

# Polymer Optoelectronics

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Section Head Polymer Optoelectronics

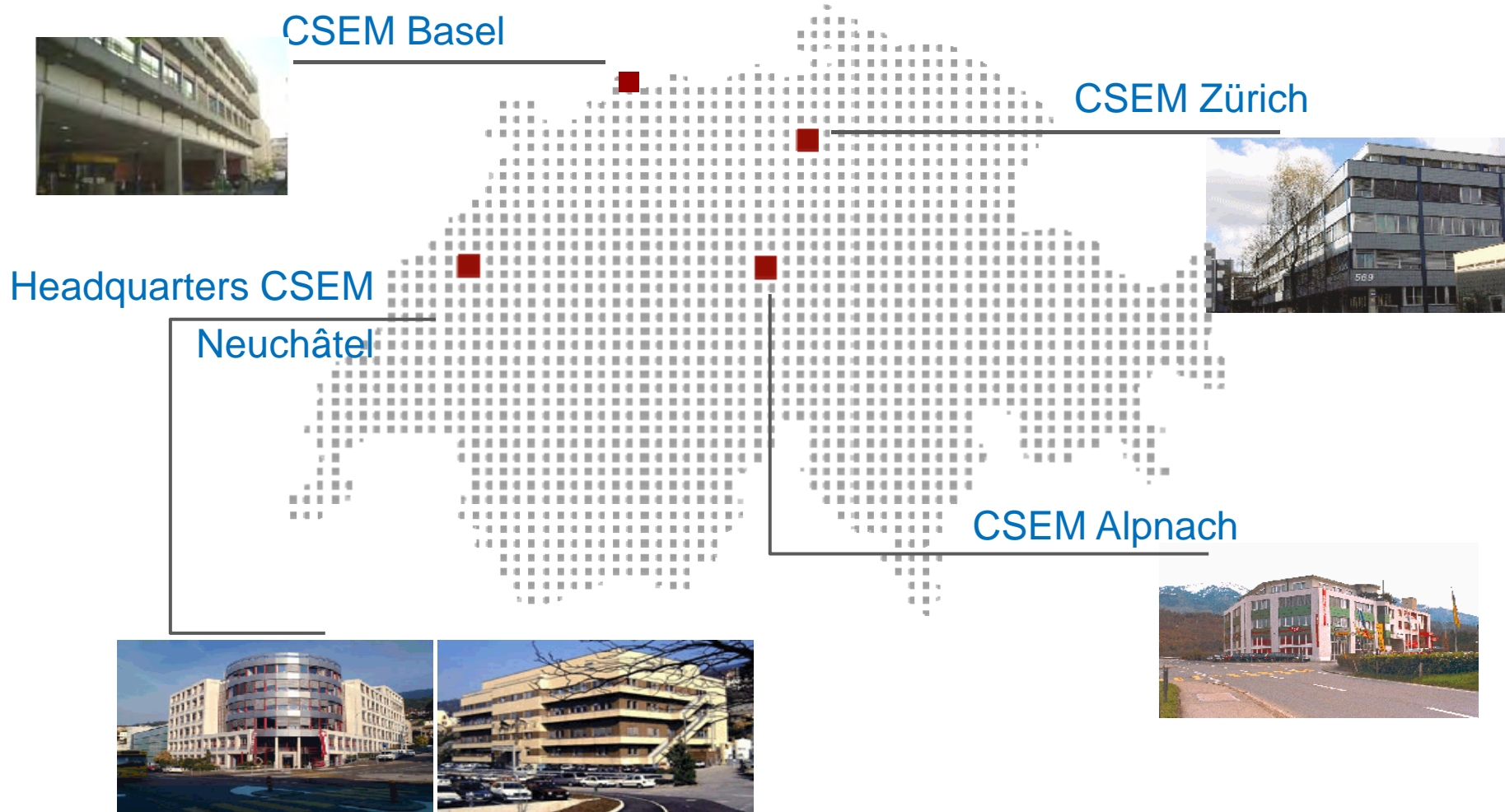
CSEM Basel, 25.06.2008

# Outline

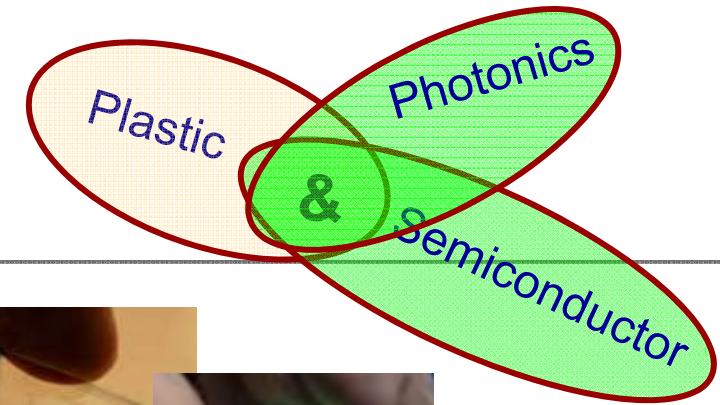
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- Introduction to Organic Optoelectronics
  - Vapor phase deposition
  - Solution processed
- Applications
  - OLED displays
  - Illumination
  - Signage
- Examples of Integrated Systems
- Conclusion

# CSEM locations



# Organic Optoelectronics



- Low-cost manufacturing:
  - amorphous substrates
  - flexible
  - thin
  - low weight
- low temperature process
- various patterning techniques
- large area

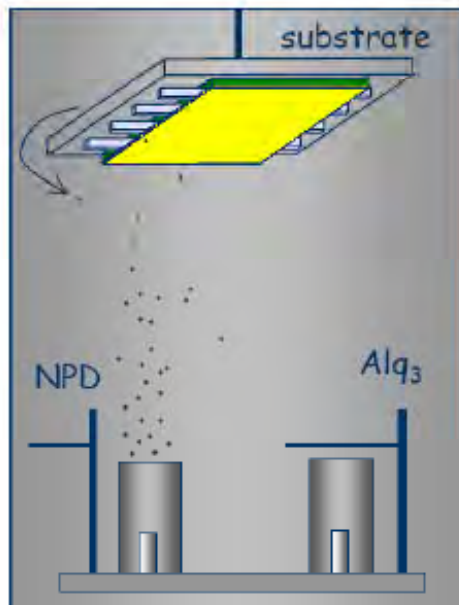


→ Printed Optoelectronics !



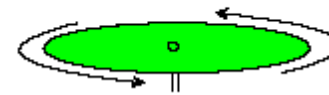
# Thin film deposition technologies

## Thermally evaporated

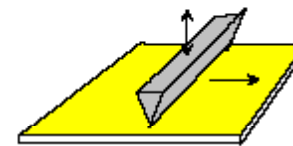


Small molecules are thermally evaporated in vacuum

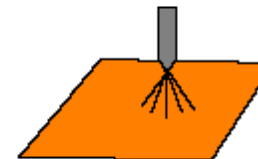
## Solution-processed



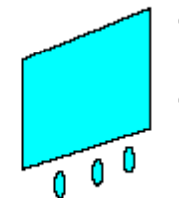
Spin Coating



Doctor Blade



Ink Jet Printing

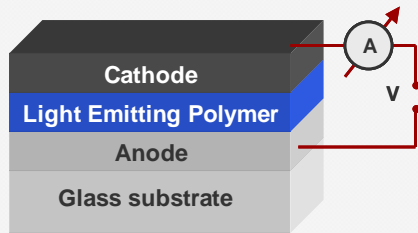
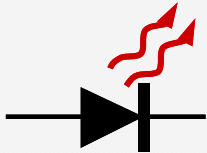


Dipping

*U. Lemmer, Uni Karlsruhe, CFN-Ringvorlesung: Physik von Nanostrukturen Optoelektronik I-III*

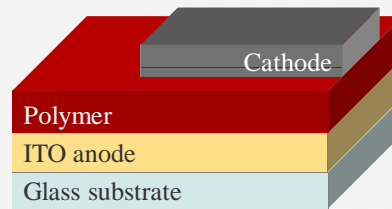
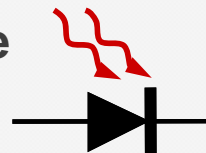
# Organic Optoelectronic Devices

## LED



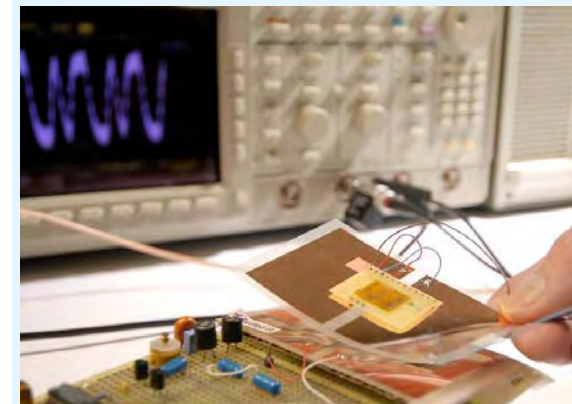
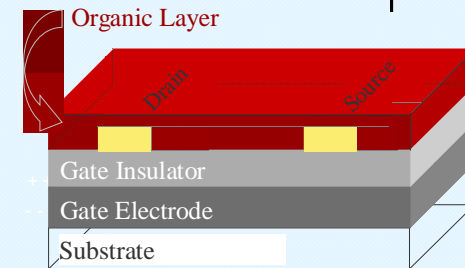
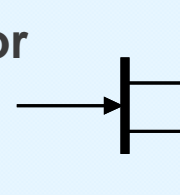
Consumer Products

## Photodiode



Demonstrators  
DuPont-Uniax

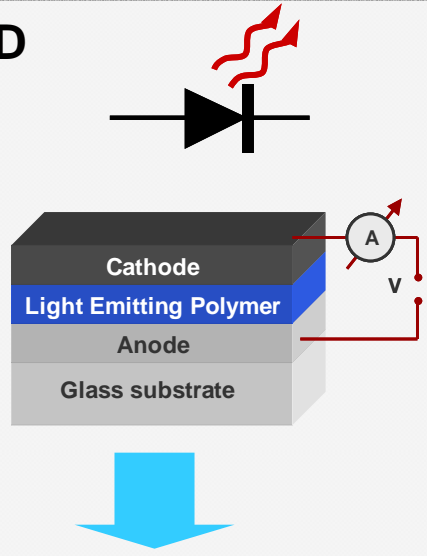
## Transistor



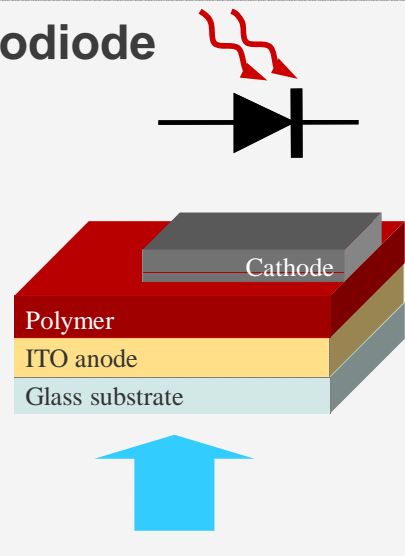
Philips  
Prototypes

# Organic Optoelectronics

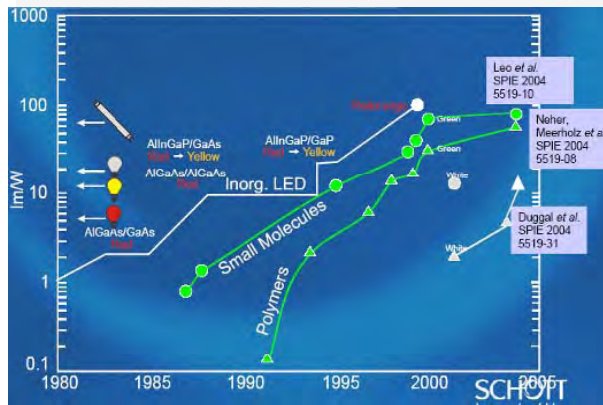
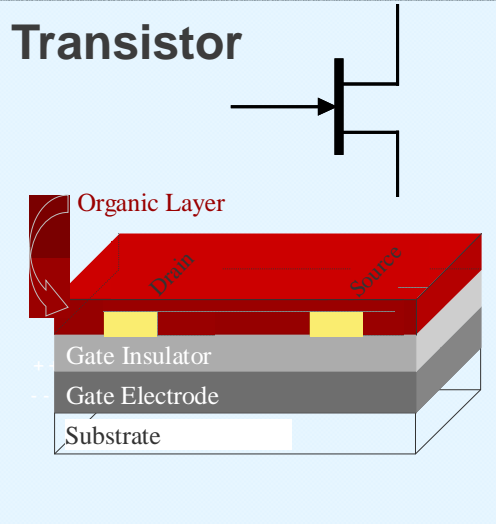
## LED



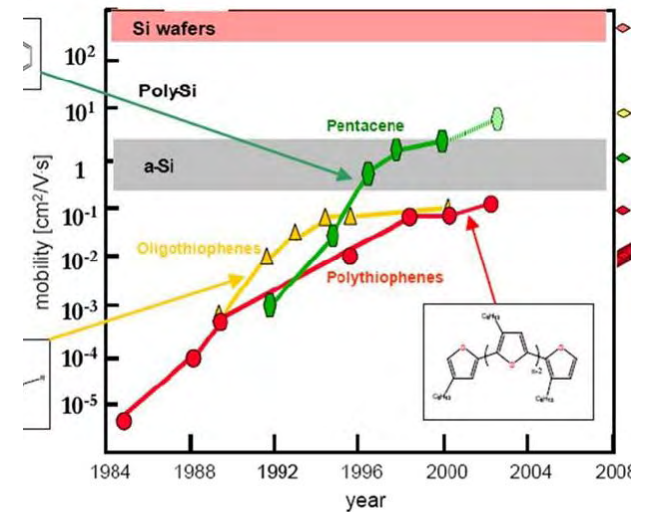
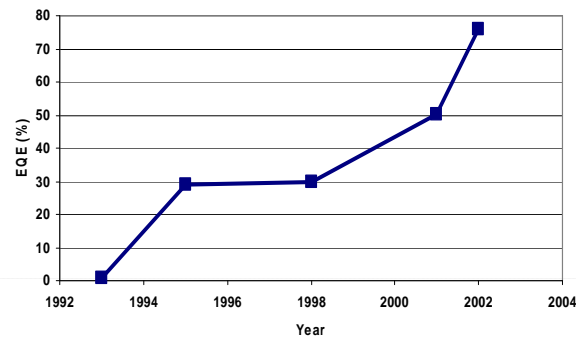
## Photodiode



## Transistor

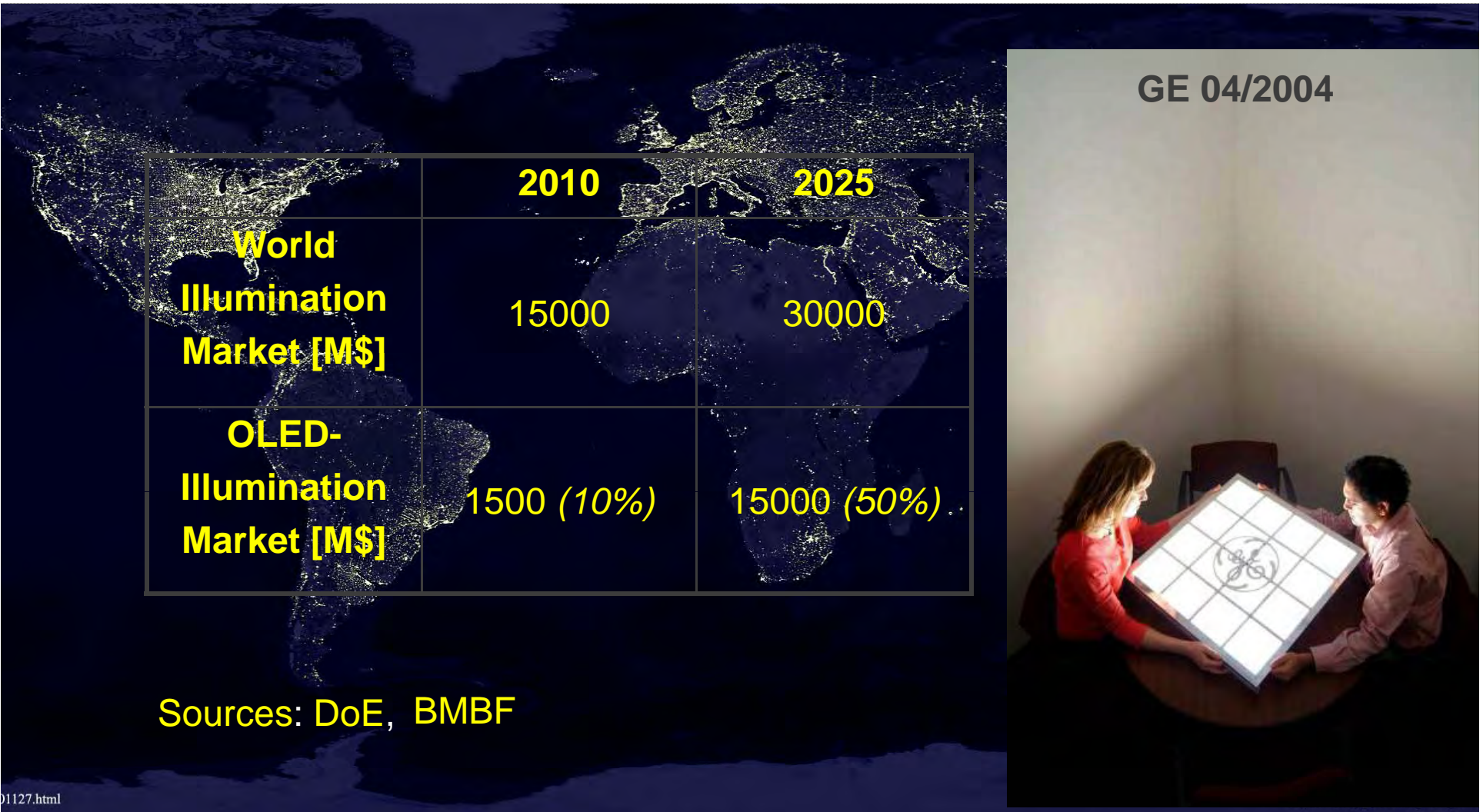


Evolution of EQE for organic heterojunction photodiodes



Target Application: OLED lighting

# Lighting





# Roll-to-Roll OLEDs for lighting applications

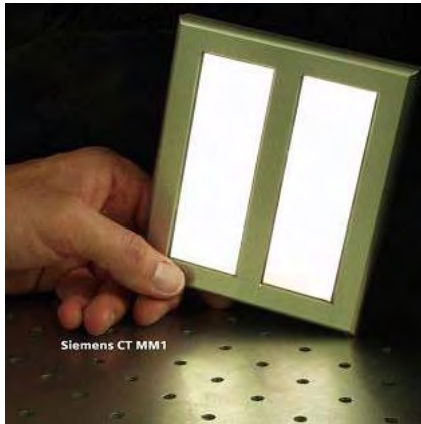
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- GE press release (~March 2008)

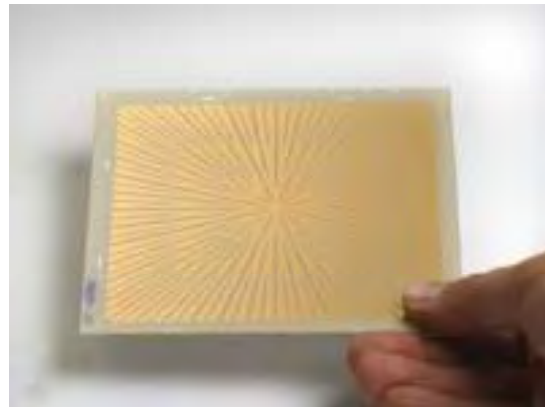


Solution/Vacuum processed

## White OLED tiles



(spin-coated, by Siemens)



OLLA

Solution / (Vacuum) deposited

<b>Brighthness (cd/m<sup>2</sup>)</b>	1000
<b>Luminous efficacy (lm/W)</b>	> 25 (50, OLLA)
<b>Lifetime (h)</b>	> 5000 (10000, OLLA)
<b>Panel size (cm<sup>2</sup>)</b>	> 15×15

- Homogeneous large areas
- Low cost

Vacuum deposition

## White OLED tiles (latest achievements)

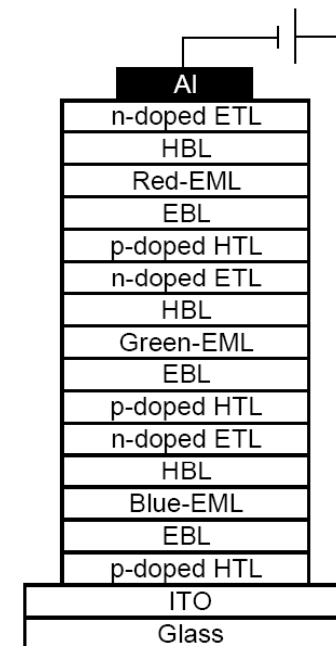
UDC

- phosphorescent OLED technology
- 102 lm/W
- CRI 70

NovaLED

- 35 lm/W
- CRI 90
- t 100,000h @ brightness of 1000 cd/m<sup>2</sup>.

[www.oled-info.com](http://www.oled-info.com)



PLED-signage on flexible substrate

## Holst Centre (NL)



# Polymer Optoelectronics @ CSEM

## Material & Device Optimization



- Polymer LEDs
- Polymer Transistors
- Polymer Photodiodes

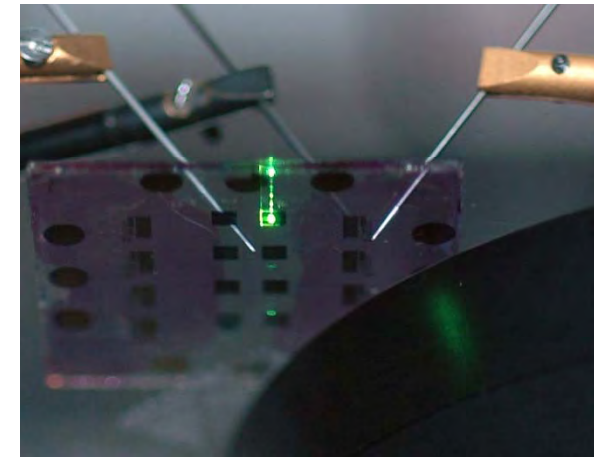
## Low-cost and / or Customizable Processes



LogoLED™

- Signage
- Illumination
- Plastic IC's

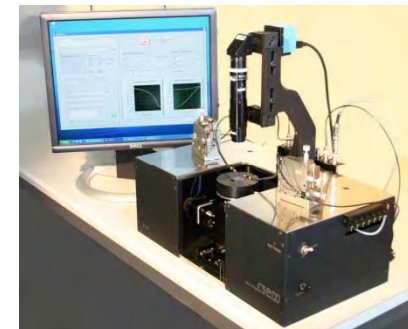
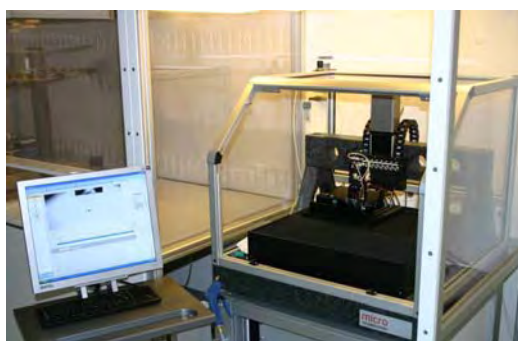
## Integrated Organic Optoelectronic Systems



PLED driven by organic IC

- System Integration: (oLEDs & oPDs & oFETs)
- Development of additive printing processes

# State-of-the-Art Processing & Characterization

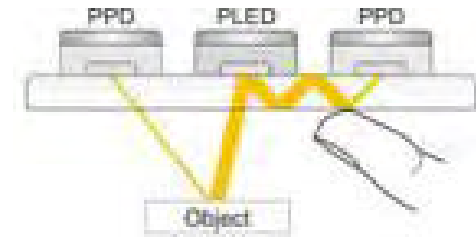


- 150 m<sup>2</sup> POE clean room environment
- 50m<sup>2</sup> Photolithography

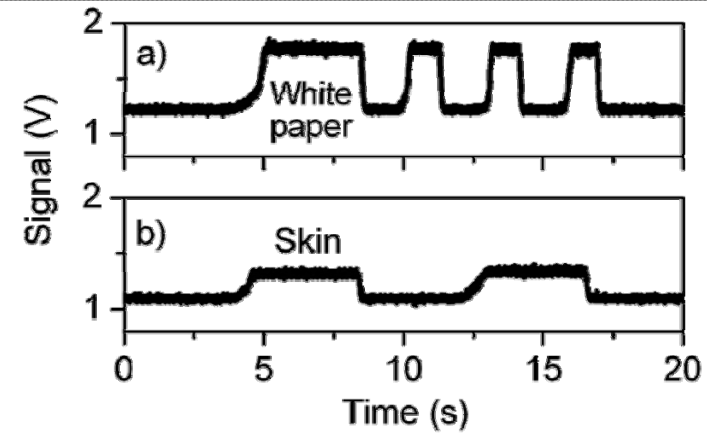


# Monolithic Integration

## SENSoLED™



- Monolithically integrated PLED & polymer PDs
- Position & Proximity sensor
- Touch screen
- Artificial haptic sense

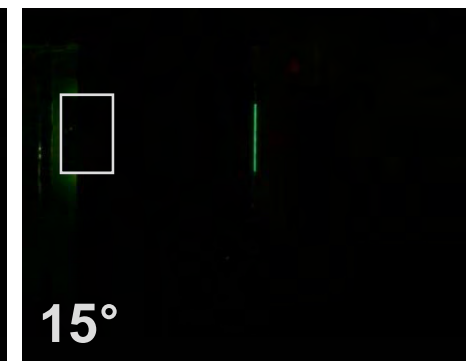
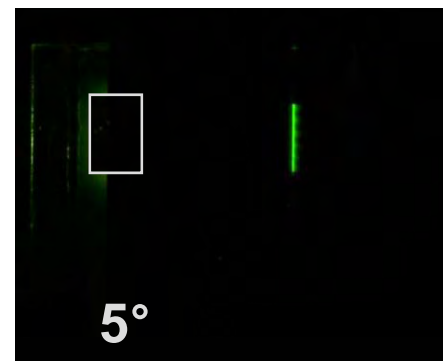
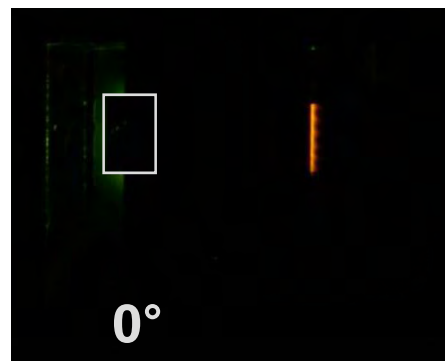
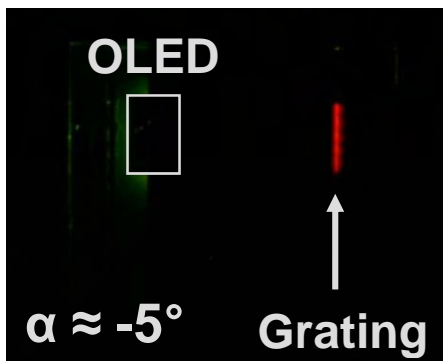
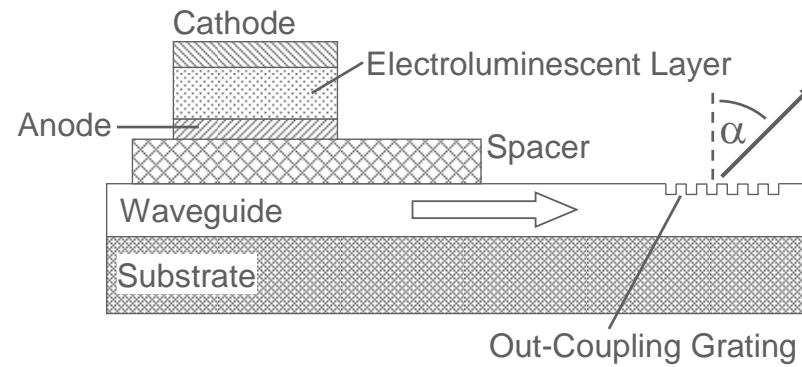
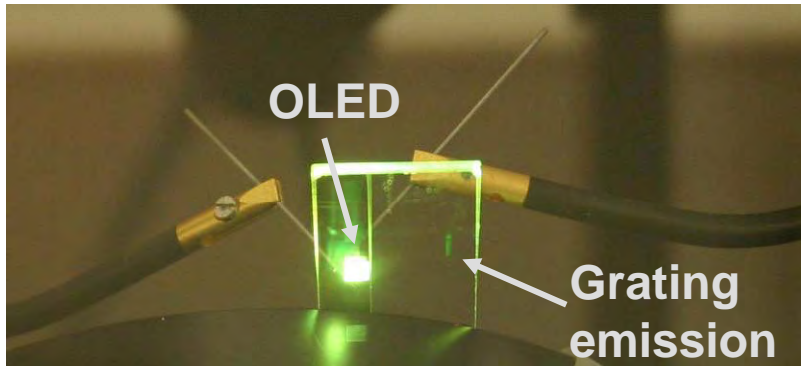


L. Bürgi et al., Organic Electronics 7 (2006) 114



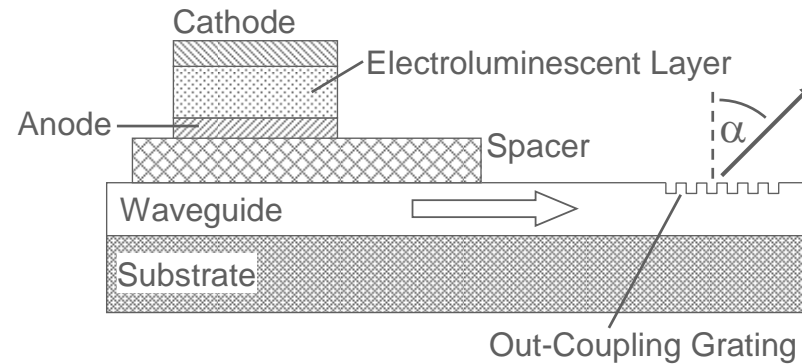
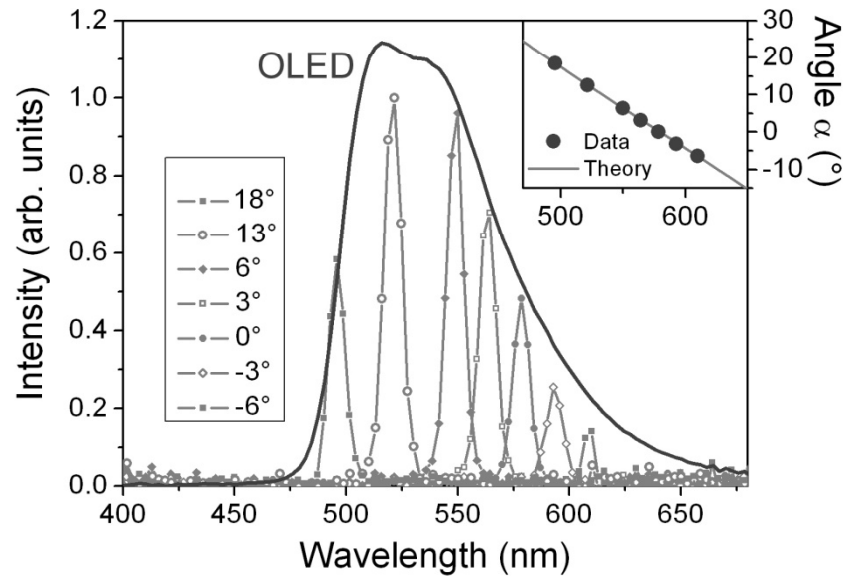
Example: OLED2WG

## Results: Spectra of Out-coupled Light



Example: OLED2WG

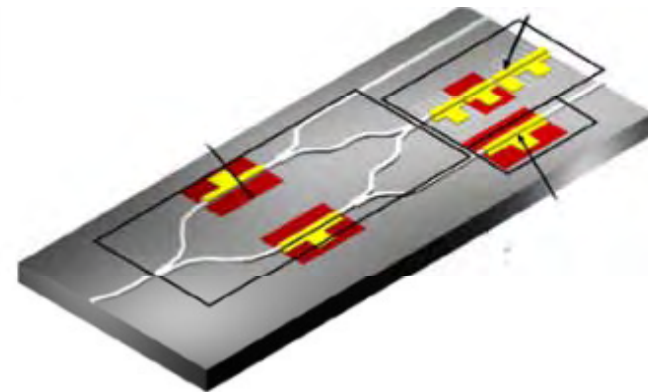
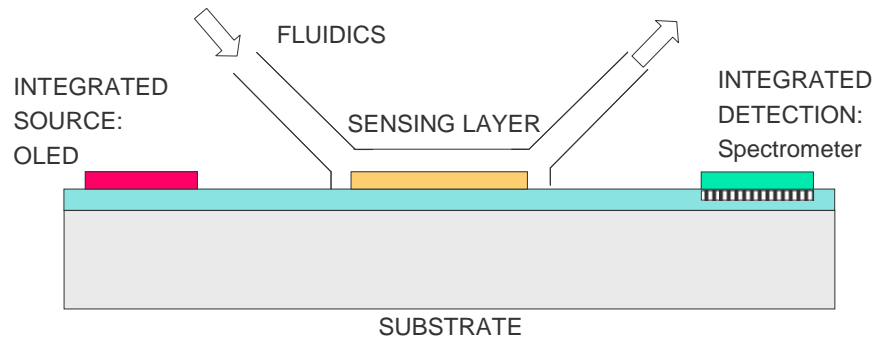
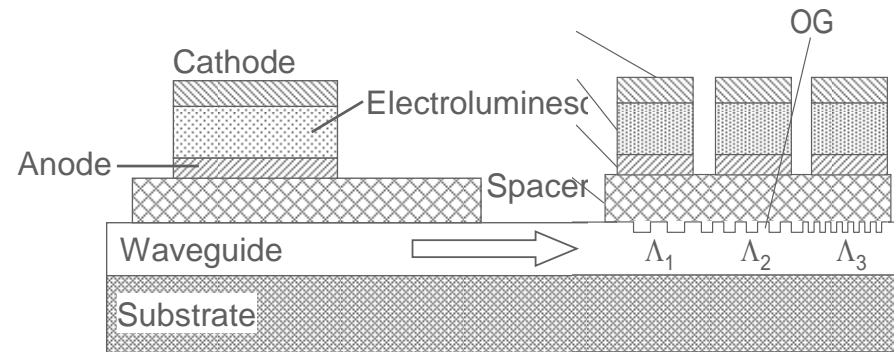
## Results: Spectra of Out-coupled Light



- Strong color-shift over narrow angular range → Waveguide modes and not substrate modes
- Coupling efficiency:  $\eta > 3\%$

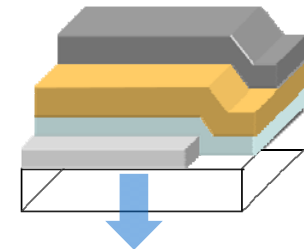
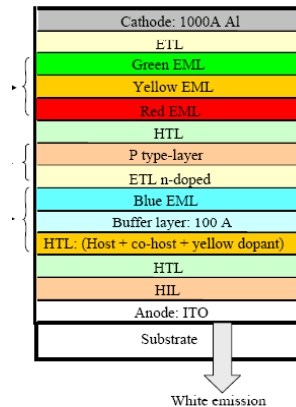
# Future Applications

- Point of Care Diagnostics
- Photonic Integrated Circuits



# Conclusion

- Vacuum deposition → multilayer structure → high performance
  - Applications
    - Displays → trend: white OLEDs & LCD (SID 2008)
    - Illumination
- Solution processed → solvent orthogonality → simple structure
  - Applications
    - Digital printing techniques → custom-designed signage, sensor systems, functional packaging
    - The ultimate: Roll-to-Roll production



# Announcement

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- FSRM Course “Polymer Optoelectronic Technologies and Applications”
  - 29.09. 2008, CSEM Basel
  - [www.fsrm.ch](http://www.fsrm.ch)
  
- Electrosuisse Trilogie “Elektronik der Zukunft, Organische Elektronik”
  - ~~25.06.2009~~, ZHAW Winterthur    03.07.2009
  - [www.electrosuisse.ch](http://www.electrosuisse.ch)

**Thank you for your attention!**