2015</th>
<th>2018</th>
</tr>
</thead>
<tbody>
<tr>
<td>Efficacy</td>
<td>15 lm/w</td>
<td>15 lm/w</td>
<td>35 lm/w</td>
</tr>
<tr>
<td>L70</td>
<td>15,000 h</td>
<td>30,000 h</td>
<td>40,000 h</td>
</tr>
<tr>
<td>Intensity</td>
<td>2,500 cd/m²</td>
<td>2,500 cd/m²</td>
<td>3,000 cd/m²</td>
</tr>
<tr>
<td>Max size</td>
<td>120*120 mm</td>
<td>150*150 mm</td>
<td>1,000*1,000 mm</td>
</tr>
<tr>
<td>Features</td>
<td>transparent, structured</td>
<td></td>
<td>color changeable/flexible</td>
</tr>
</tbody>
</table>

**Note:** OLEDs of the Lumiblade Decorative Line are normally reflecting in off-state as where otherwise indicated. Color point adjustable to customer specifications. Short realization and production cycle for new forms and shapes.
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### Roadmap - Performance Line

<table>
<thead>
<tr>
<th>Year</th>
<th>2014</th>
<th>2015</th>
<th>2018</th>
</tr>
</thead>
<tbody>
<tr>
<td>Efficacy</td>
<td>60 lm/W</td>
<td>&gt;90 lm/W</td>
<td>130 lm/W</td>
</tr>
<tr>
<td>L70</td>
<td>15,000 h</td>
<td>20,000 h</td>
<td>40,000 h</td>
</tr>
<tr>
<td>Intensity</td>
<td>4,500 cd/m²</td>
<td>5,000 cd/m²</td>
<td>&gt;5,000 cd/m²</td>
</tr>
<tr>
<td>Lumen Output</td>
<td>10,000 lm/m²</td>
<td>15,000 lm/m²</td>
<td>&gt;15,000 lm/m²</td>
</tr>
<tr>
<td>CRI</td>
<td>&gt;90</td>
<td>&gt;92</td>
<td>&gt;95</td>
</tr>
<tr>
<td>Max size</td>
<td>150*150 mm</td>
<td>170*170 mm</td>
<td>400*400 mm</td>
</tr>
</tbody>
</table>

Note: OLEDs of the Lumiblade OLED Performance line are non reflective in off-state.
The World of OLED lighting

Summary

- OLEDs are more than just another light source.
- OLEDs are the last revolution in lighting.
- OLEDs are highly adaptable material that emits beautiful light.
- OLEDs remove the boundaries of shapes and size associated with conventional lighting.
- OLEDs are extremely thin and easy to integrate.
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Thank you for listening

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Got any questions? E-mail me: matt.hanbury@philips.com