OLED Transfer Standards

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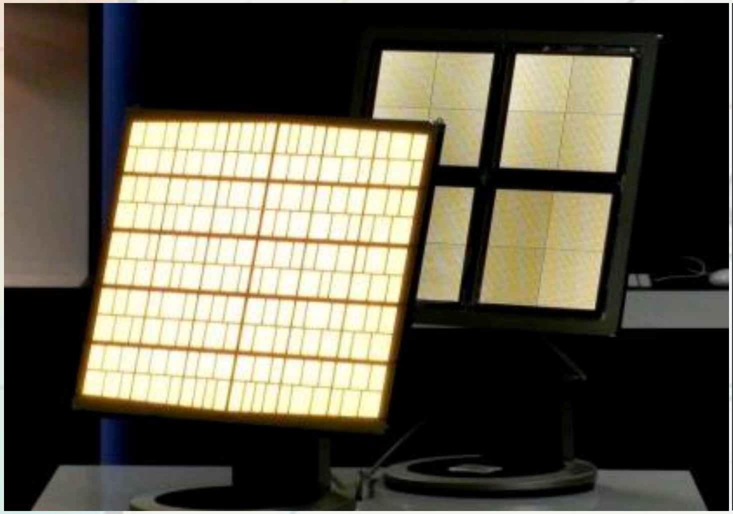
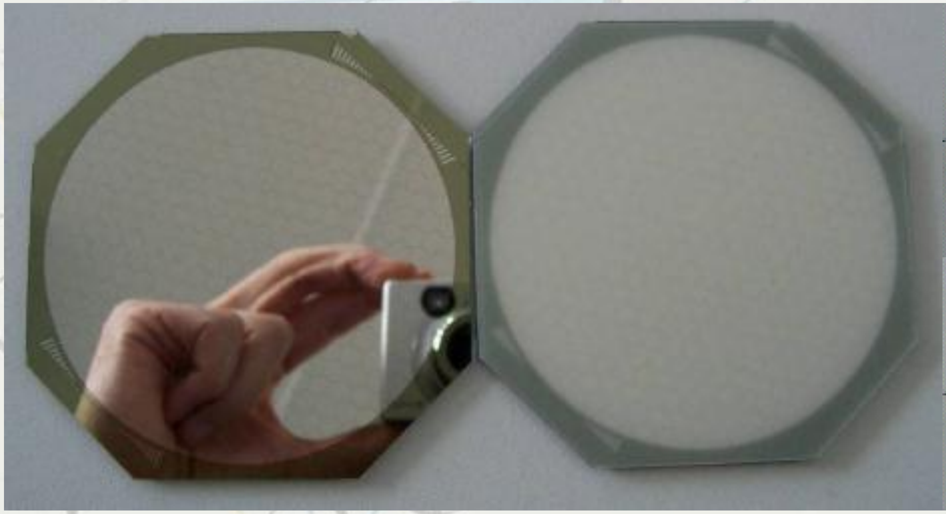
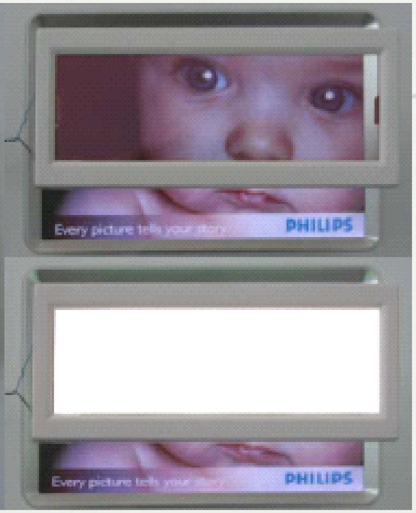
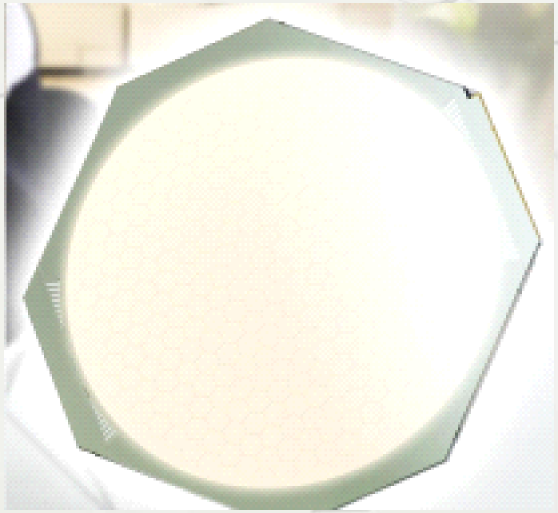
2 Organic LEDs or Organic EL (Electroluminescence)


Thin: ≤ 3 mm   Large-area: ≤ 33 x 33 cm²   Colorful or white

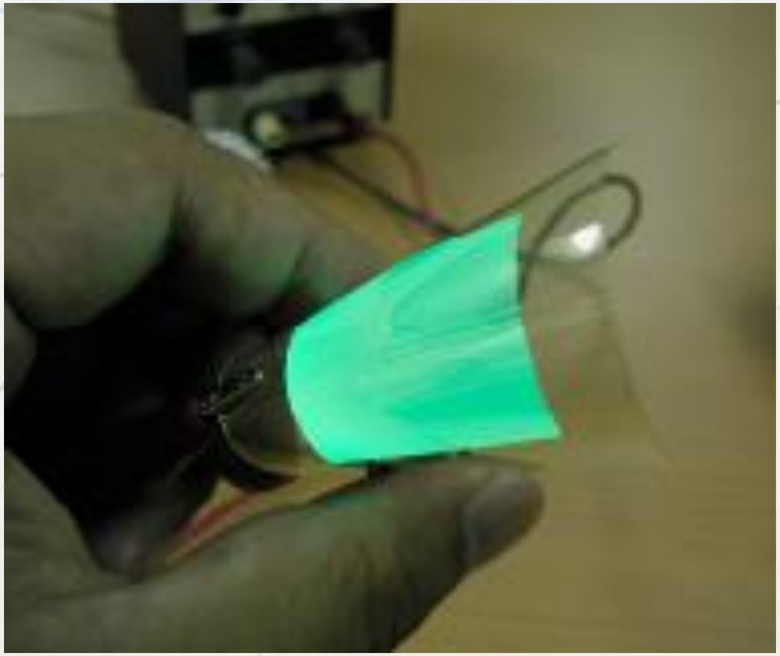


Off-state behaviour can be: mirrorlike, milky or transparent

Source: Fraunhofer IPMS, Osram and Philips

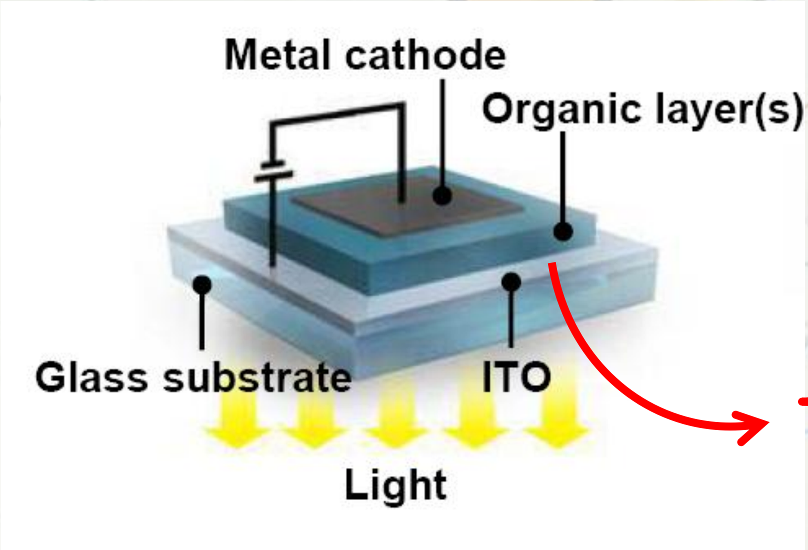
3 Properties of OLEDs

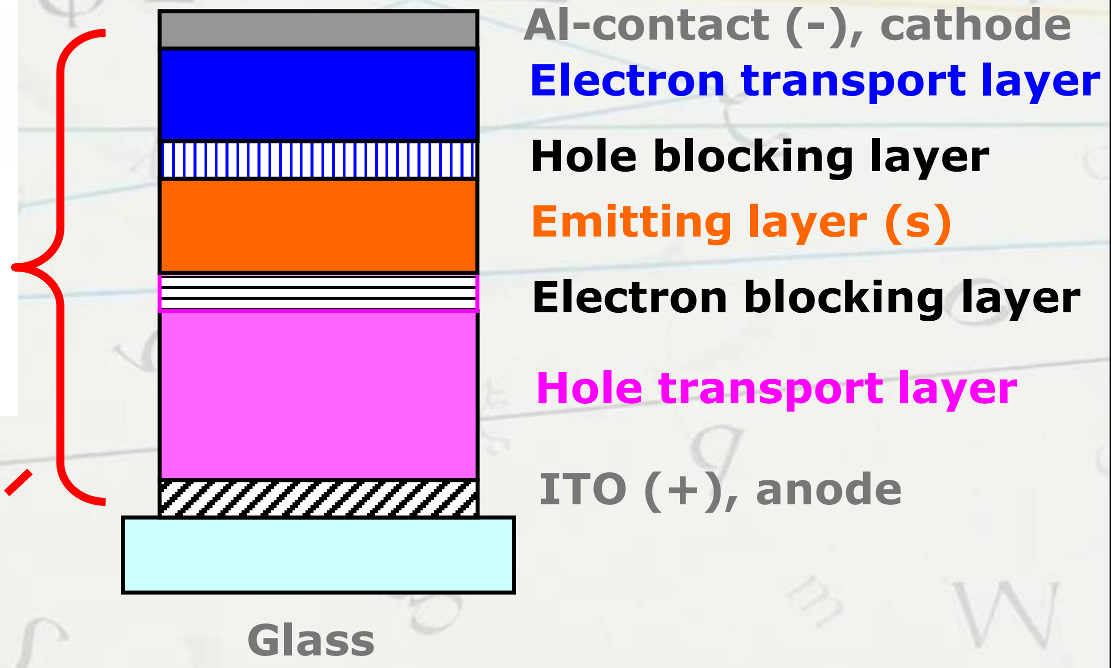
- Diffuse, non-glaring illumination
- Good colour rendering properties
  - many emitters available (differ in efficiency and lifetime)
  - daylight spectrum feasible
- Flexible (under development, no commercial products)
- Transparent (under development, no commercial products)
- Potentially, any shape
- Efficient
- Dimmable
- Instant-on
- Low voltage device
- Color-tunable
- Enviromentally friendly



Source: Philips

Device setup small molecule OLED

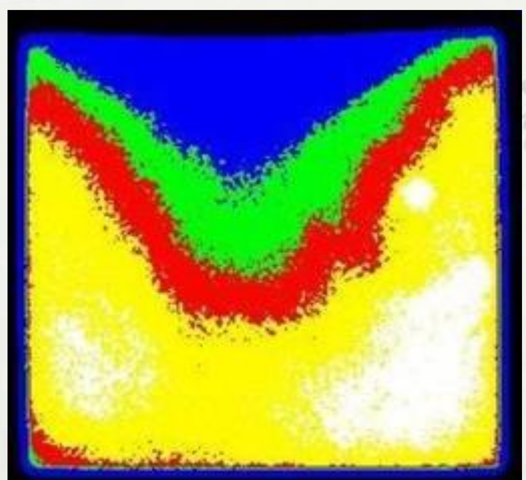




Layer thickness : 100-200 nm

Source: Philips

5 Luminance distribution of a large area OLED



L >97% L_0 → white

L >95% L_0 → yellow

L >93% L_0 → red

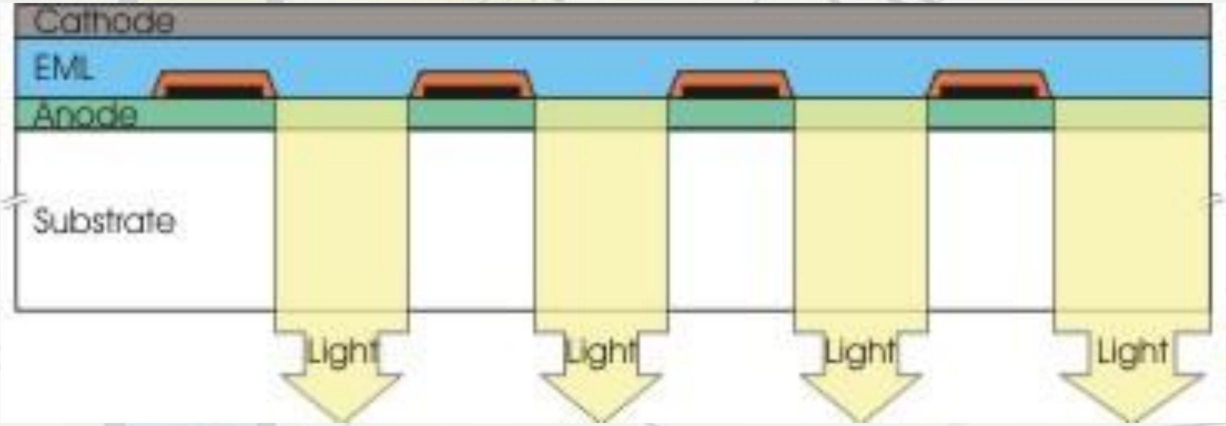
L >90% L_0 → green

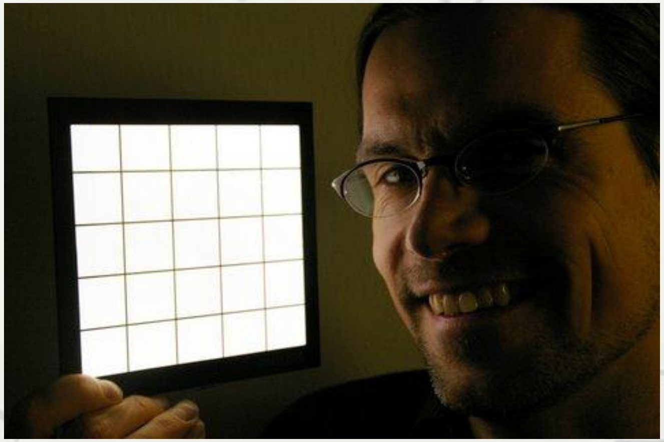
L >80% L_0 → blue

6 Large area OLEDs

Nonuniformity is caused by a too low ITO conductivity

➢ Including metal bus bars for better current distribution

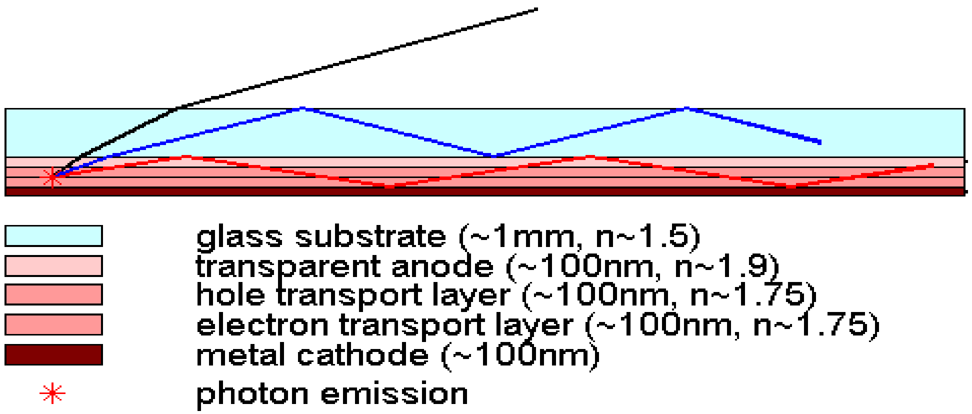




Source: Fraunhofer IPMS, Philips

7 Light outcoupling problem

In a conventional OLED only 20% of the generated light leaves the device due to refractive index mismatch!

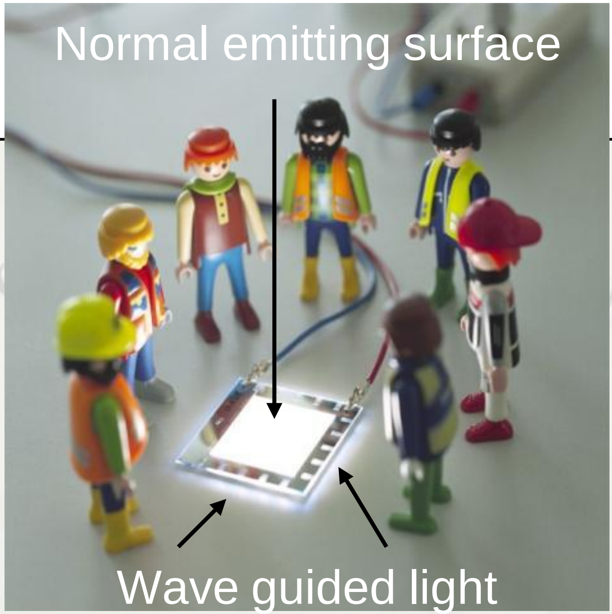


Photons in air (~20%)

Photons trapped in glass (~30%)

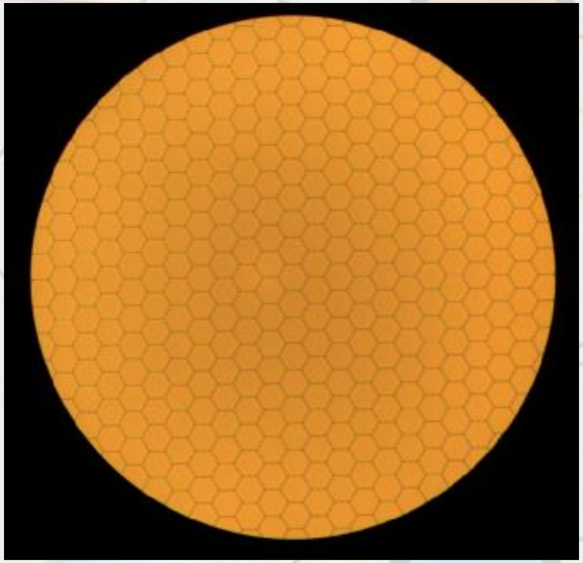
Photons trapped in organics (~50%)

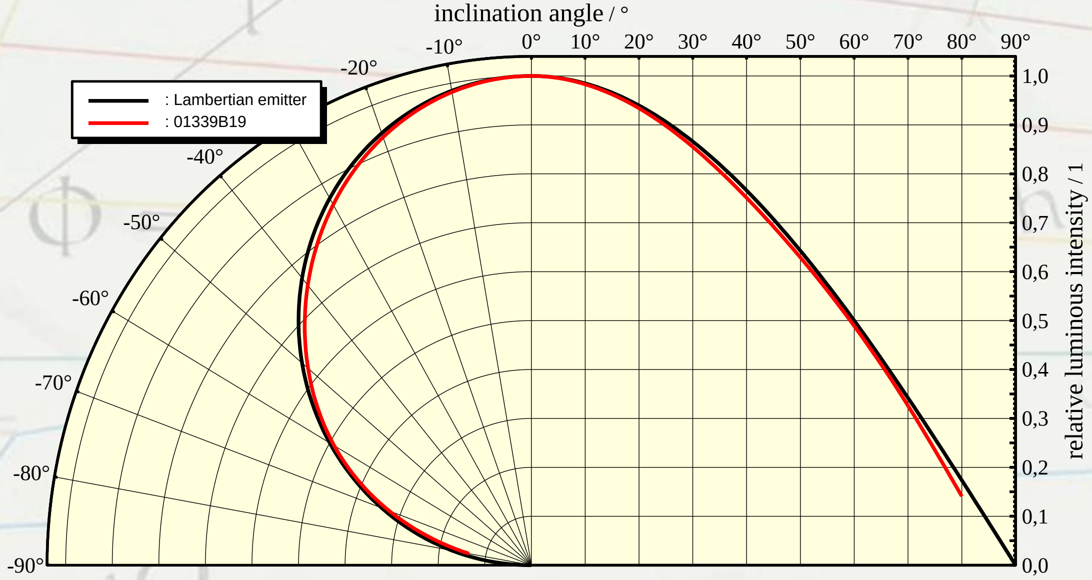
- Index-matched substrate
- Outcoupling structures

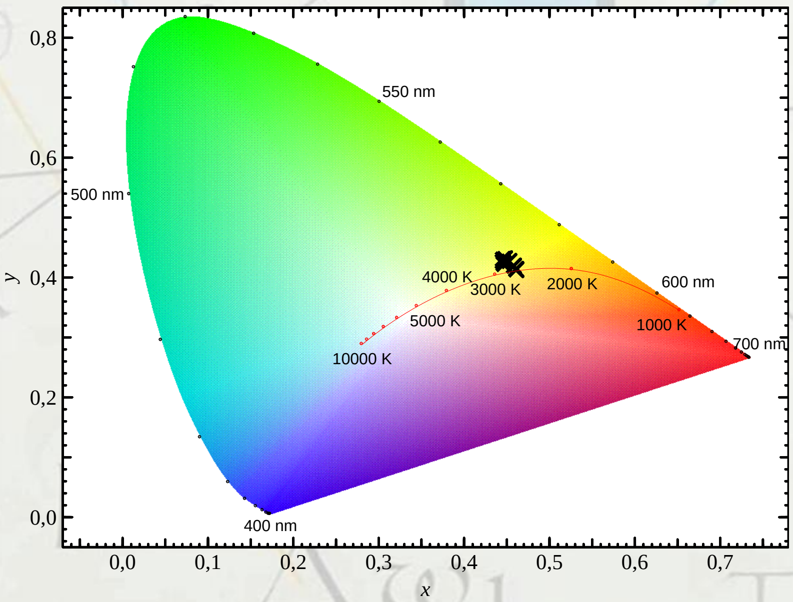


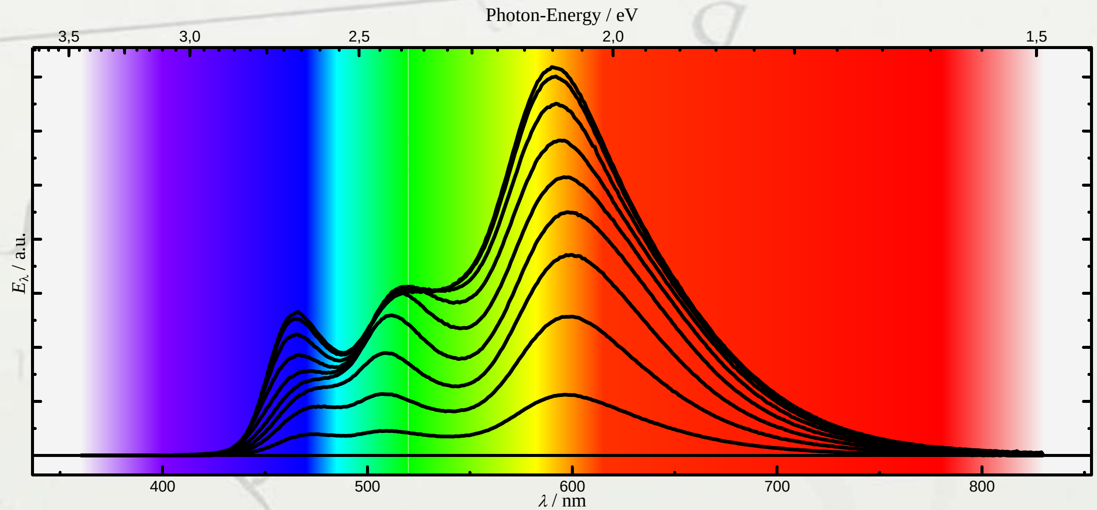
Source: Philips

8 Circular OLED

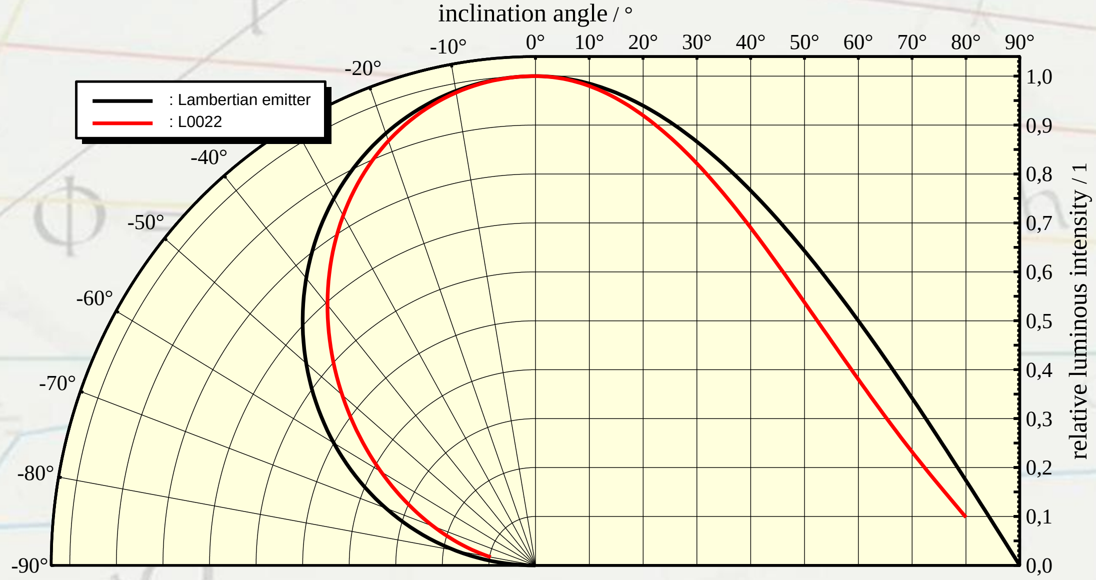


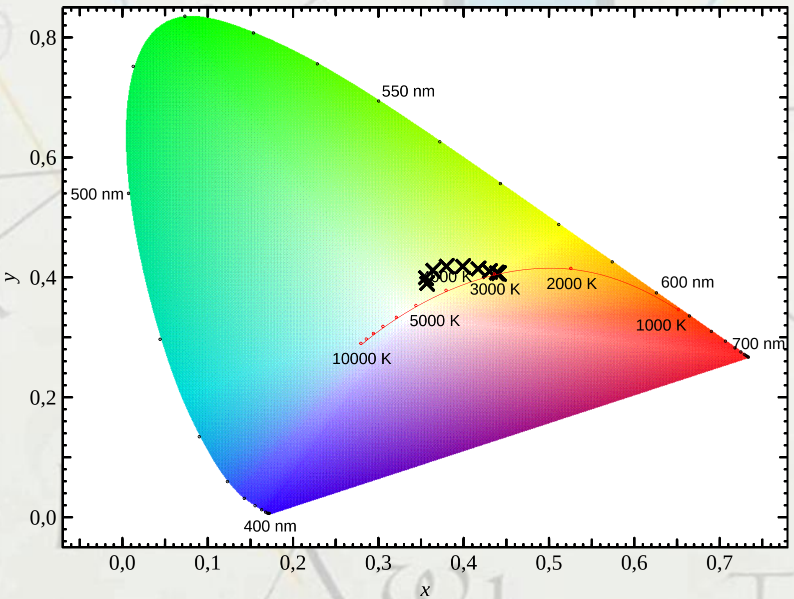


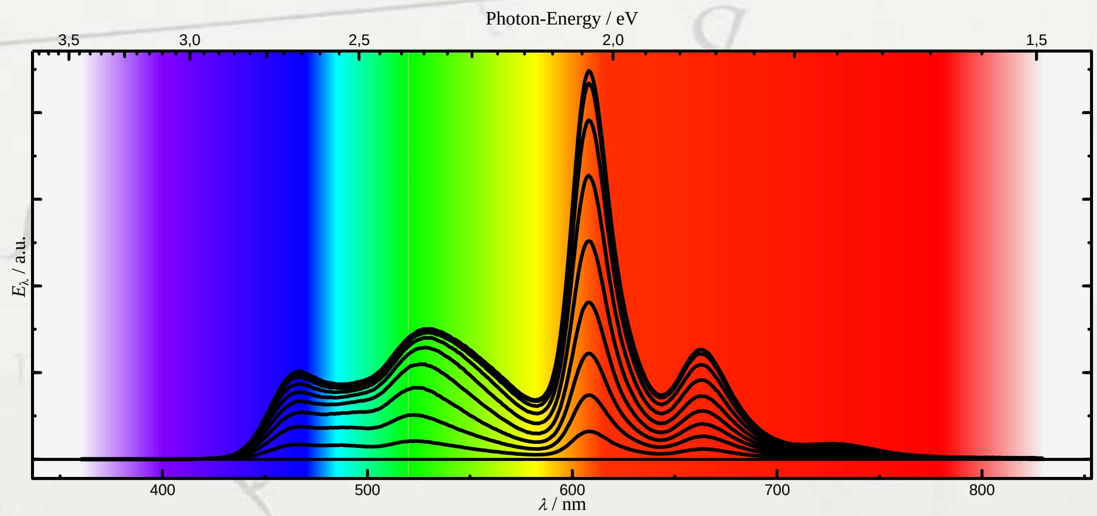




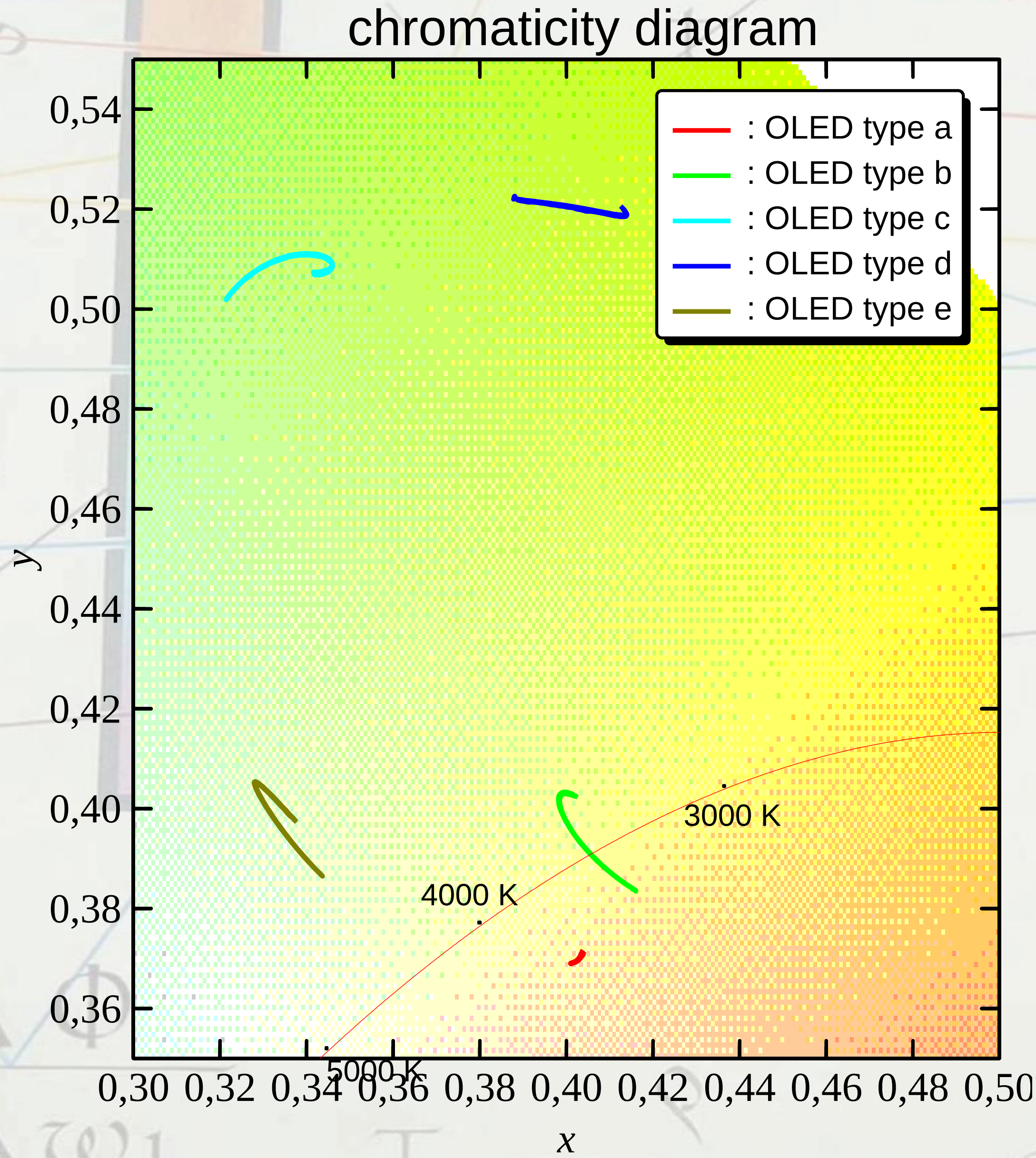
9 Rectangular OLED



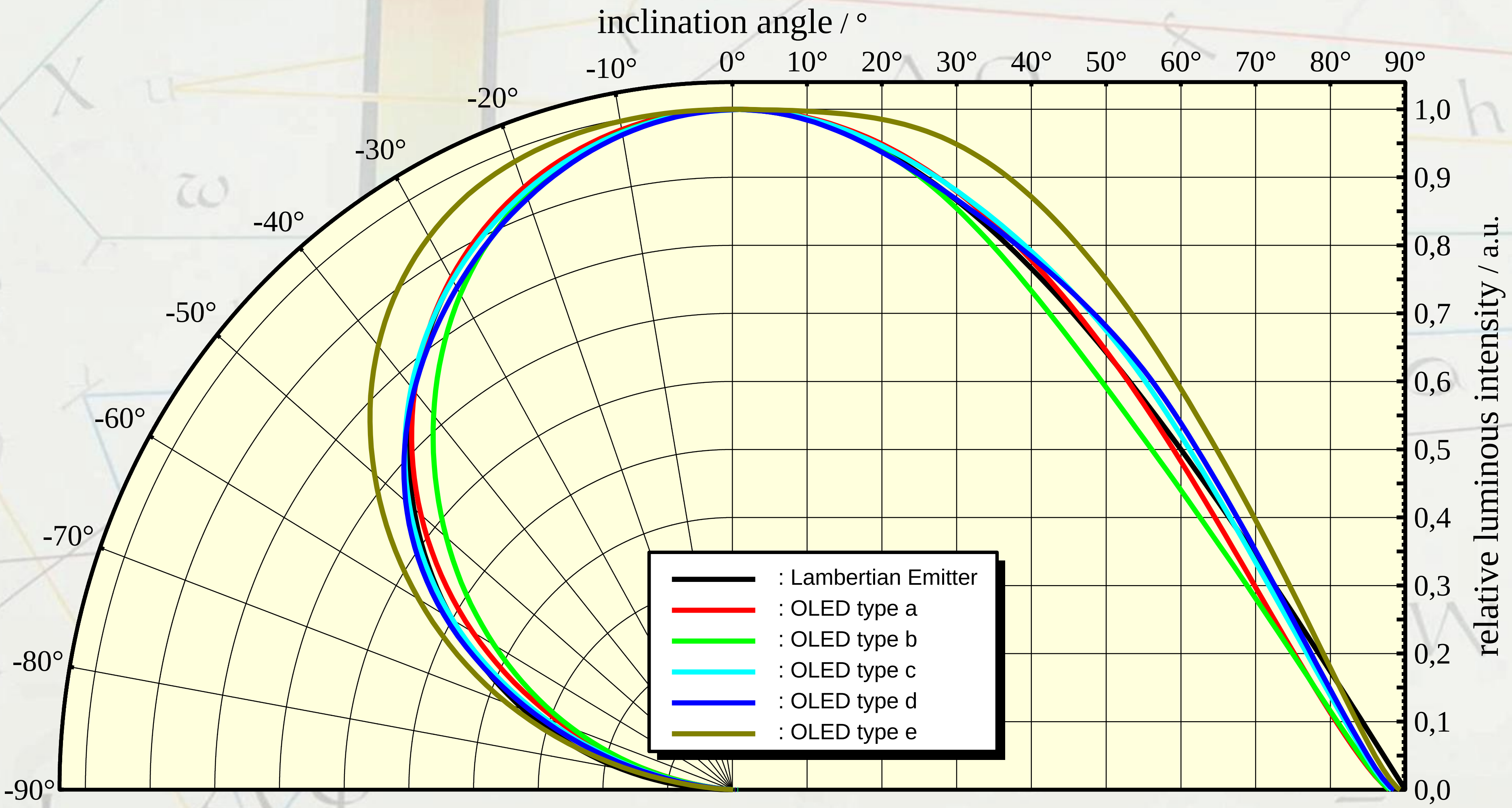




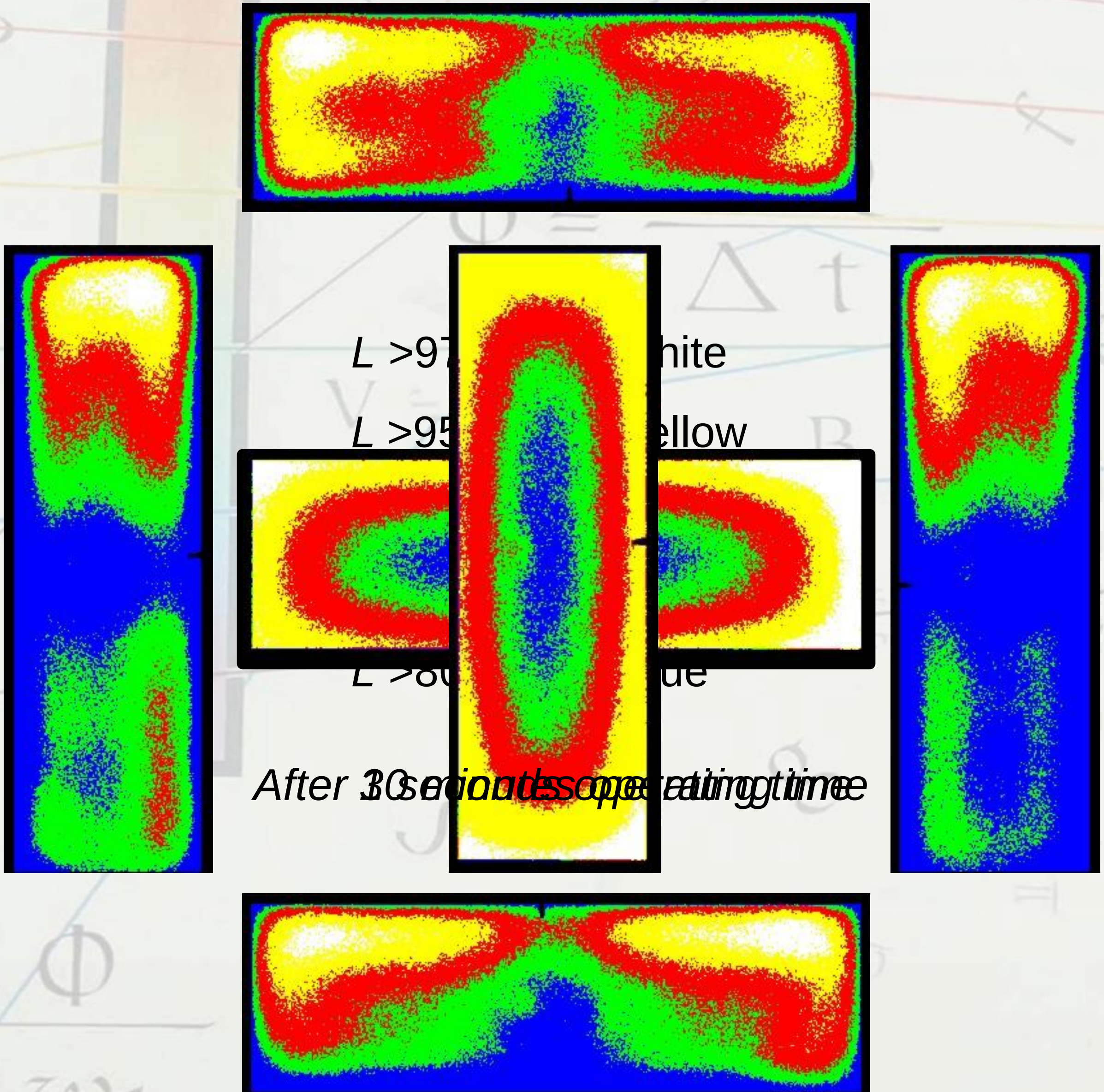
10 Chromaticity shift of the light of an OLED



11 Spatial luminous intensity distributions



12 Geometrical alignment

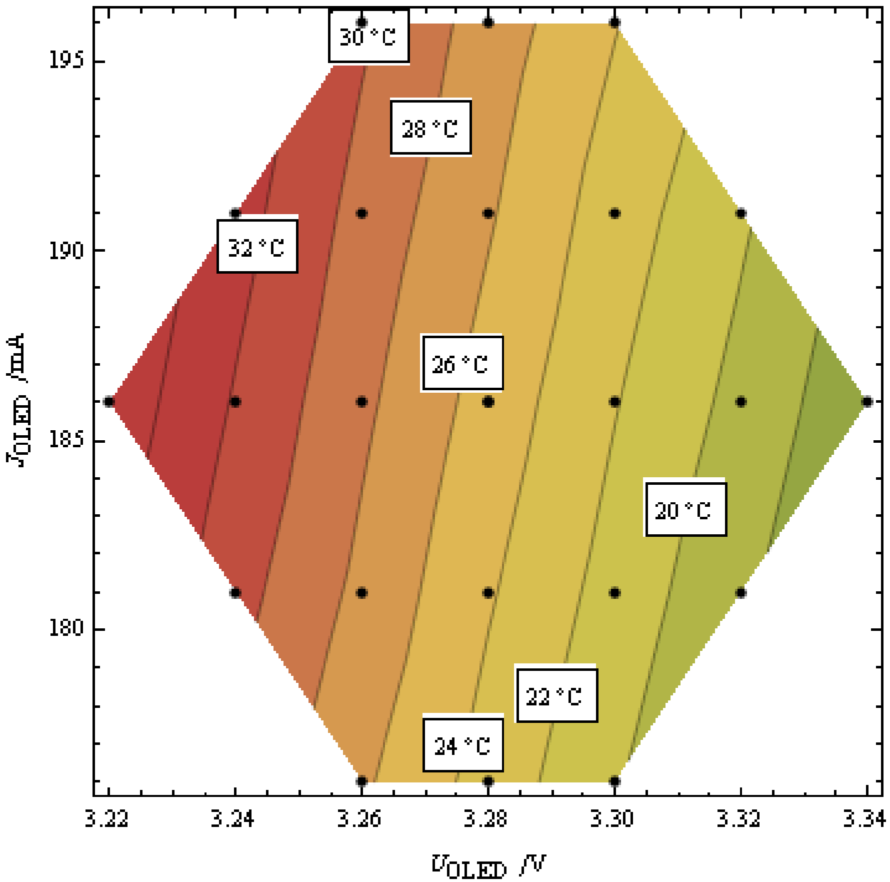


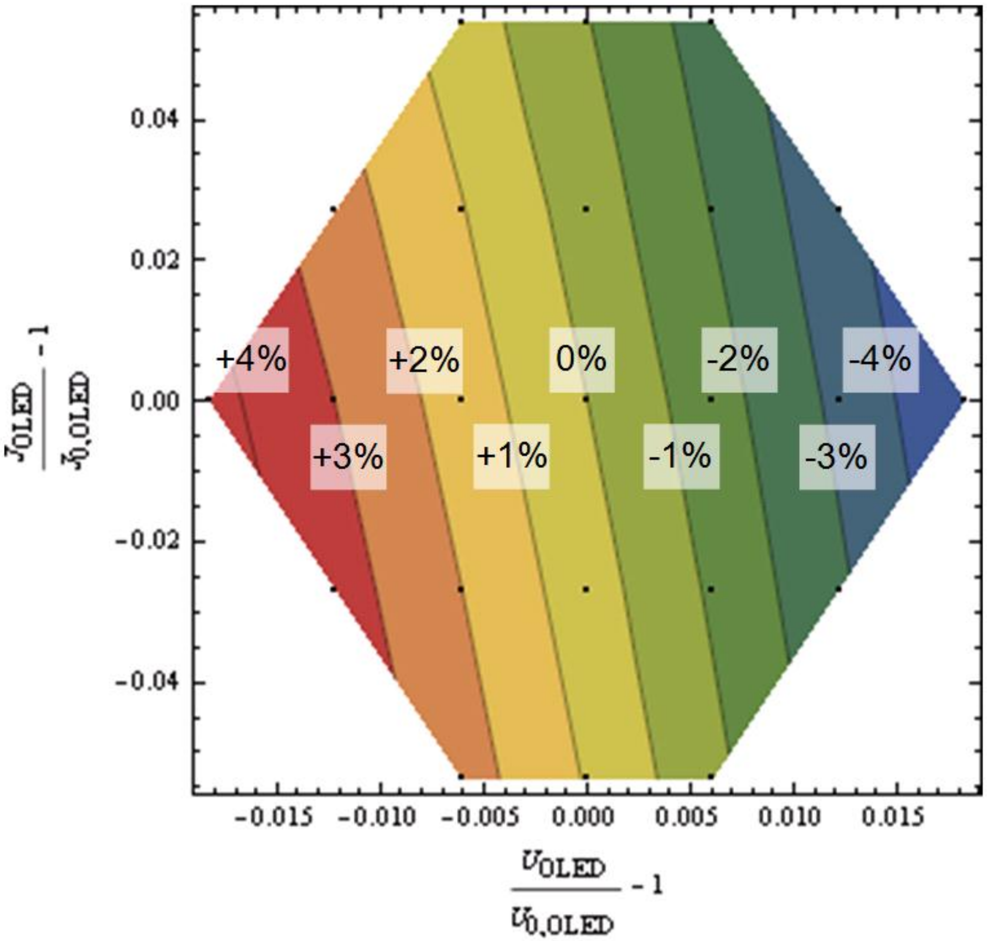
After 30 seconds operating time
After 3 minutes operating time

13 OLED Transfer Standard

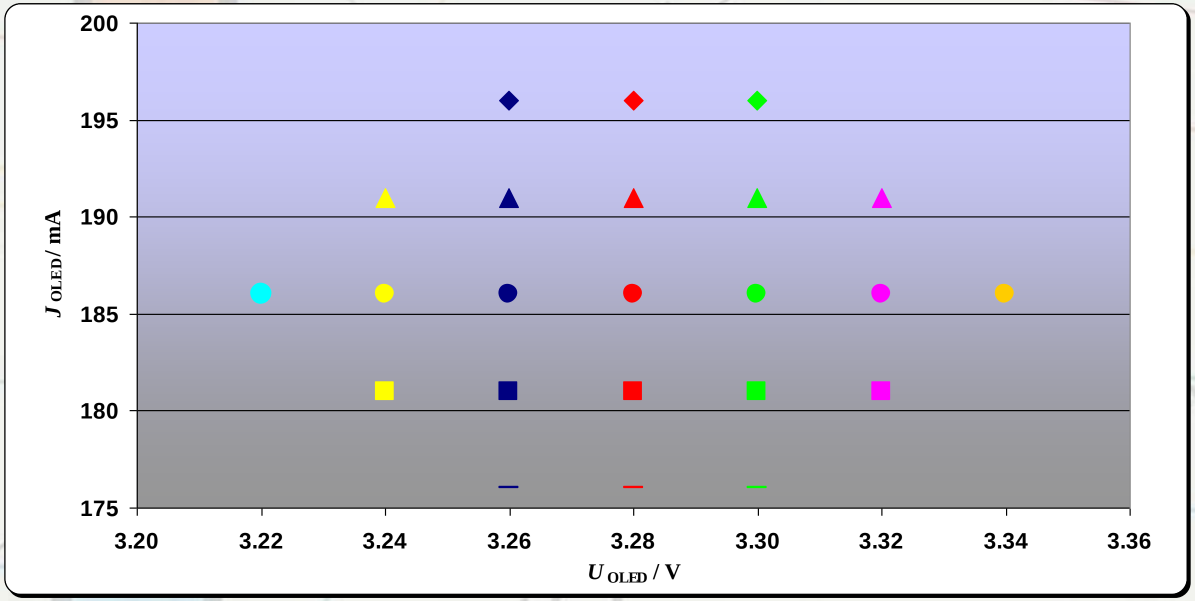
Current/Voltage – Luminance correlation

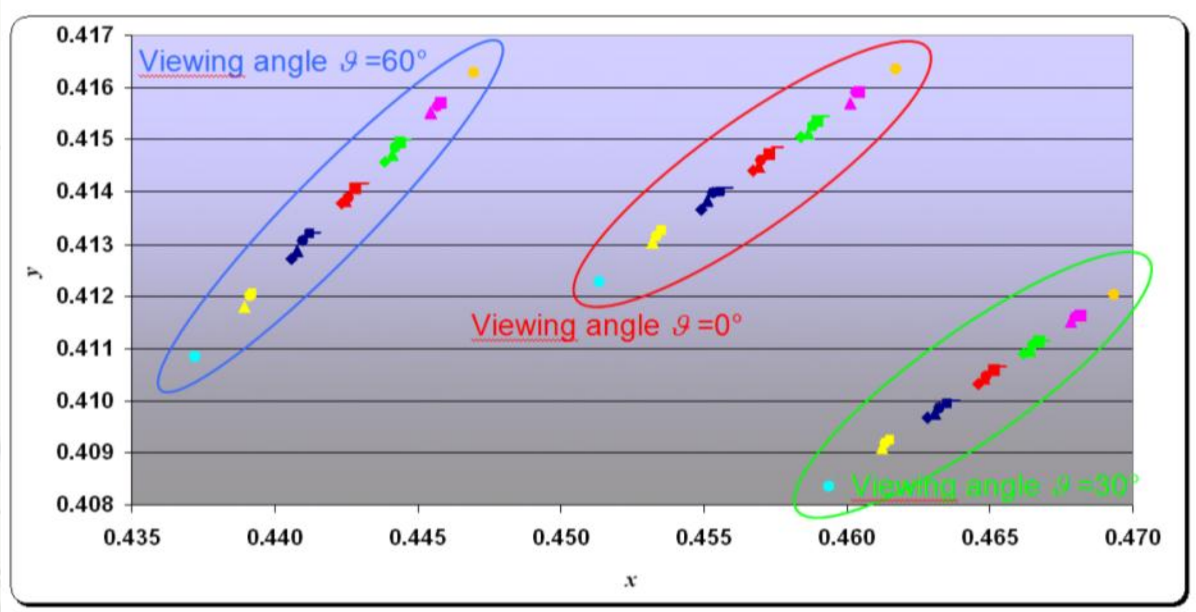
$$L_{\mathrm{OLED}} = L'_{\mathrm{OLED}} \cdot \left(\frac{J_{\mathrm{OLED}}}{J_{0,\mathrm{OLED}}} \right)^{-0.0025} \cdot \left(\frac{U_{\mathrm{OLED}}}{U_{0,\mathrm{OLED}}} \right)^{-2.55}$$





15 Current/Voltage – chromaticity correlation



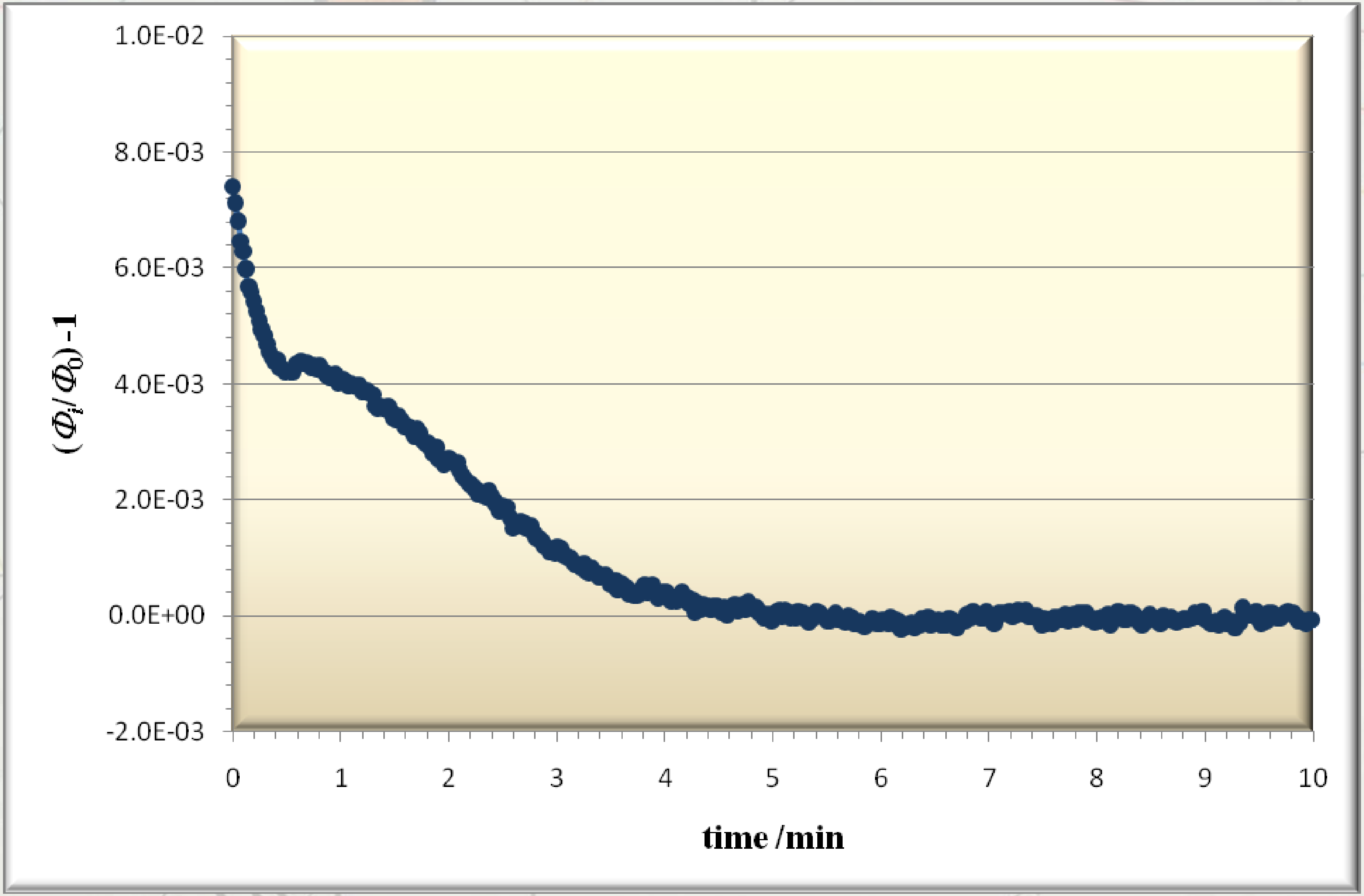


16 Flux measurements in an integrating sphere

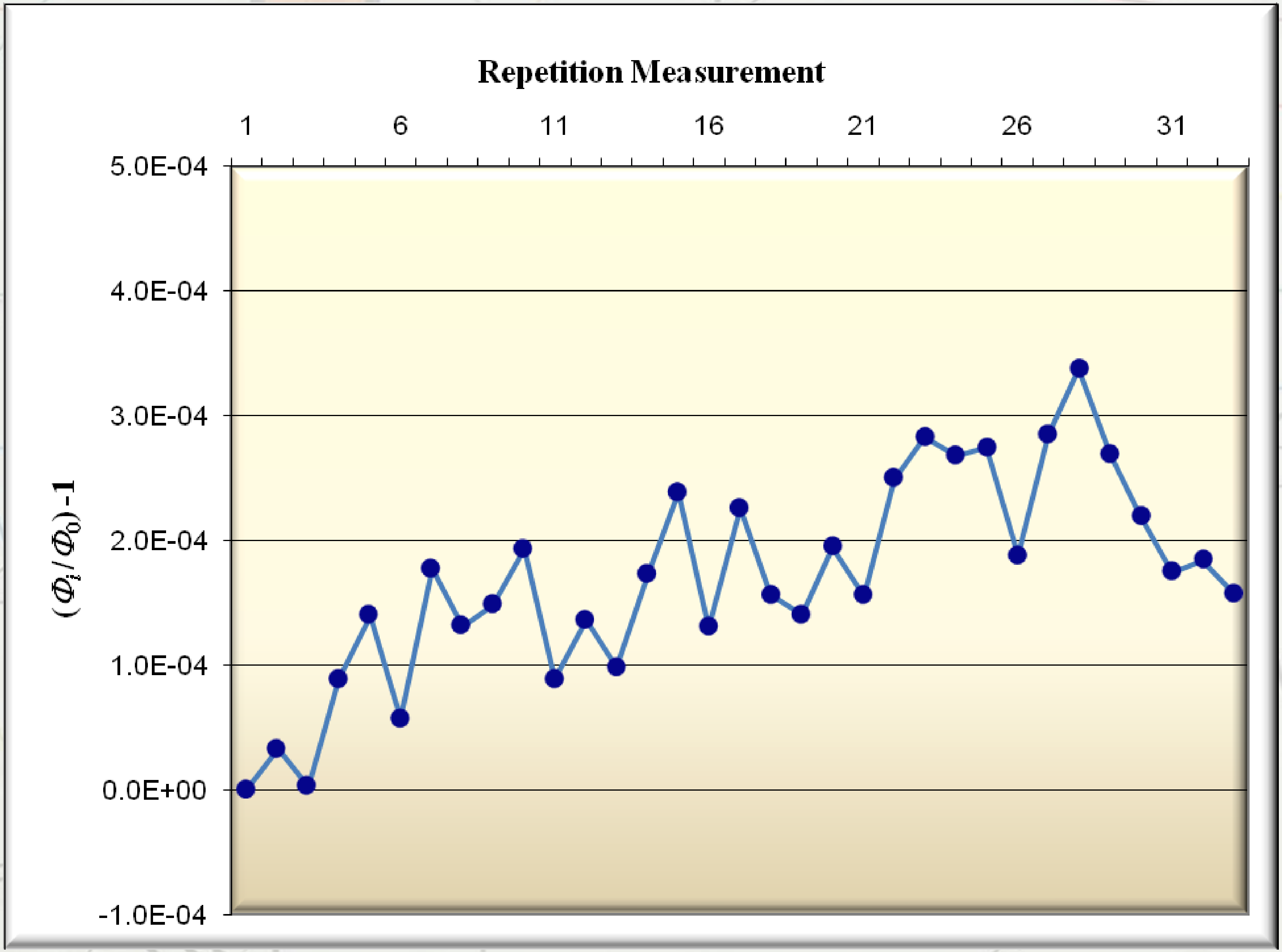
diameter	d	2.5 m
reflectance	ρ	0.95
throughput	τ	1.0

$$\tau = \frac{\rho}{\pi \cdot d^2 \cdot (1-\rho)}$$

17 Warm-up behaviour of the OLED transfer standard



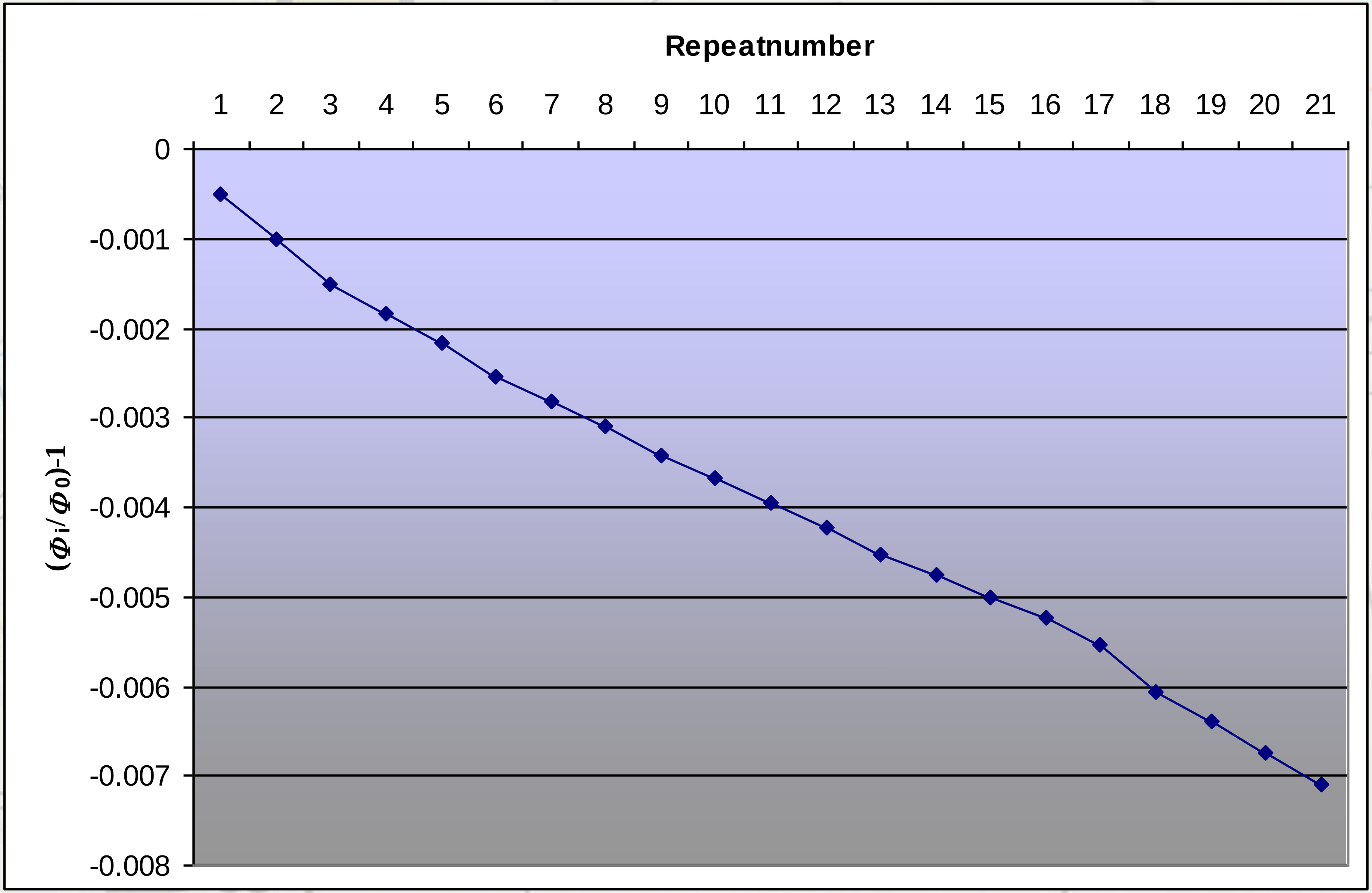
18 Relative luminous flux of the OLED standard



19 Relative luminous flux of an OLED w/o T-control

Operating-time: 47 min

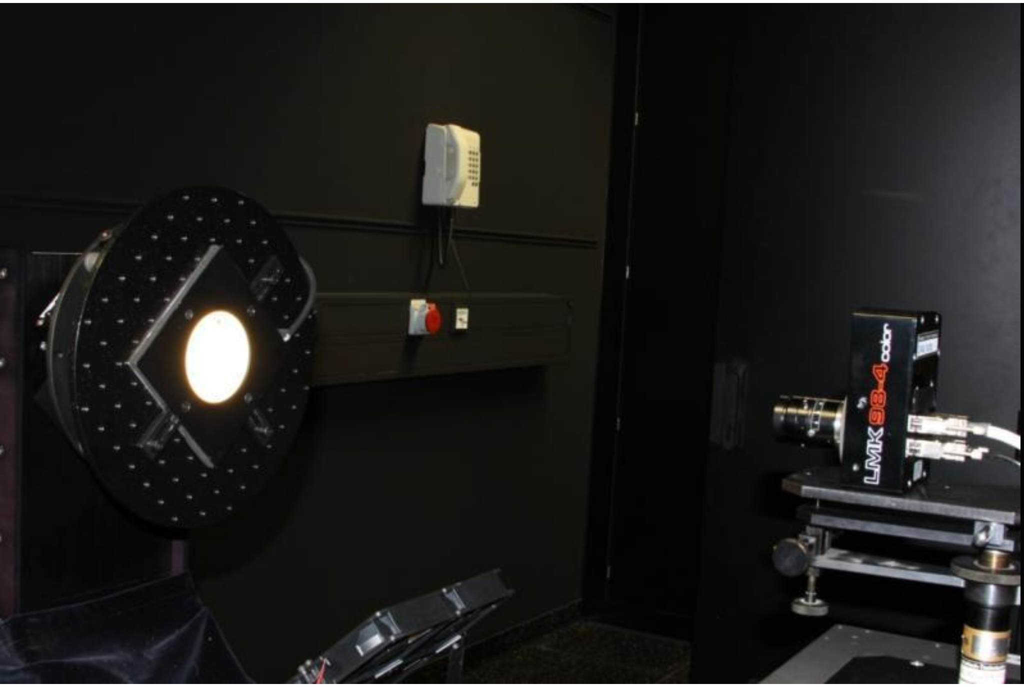
Off-time: 30 min

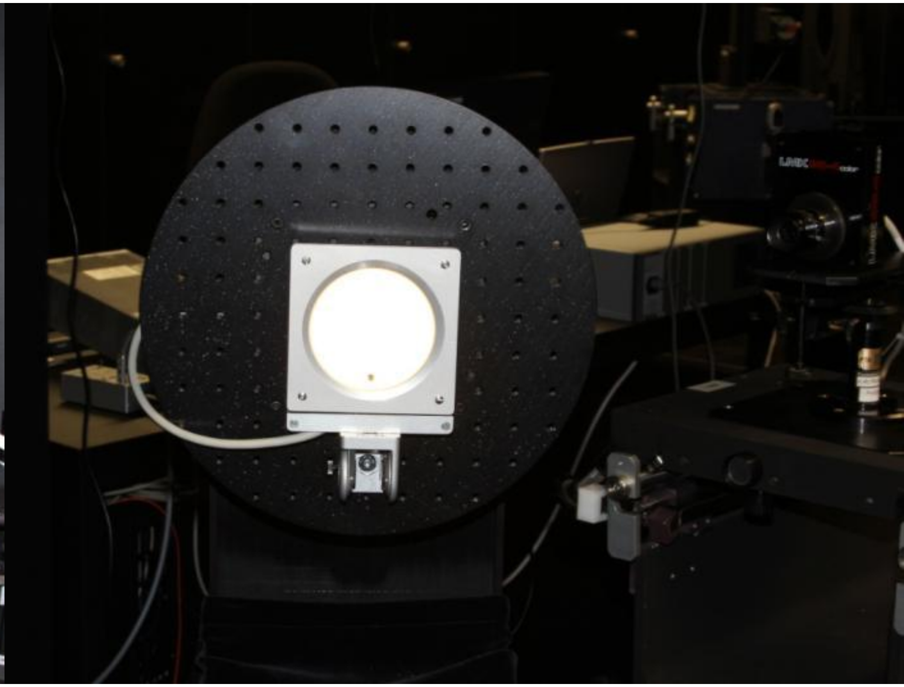


20 Luminance changes for two geometrical alignments

OLED without temperature control

OLED with temperature control





21 Summary

- Light sources of different technologies vary in their photometric properties. For calibration of measurement equipment it is always desirable to use transfer standards which have very similar properties as the light sources which shall be characterised with the equipment.
- Thus, the presented OLED transfer standard is based on a commercially available OLED.
- Most important to increase the reproducibility of photometric values is the stabilization of the OLED stack temperature. Due to the direct correlation between the stack temperature and the driving voltage it is possible to use the voltage as the monitoring quantity for temperature control.

Thank you for your attention.

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ACKNOWLEDGMENT

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