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sense and simplicity

Philips Lumiblade
Challanges in the commecialisation of OLED lighting products

www.lumiblade.com

June 06, 2011

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Agenda

- OLED lighting – the motivation
- OLED for lighting – a transition
- The technological challenges
  - Efficiency
  - Cost
  - Manufacturability
  - Design flexibility and features

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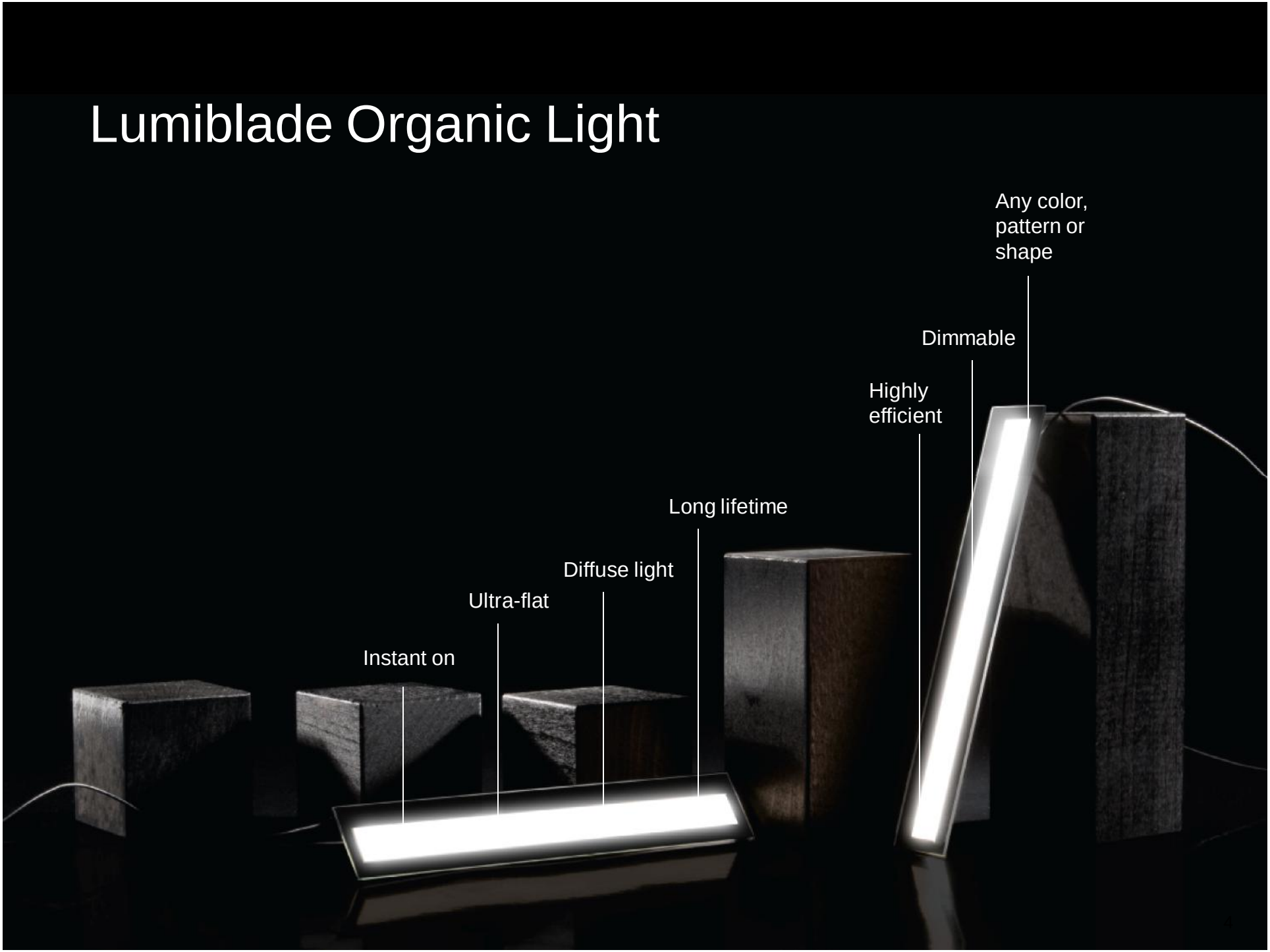
History of OLEDs in Philips

1991	Research: Projects on Polymers
1997	Development of Displays: polymer-based passive-matrix displays
1999	Creation of pilote factory in Heerlen/NL
2000	Philips Research starts on OLED Lighting
2004	Start of Development activity for Lighting
2005	Philips stops Display Production
2007	Start of pre-pilot line at Lighting
2008	Introduction of **Lumiblade™** OLED Lighting Technology

OLED today:

- Global Business Unit OLED lighting, Aachen
  - Technology development
  - Business development
  - Manufacturing
- Research Aachen and Eindhoven
- Other Lighting organizations (GTD mech. Aachen, ADL)

Lumiblade Organic Light



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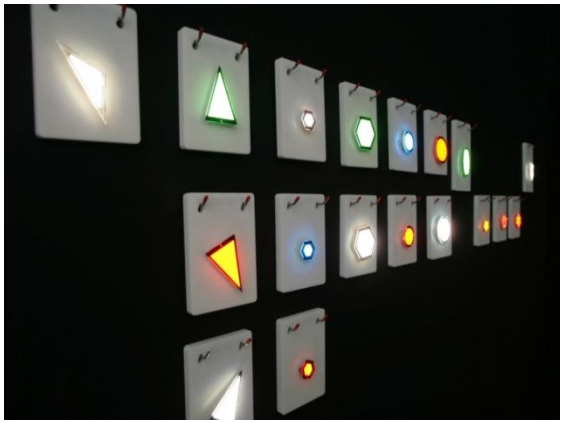
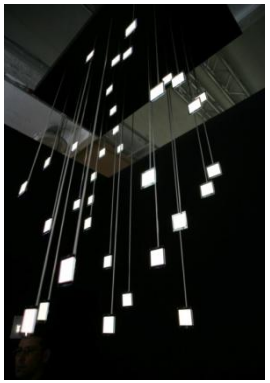
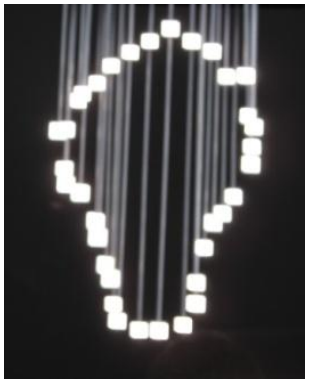
Lumiblade® First product concepts 2009



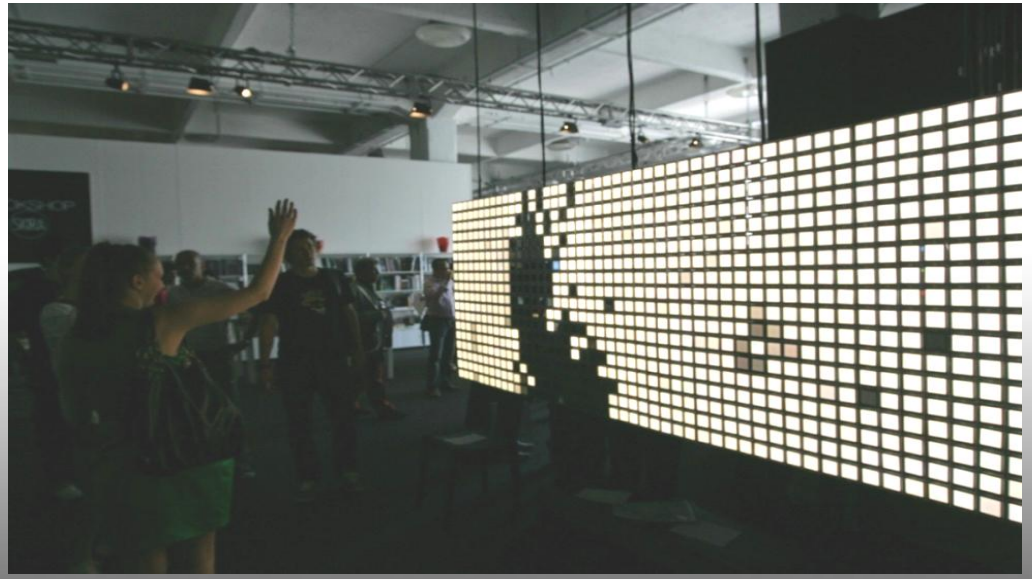
Lumiblade
"*The collection*"
Available online at www.lumiblade.com





Lumiblade
"*E27*"
Design by Husseini & Richter

First Product concepts:
decorative lighting



Lumiblade
"*Interactive Mirror-Wall*"
Design by rAndom international

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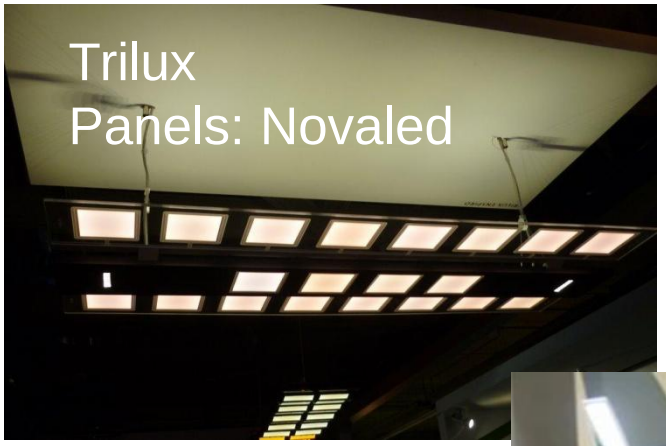
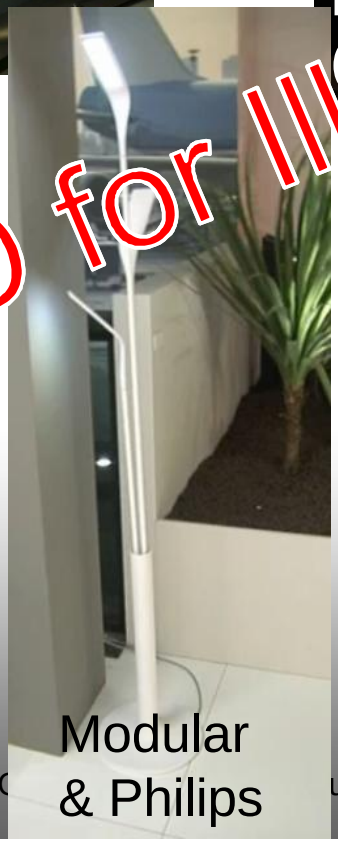
Light&Building 2010



OLED for Illumination



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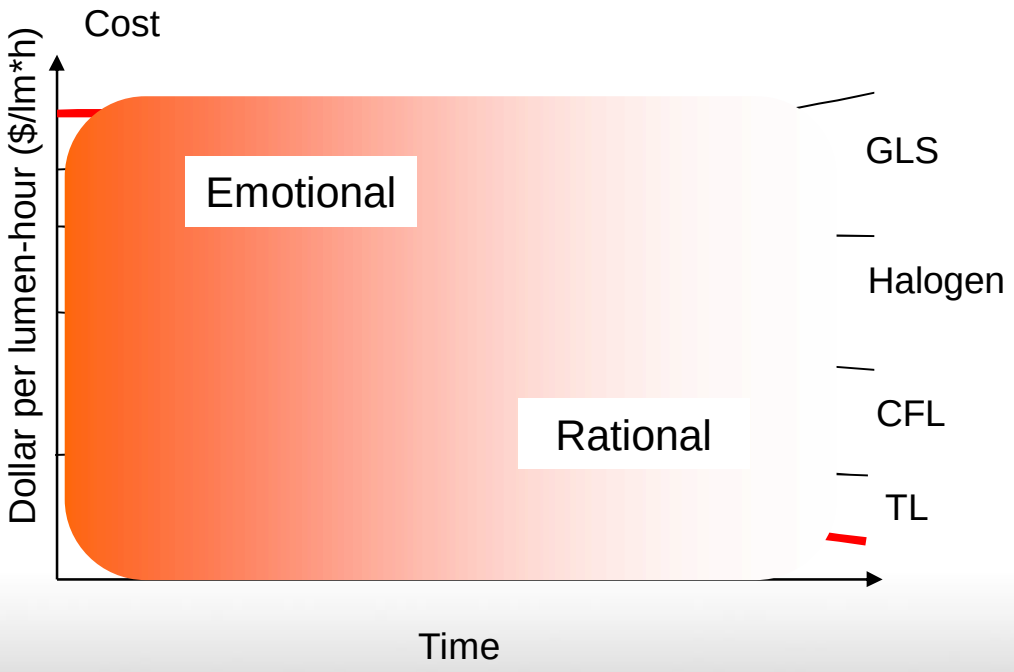
The innovators dilemma in OLED

- Rational value drivers (long term)
  - Potential for OLED lighting to beat TL performance
  - Similar technology than LED with similar value drivers (efficiency, life time, dimmability, ...)

- Emotional value drivers (short term)
  - High aesthetic value of light source
  - Becomes part of luminaire design in the future
  - Initial niche applications in decorative, gadgetry, hospitality, signage etc.



Classical disruptive nature

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Feature: Efficiency

Topics to be adressed

- Highly efficient materials
- Improved light outcoupling
- High efficiency at high brightness
- High life time at high brightness

Current product performance

- CFLi – 40-55 lum/W
- TL - 70-90 lum/W
- LED - 40-70 lum/W
- OLED - 15-25lum/W
  2'nd generation 50lum/W

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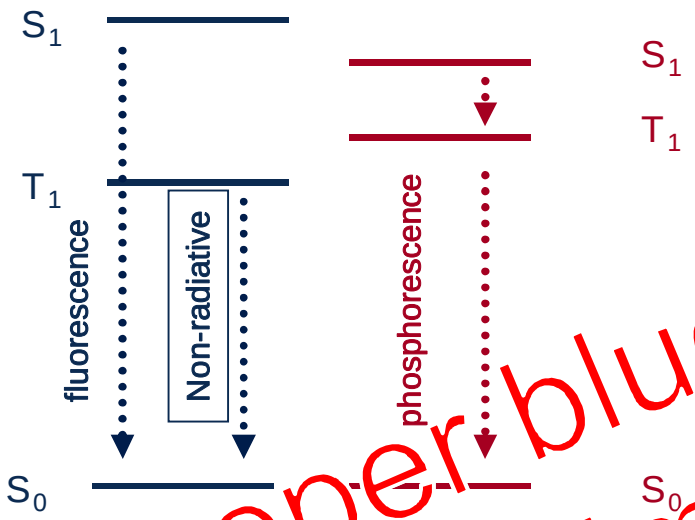
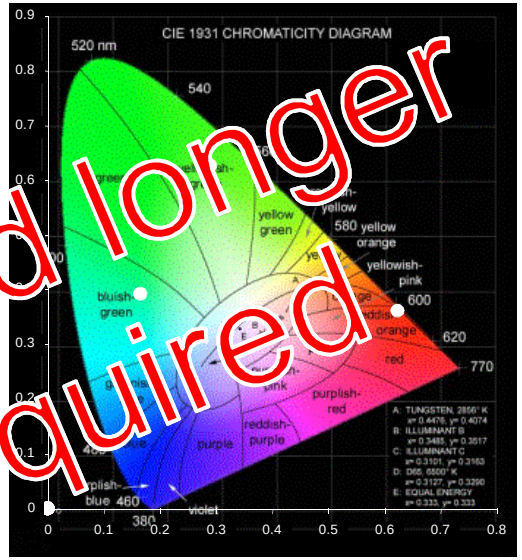
Efficiency
- Efficient materials -





Deeper blue and longer Life time required

Current Phosphorescent material performance
Red: >20lum/W, >300kh life time
Green: >70lum/W, >500kh life time
Blueish: >40lum/W, <10kh life time

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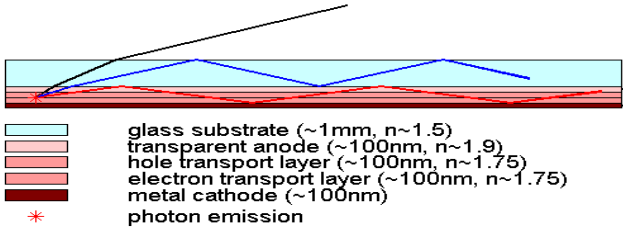
Efficiency
- Improved light outcoupling -



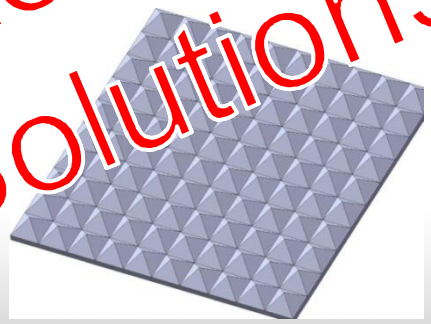
Photons in air (20%)

Photons trapped in glass (30%)

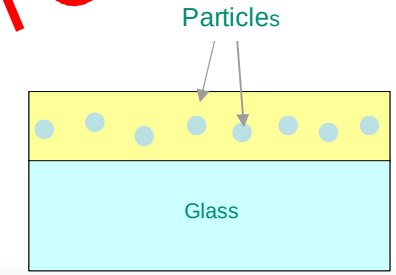
Photons trapped in organics (50%)

Better internal light outcoupling Solutions required

External measures



Internal measures



Scatter layers in the OLED

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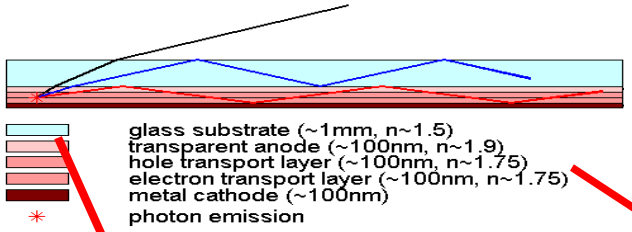
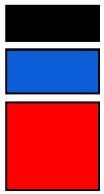
Efficiency
- Improved light outcoupling -





Photons in air (20%)

Photons trapped in glass (30%)

Photons trapped in organics (50%)

Substrate with matched refractive index improves light outcoupling *2

Organics with low refractive index improves light outcoupling

Better matching of refractive Indices of OLED materials

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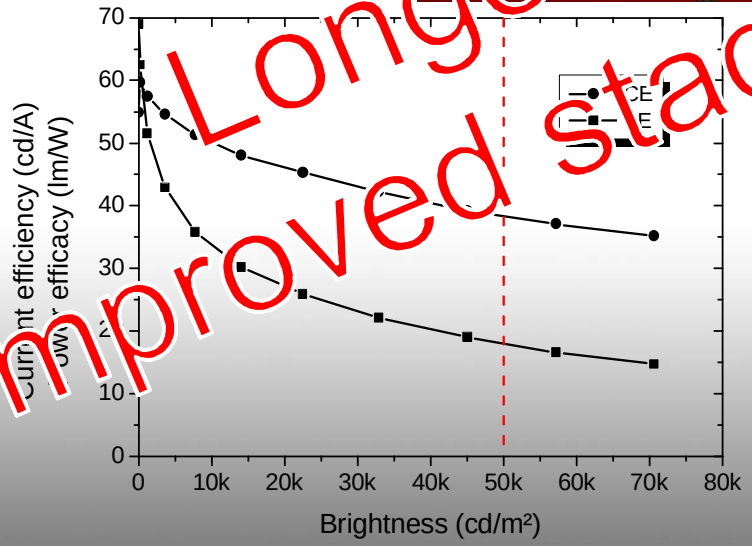
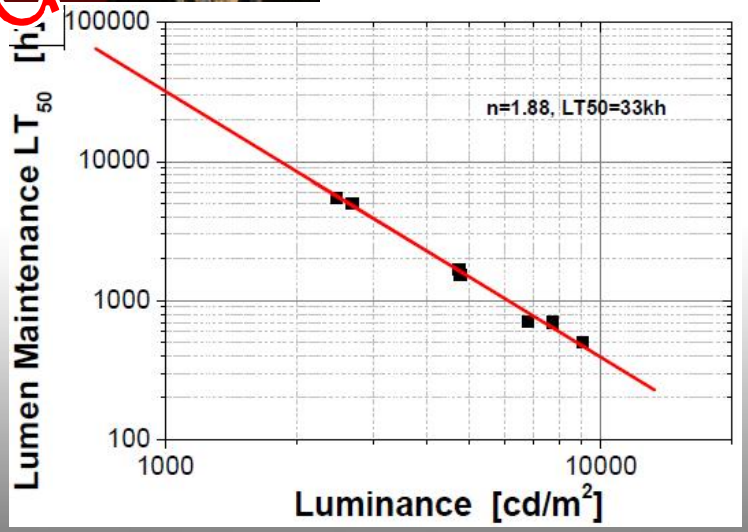
Efficiency
- High brightness -

Longer life times and
Improved stack design required





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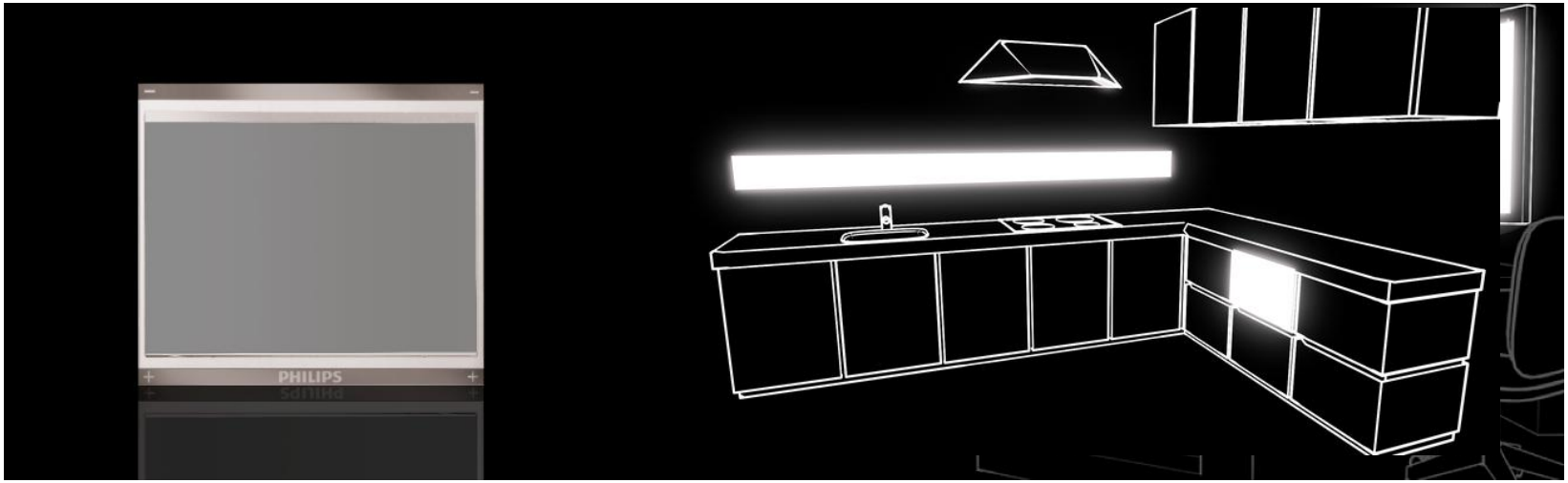
Feature: Cost



Topics to be addressed

- Substrate costs
- Core process costs
- Encapsulation costs
- Manufacturing costs (separate topic)

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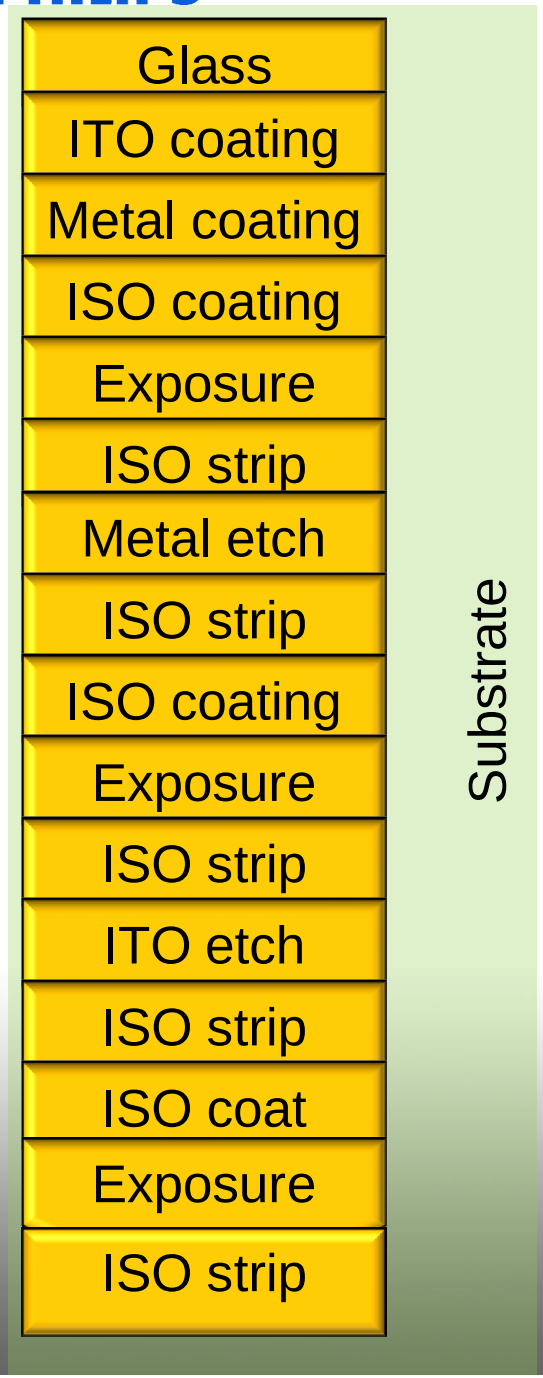
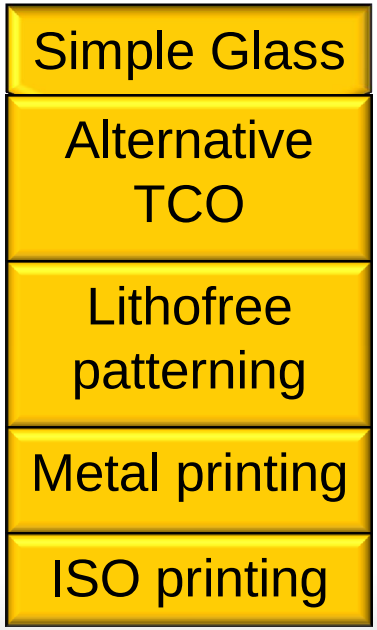


Cost
- Substrate costs -

Main cost drivers
- Komplexity of process
- Material losses (ISO, etchant, etc.)
- Equipment cost
- Metal
- ITO
- Overspecified glass



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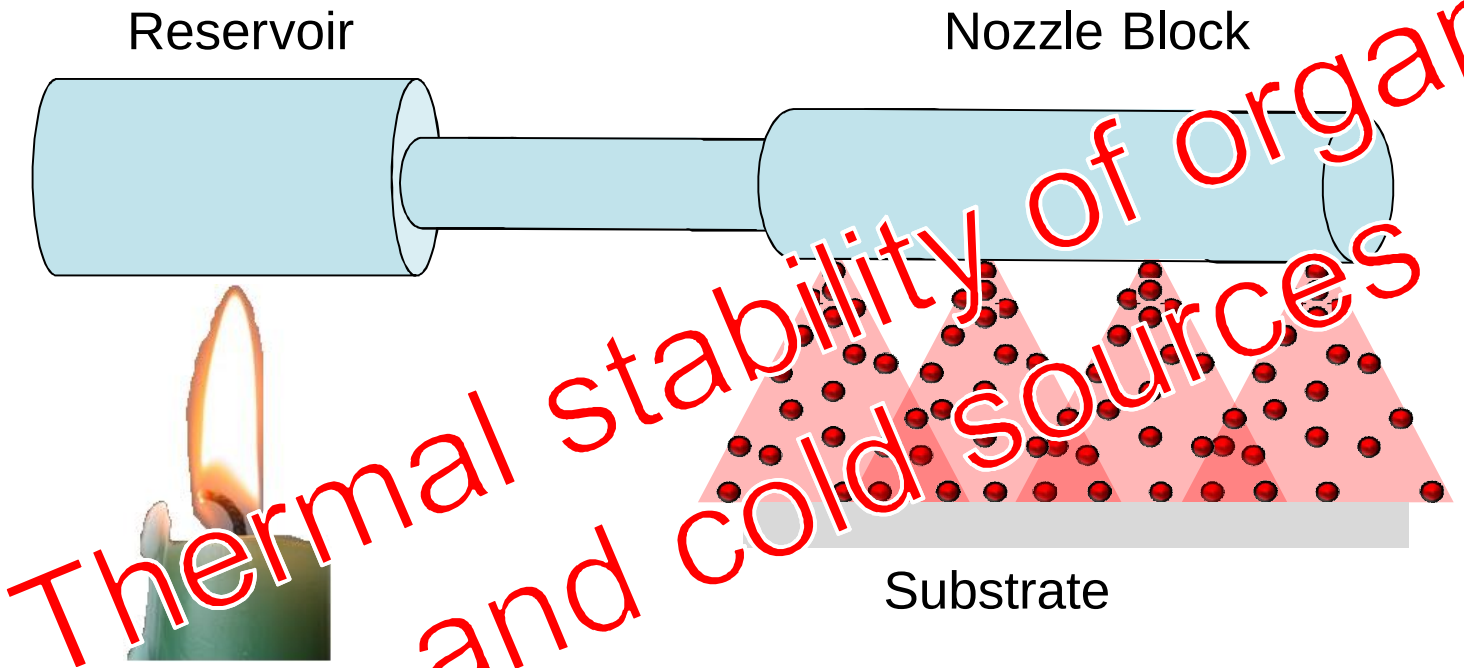
Cost
- Core process costs -



Thermal stability of organics and cold sources

Material losses due to
- Masking
- Overcoating
- Thermal degradation

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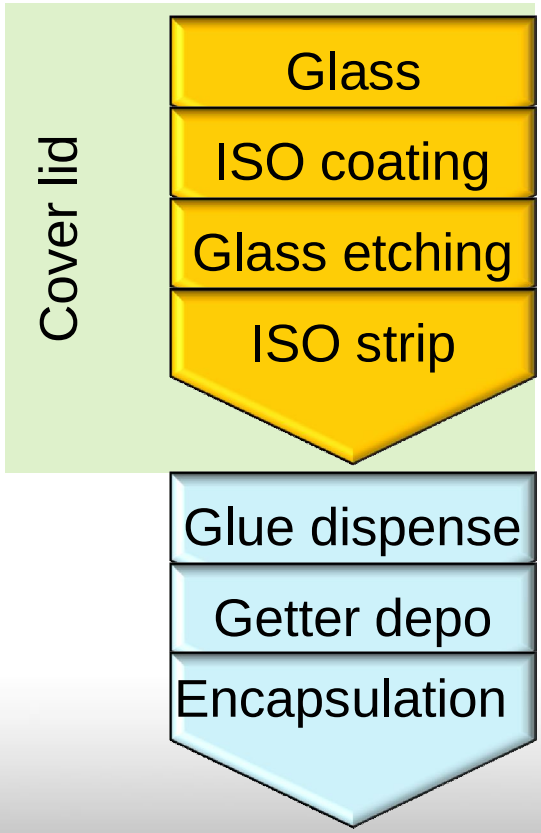
Cost
- Encapsulation costs -



Main cost drivers
- Cavity lid glass
- Getter
- Process time

Thin film barrier layer

Print scratch resist

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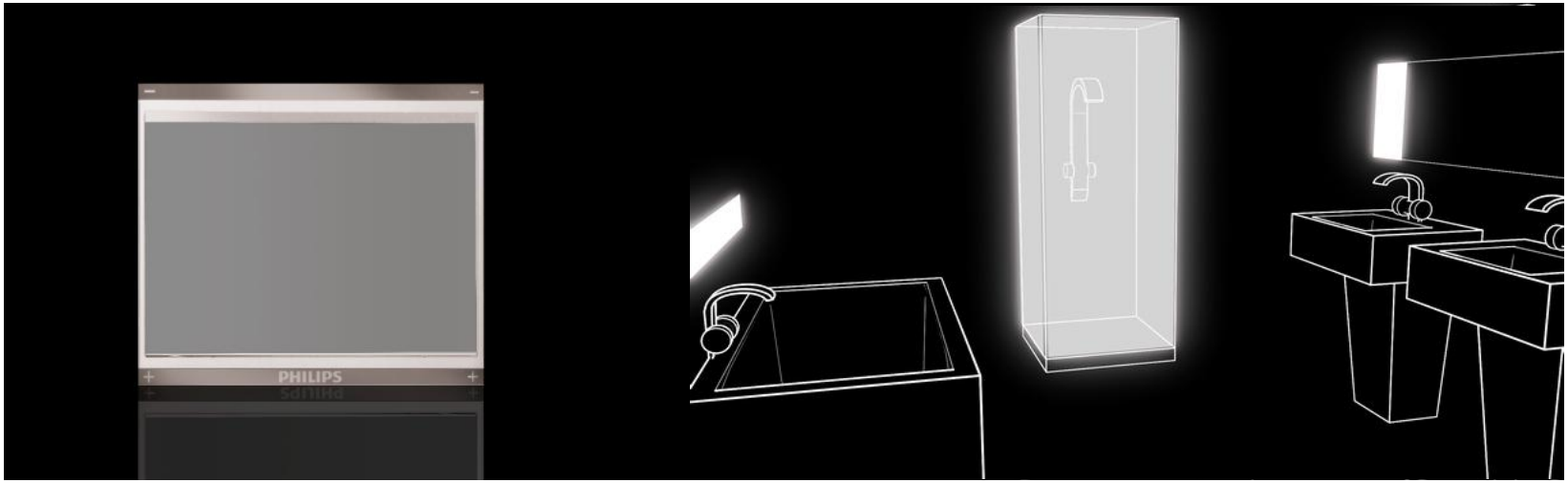
Feature: Manufacturability



Topics to be addressed

- Equipment up time
- Yield
- TACT times

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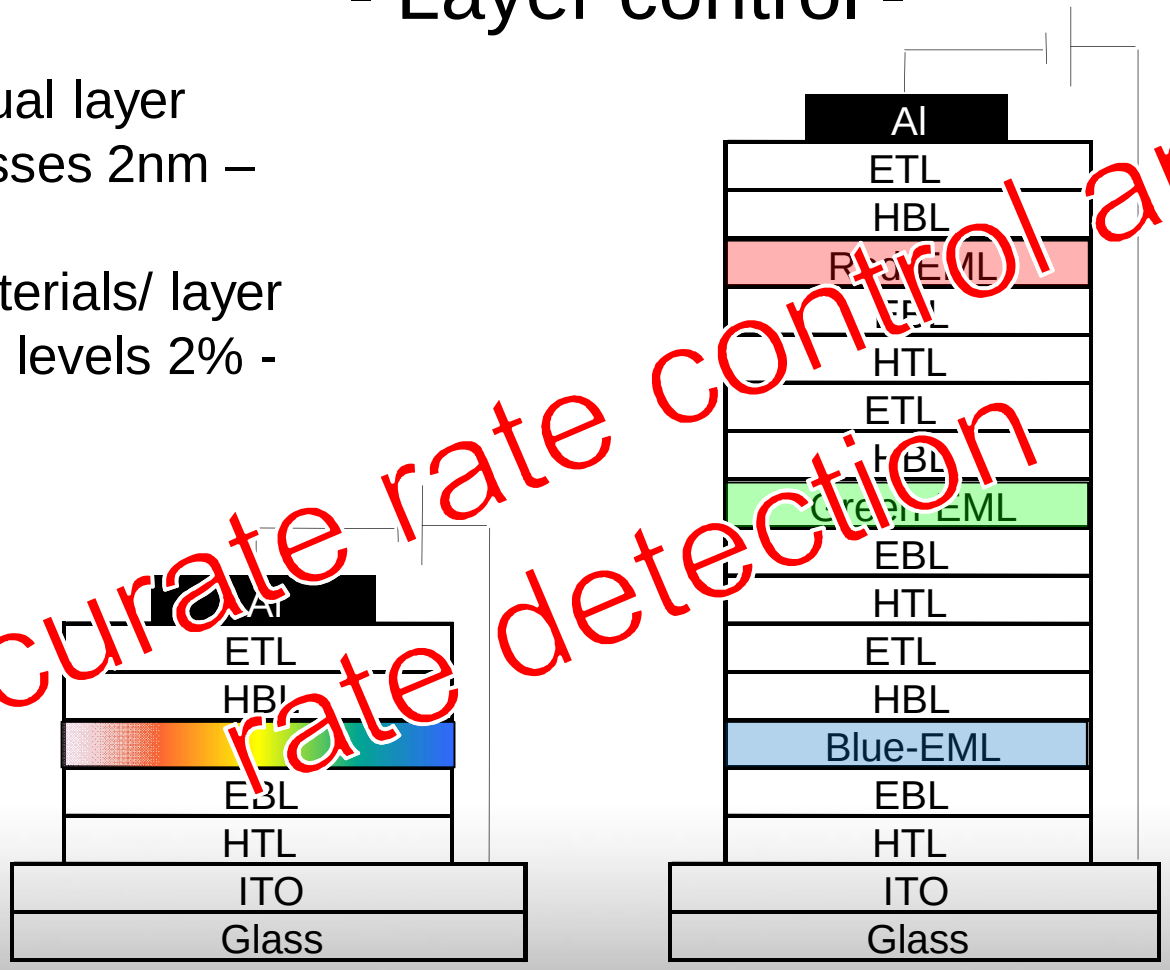
Manufacturability
- Layer control -

- Individual layer thicknesses 2nm – 40nm
- 1-3 Materials/ layer
- Doping levels 2% - 30%



(a) standard device

(b) stacked white OLED

Accurate rate control and rate detection

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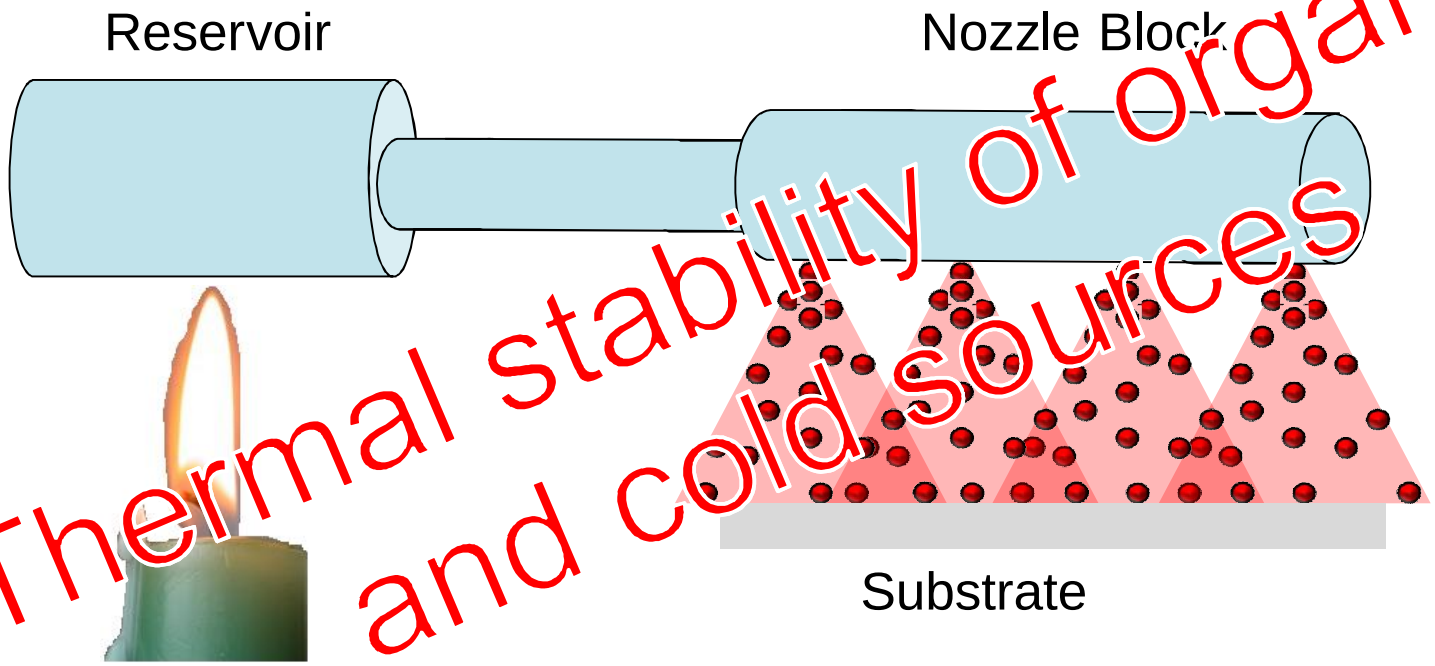
Manufacturability
- TACT time-



Thermal stability of organics and cold sources

TACT time scales with substrate size and line speed
- Higher source temperature
- More material in the source

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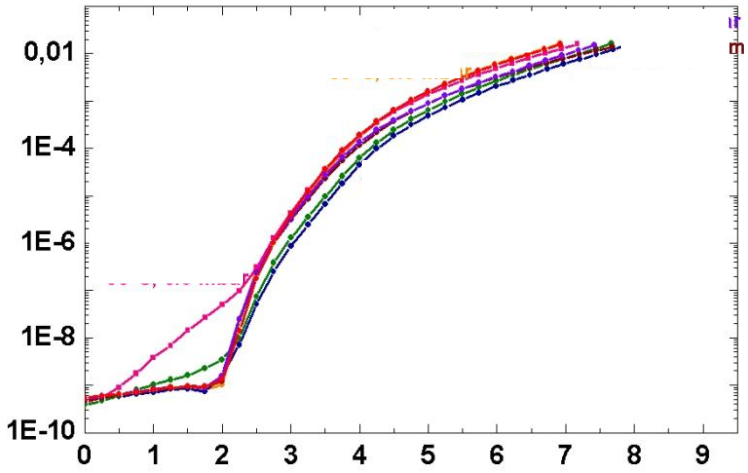
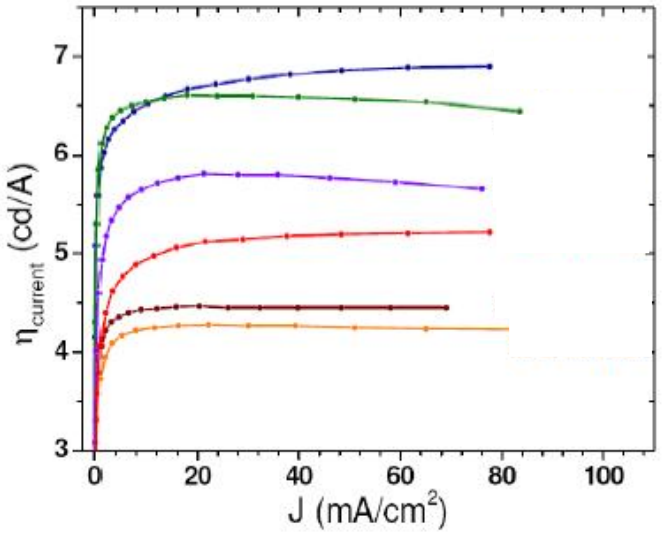
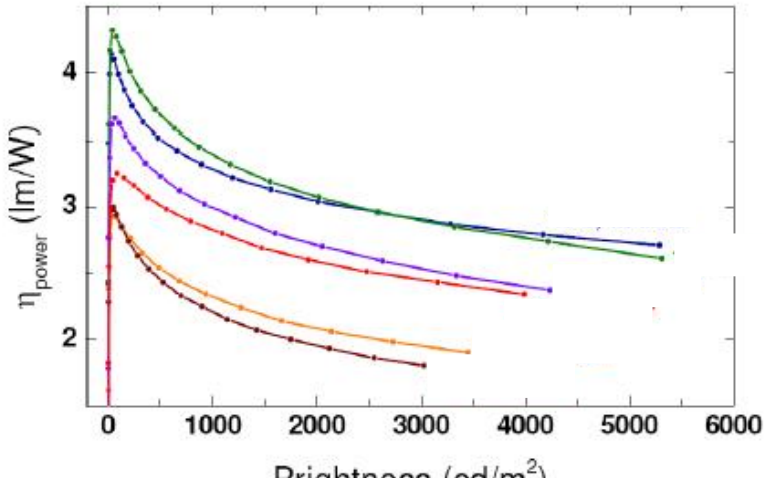
Efficiency
- Process dependence-







Same nominal stack deposited with different process parameters

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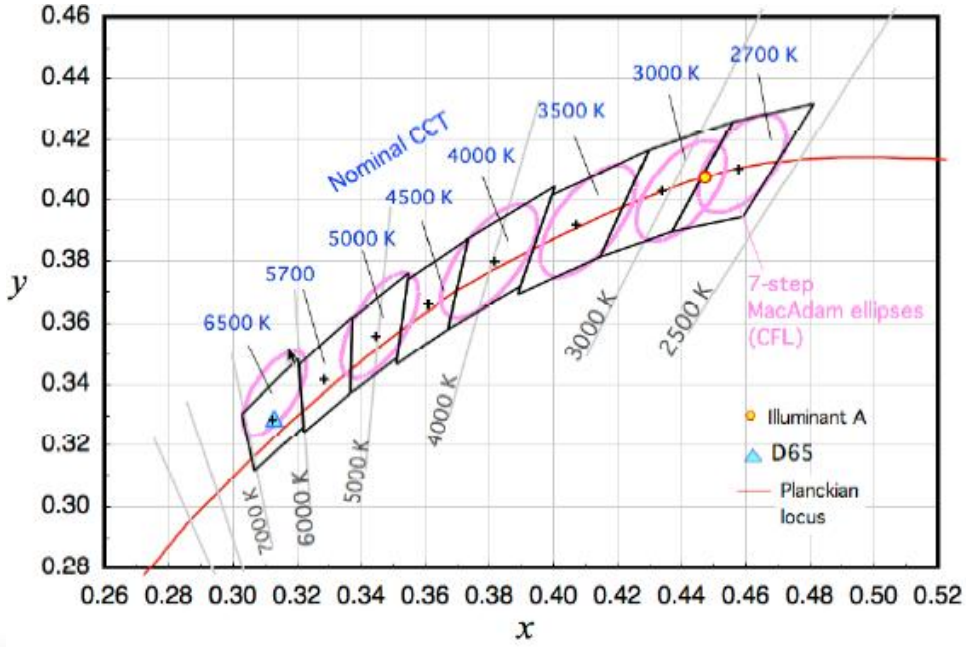
Manufacturability
- Binning -



- Equipment up time
- Yield
- TACT times

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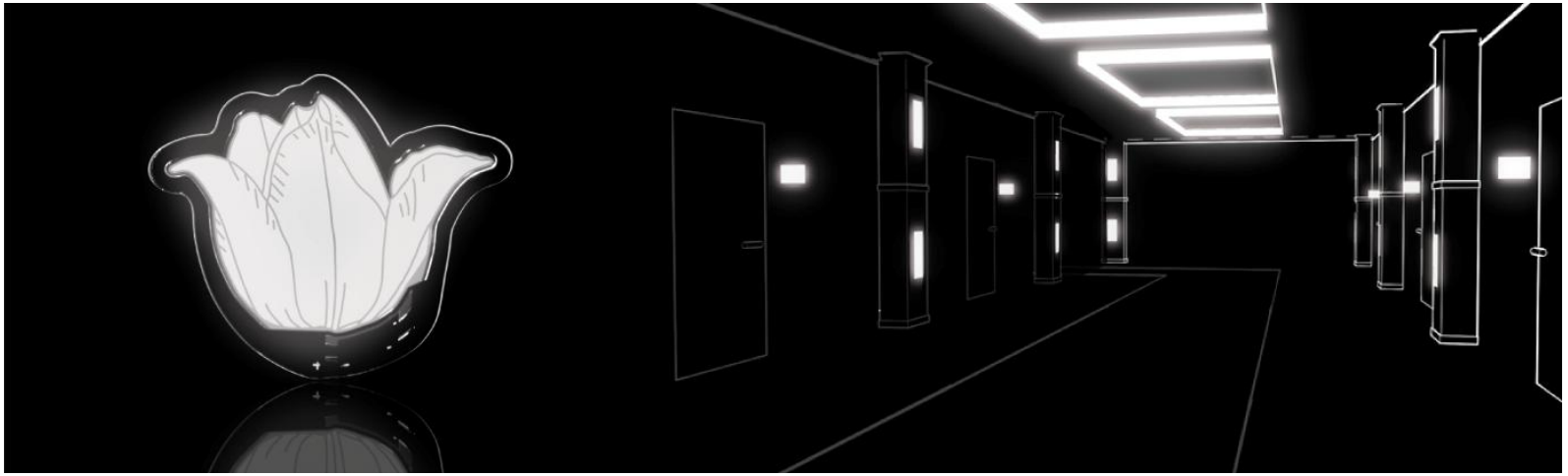
Feature: Design flexibility



Topics to be addressed

- Colour point adjustment per product
- Shape flexibility
- Transparency
- Flexibility
- Colour tunability

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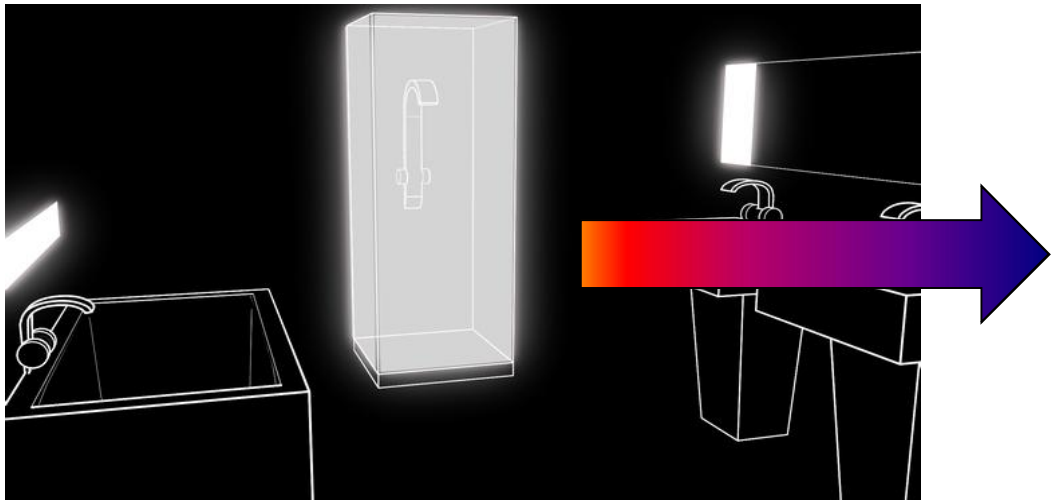
Transparency



Built in solutions require

- Very long shelf life times (>20 years)
- Large area (single tiles or seamless tiling)
- Invisible shunt lines (high aspect ratio metal lines)
- Post manufacturing structuring

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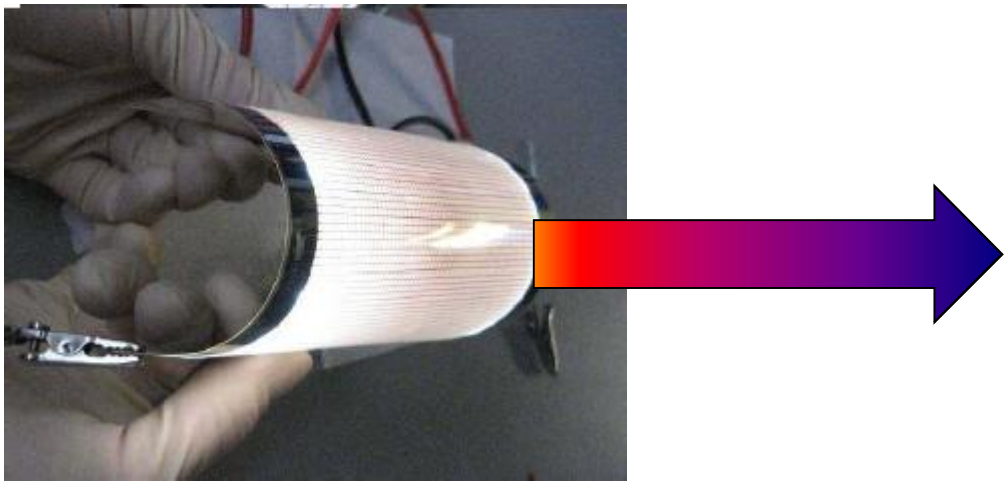
Flexibility



Flexible OLED's require

- Flexible substrates with
  - High good water barrier properties
  - High temperature resistivity
  - Good bendability
- Flexible anode material
- Flexible encapsulation

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Colour tunability

Colour tunable Oled's require

- Highly transparent interelectrodes
  - High lateral conductivity
  - Invisible shunt structures to realize large area
  - Low voltage drop across the interlayer

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Outlook

- OLED is a new technology with high potential for low cost, highly efficient, customised lighting solutions
- In transition from lab to fab
- For the next years to come still a area of intense research und innovation

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the EU: OLED100 (FP7-224122),
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Thank you for your attention!

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