

# Polymer Light Emitting Diodes

Presentation for the lecture “Incoherent Light Sources”

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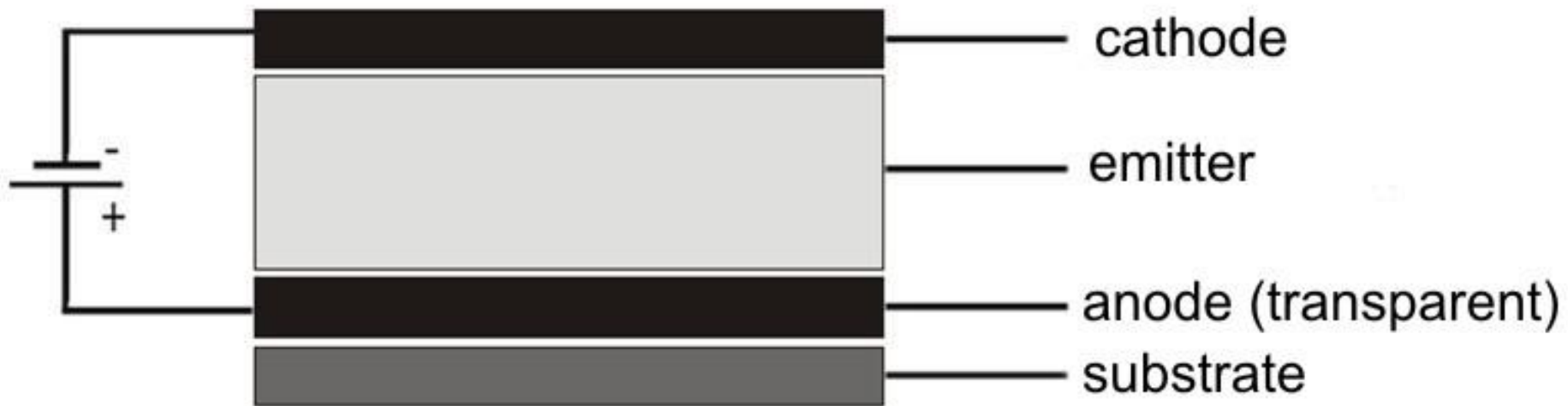
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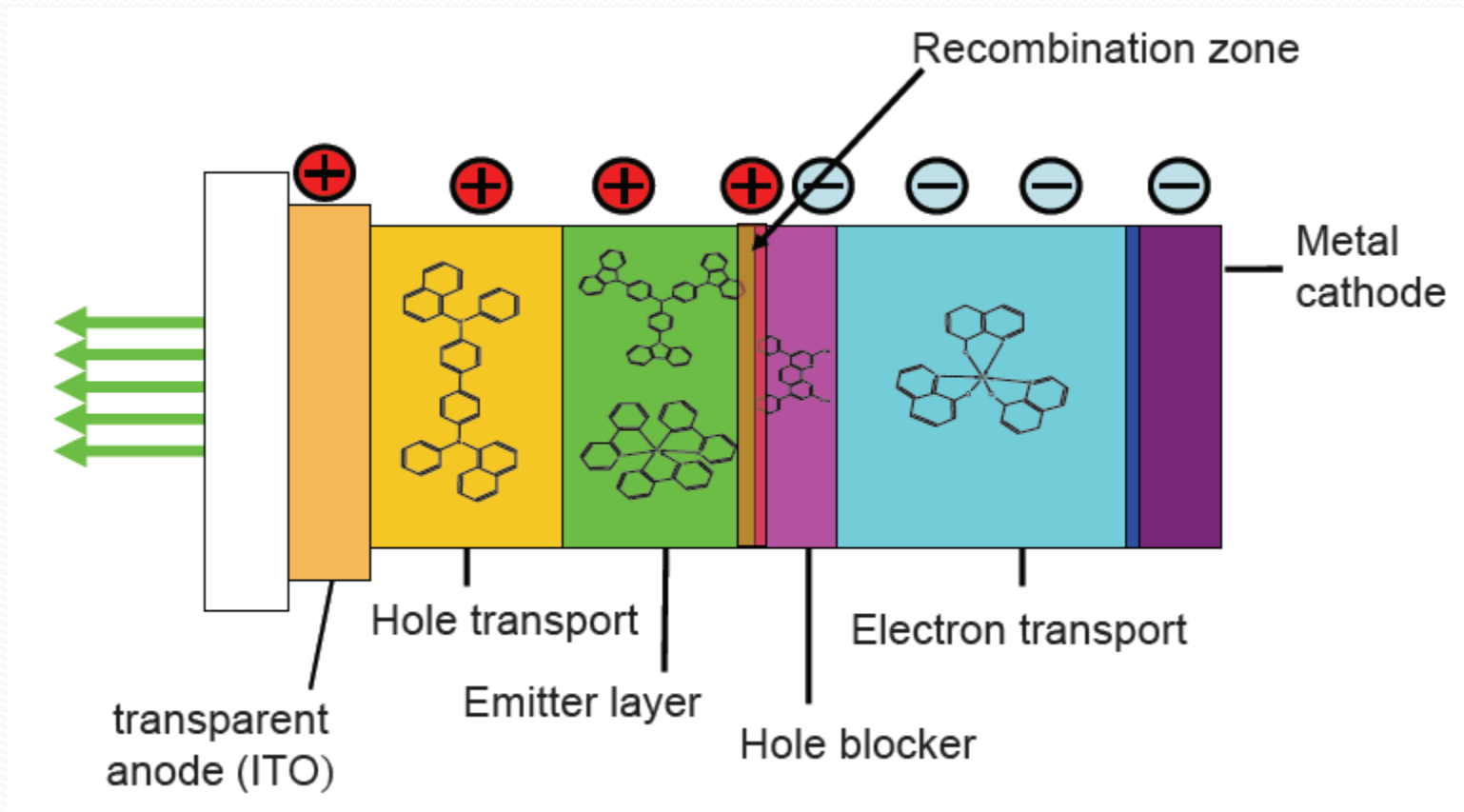
# History of OLEDs

- 1953: electroluminescence in organic materials was observed
  - 1987: first OLED with driving voltage of 10V
  - **1990: discovery of  $\pi$ -conjugated polymers for OLEDs**
- ➔ Beginning of intensive research because of the advantages of polymers**

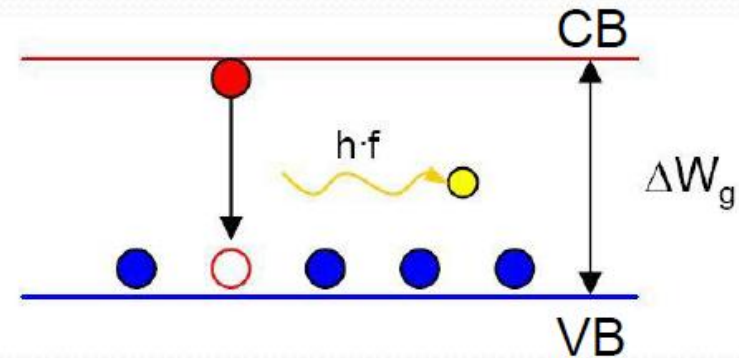
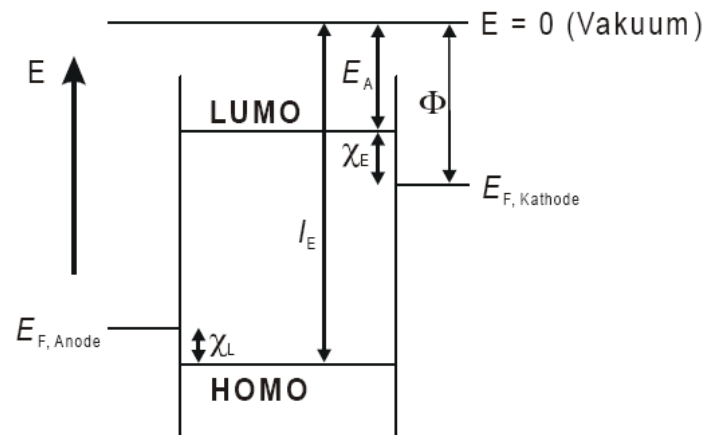
# Functional Principle of an OLED



# Functional Principle of an OLED



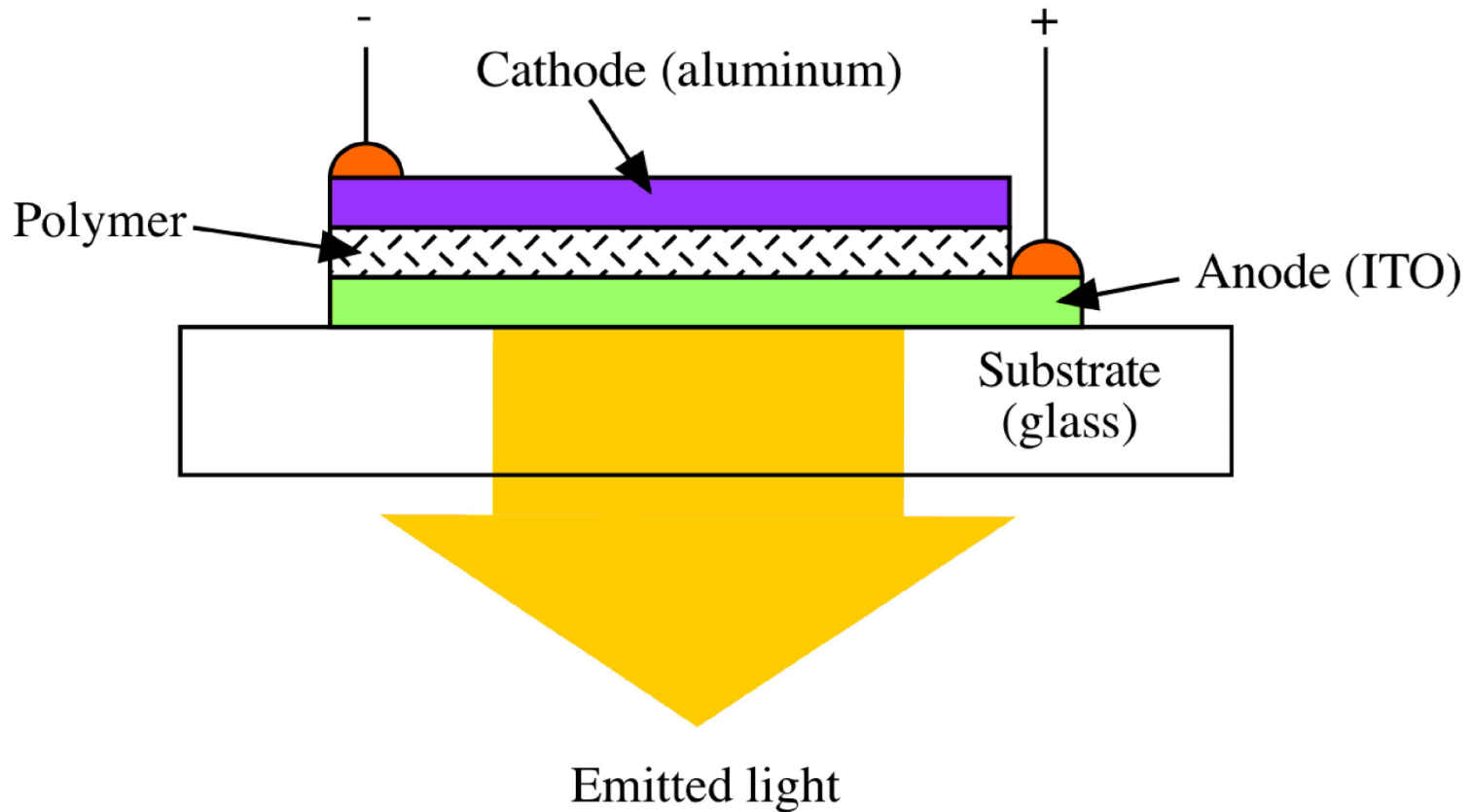
# Functional Principle of an OLED



$E_A$ : Elektronenaffinität  
 $E_F$ : Fermi-Energie  
 $I_E$ : Ionisierungsenergie

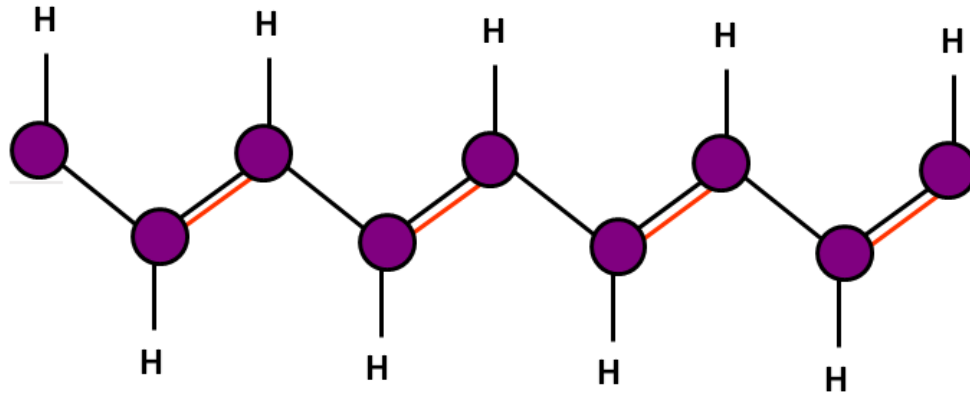
$\Phi$ : Austrittsarbeit  
 $\chi_L$ : Injektionsbarriere für Löcher  
 $\chi_E$ : Injektionsbarriere für Elektronen

# PLED as a special type of OLED



# PLED as a special type of OLED

- $\pi$ -conjugated polymer



→ semiconducting properties



# PLED as a special type of OLED

- Injection
- Interchain transport
- Recombination in light emission

# PLED as a special type of OLED

- length of polymer chain determines the emitted wavelength
- similar to the band gap in anorganic LEDs



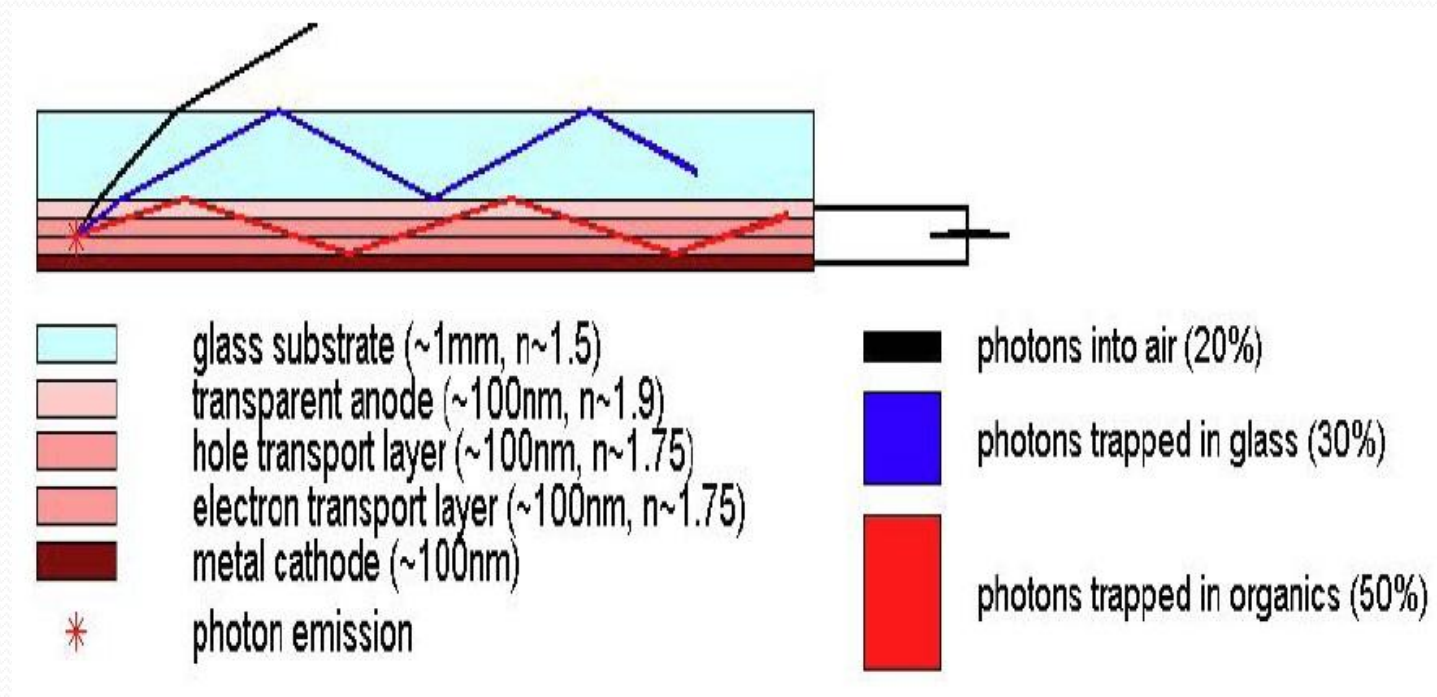
# Fabrication Process

- transparent electrode (ITO)
- polymer solution
- spin coating
- a few 100nm thin layer
- further layers are coated using CVD



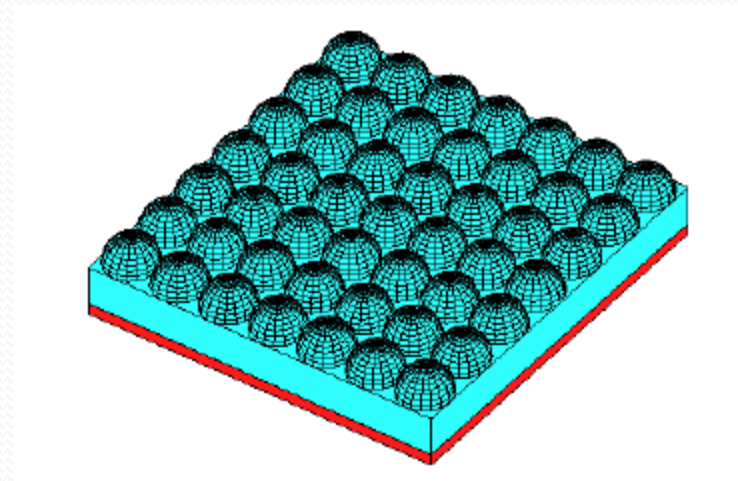
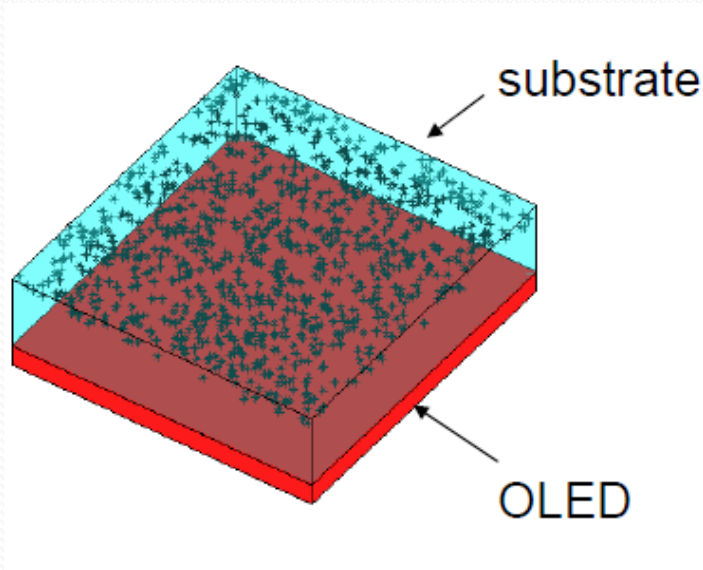
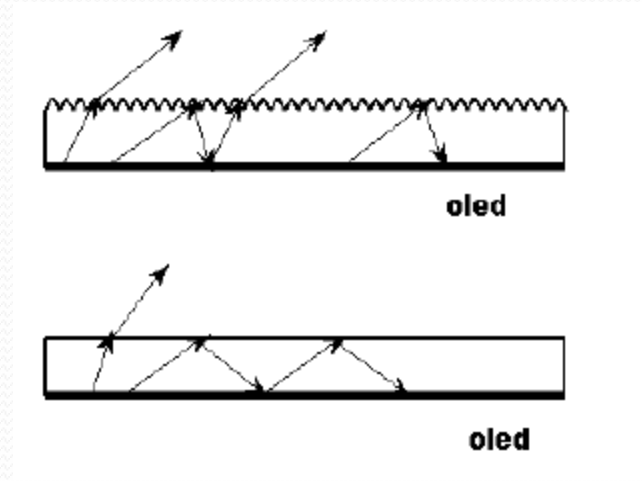
# Light Extraction

- total internal reflection due to different refractive indices → low luminous efficacy



# Light Extraction

- proposals for solution
  - high index substrates
  - scattering structures
  - AR-coating



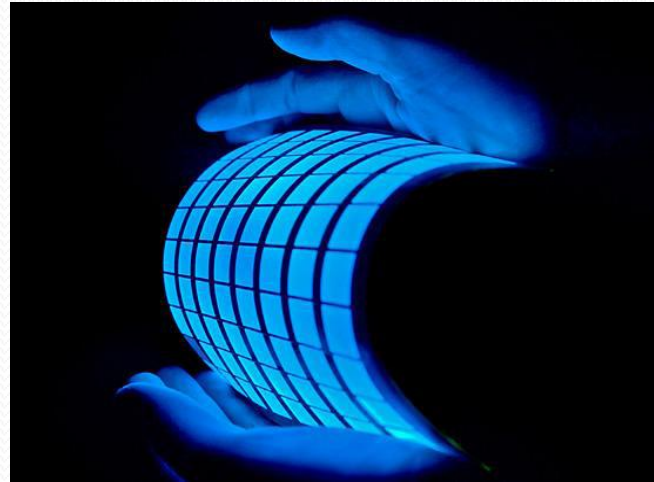
# Applications

- Displays
  - Mobile Phone
  - Laptop
  - TV
  - Advertising Space
- Lighting



# Advantages

- large single emitter
- smooth brightness
- arbitrary structures
- thin and flexible
- short response time
- high contrast
- large viewing angle
- high temperature range
- low production costs



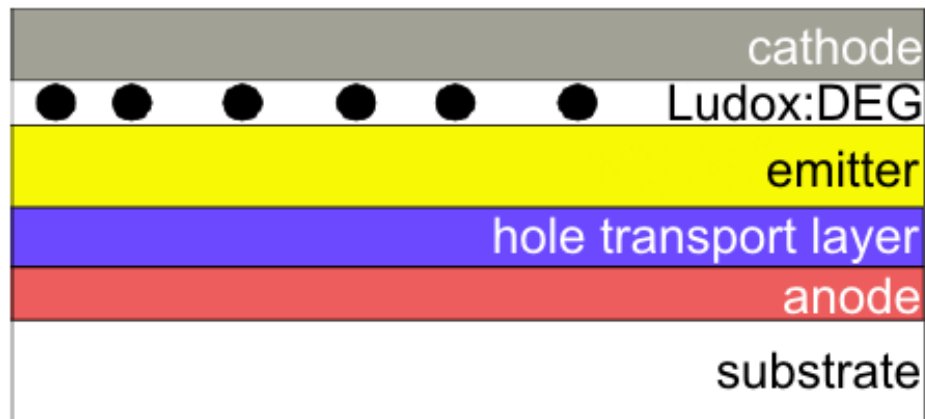
# Disadvantages

- emitter is sensitive to oxidation and humidity
- different lifetime of the emitting polymers  
→ color shift
- short lifetime at high luminescence



# Outlook

- Raise of internal quantum efficiency by additional layer of nanoparticles
- Aim to print OLED with electronic  
→ lower price and higher flexibility



# Sources

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- [www.oled.at](http://www.oled.at)