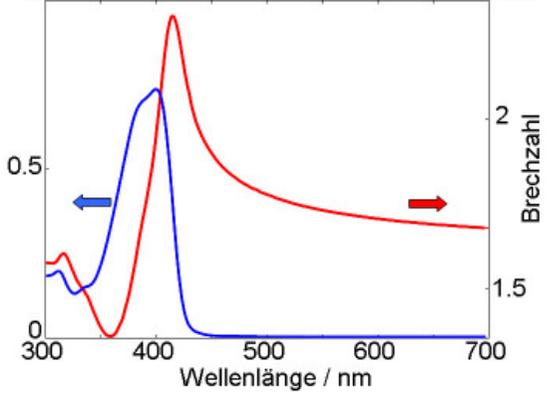
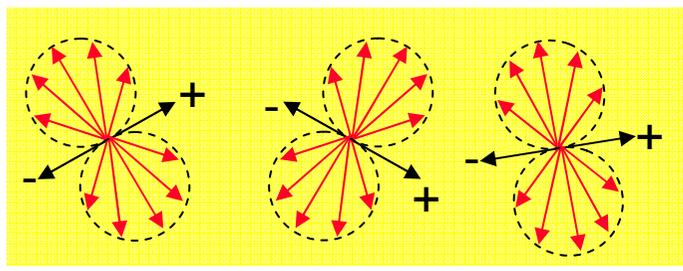


## OLED – Optik

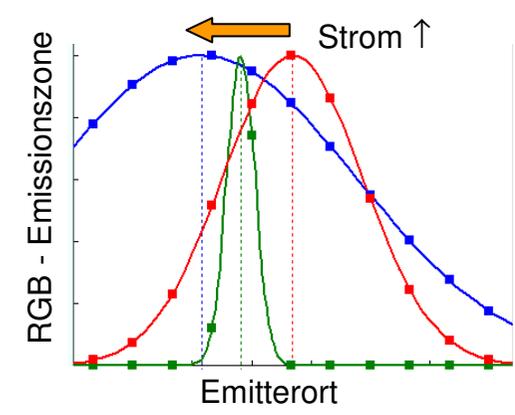
### Charakterisierung des Schichtsystems



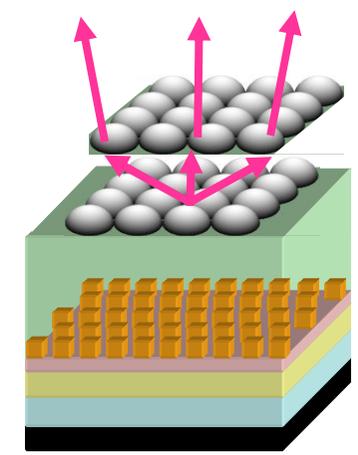
### Charakterisierung des aktiven Materials



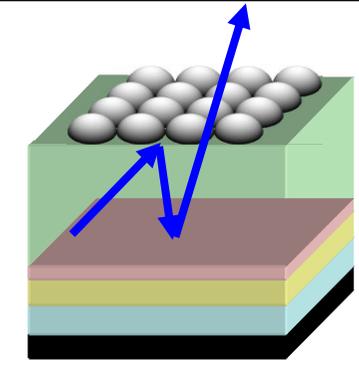
### Beiträge zur Bauteilphysik



### Lichtmanagement

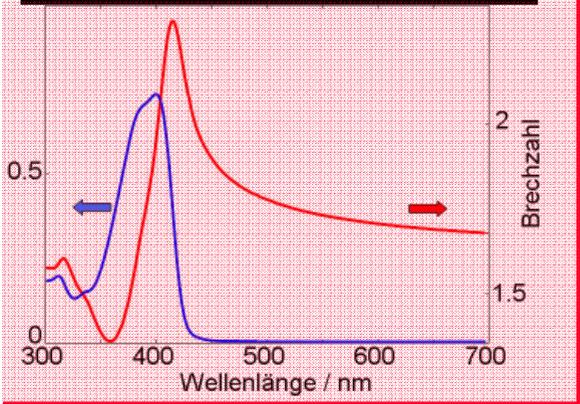


### Lichtauskopplung

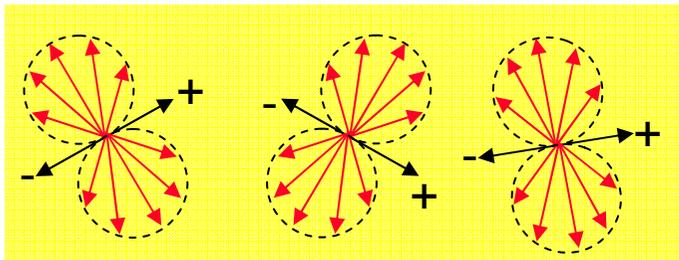


## OLED – Optik

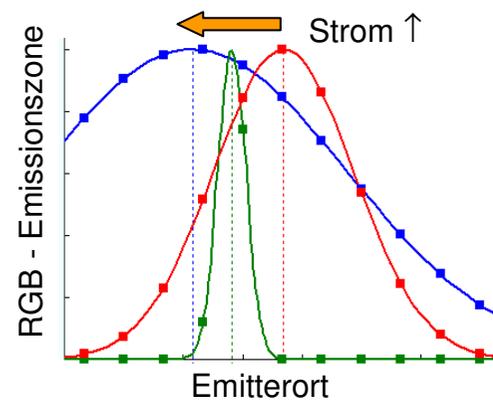
### Charakterisierung des Schichtsystems



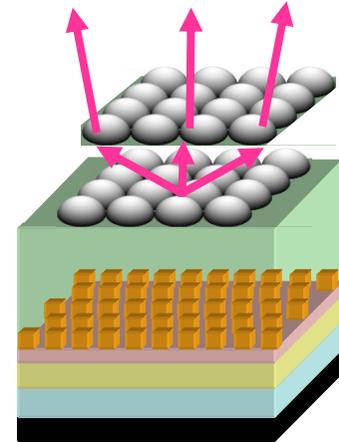
### Charakterisierung des aktiven Materials



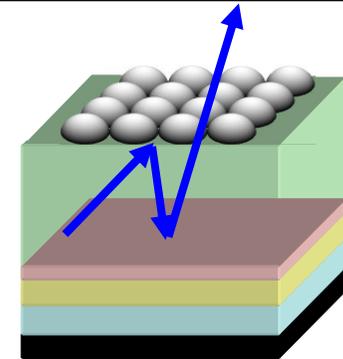
### Beiträge zur Bauteilphysik



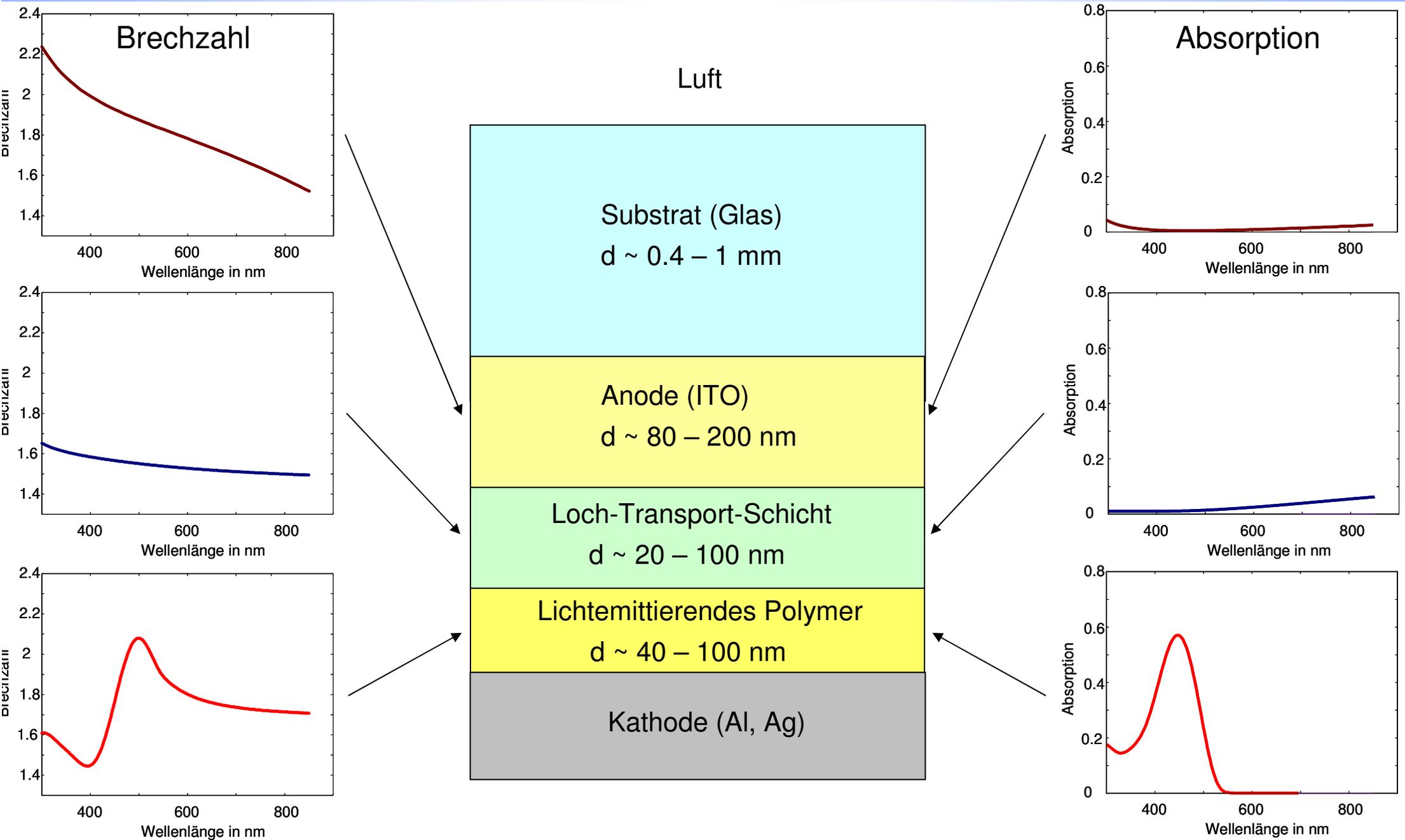
### Lichtmanagement



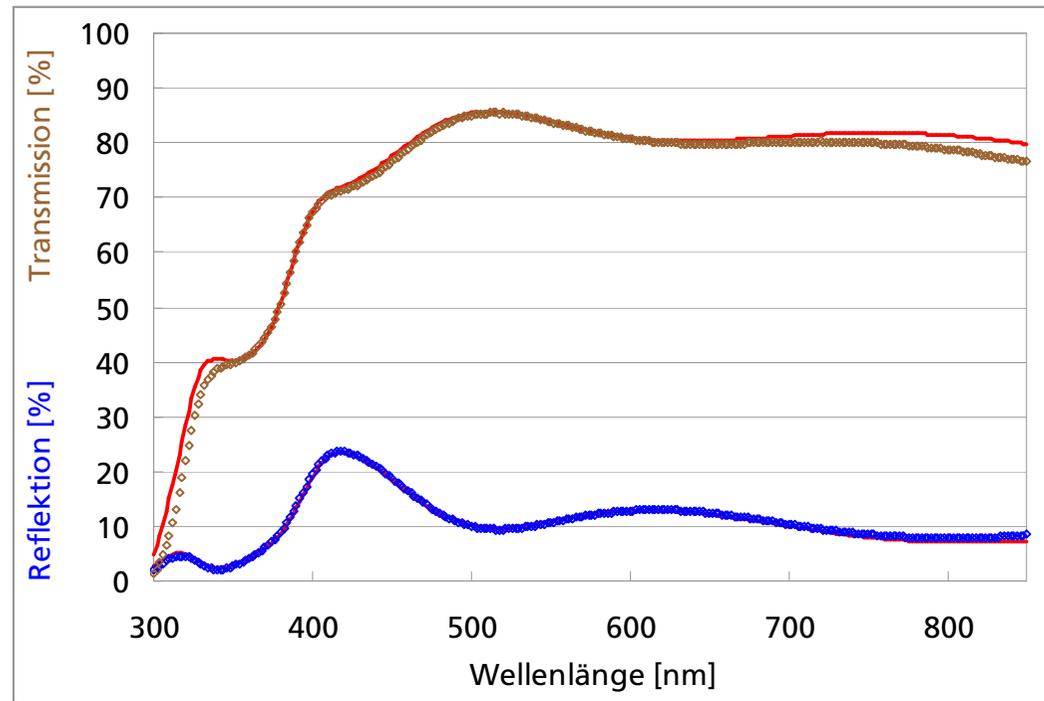
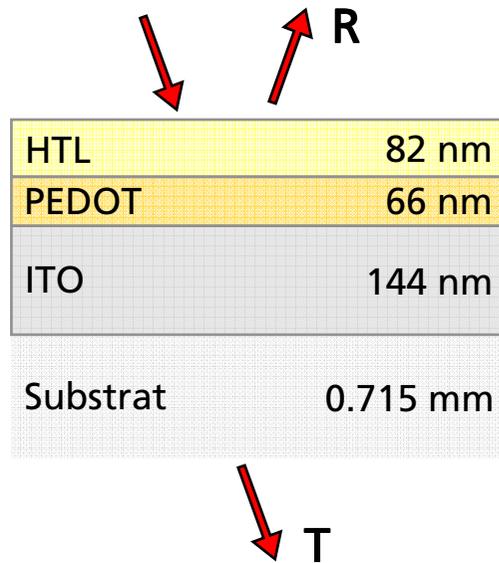
### Lichtauskopplung



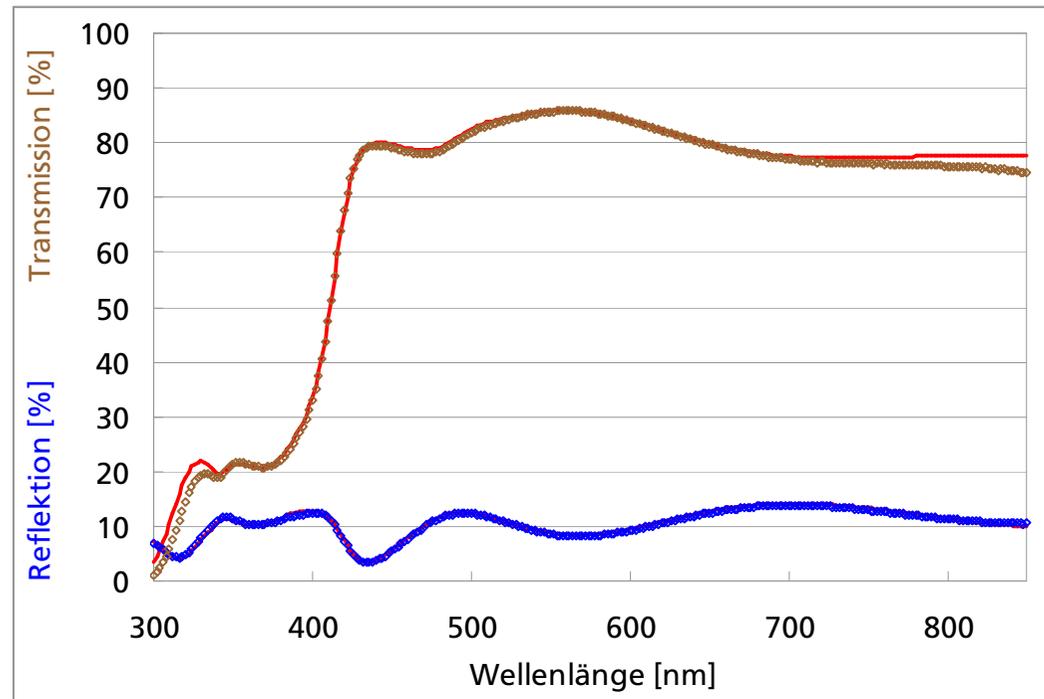
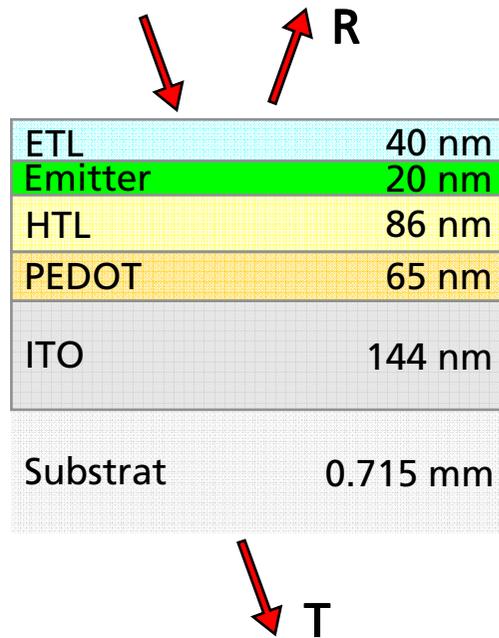
# Optik-Simulation → Dispersionen von OLED-Materialien



Sukzessiver Aufbau einer OLED → System: Substrat – ITO – PEDOT – HTL



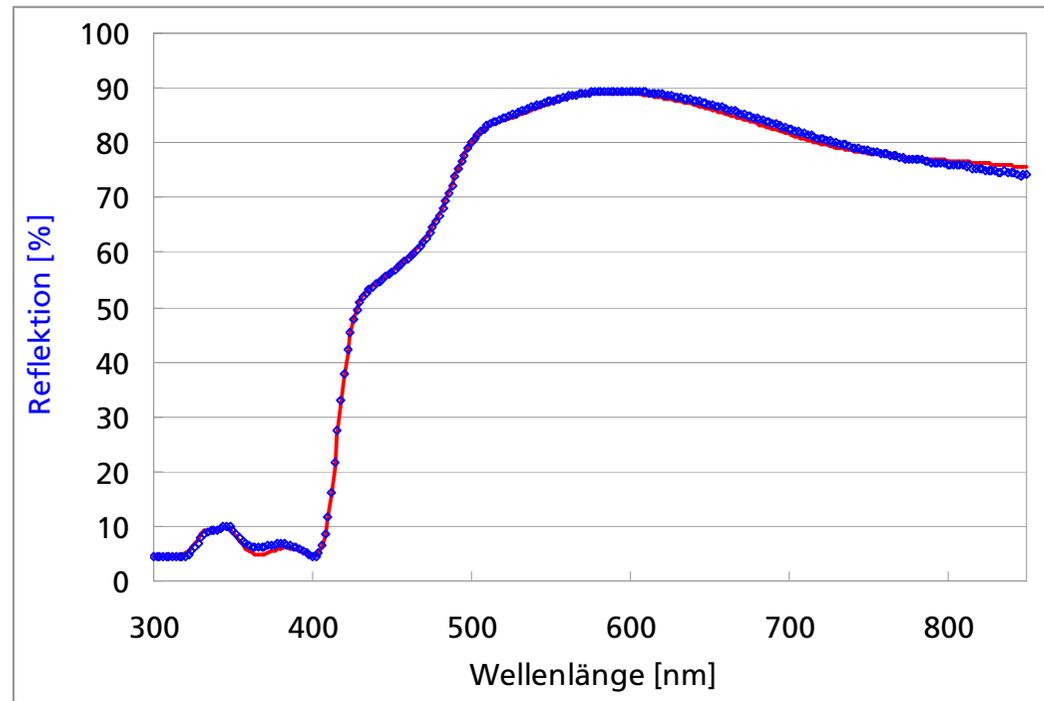
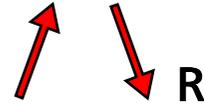
Sukzessiver Aufbau einer OLED → System: Substrat – ITO – PEDOT – HTL – Emitter – ETL



# Verifikation der Dispersionsdaten / Schichtdicken

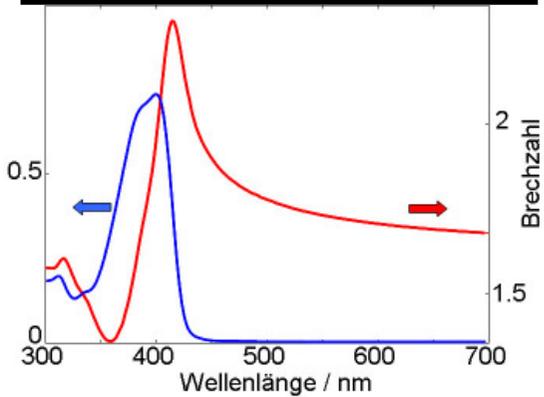
Sukzessiver Aufbau einer OLED → System: Substrat – ITO – PEDOT – HTL – Emitter – ETL – Silber

Silber	150 nm
ETL	40 nm
<b>Emitter</b>	<b>20 nm</b>
HTL	75 nm
PEDOT	65 nm
ITO	144 nm
Substrat	0.715 mm

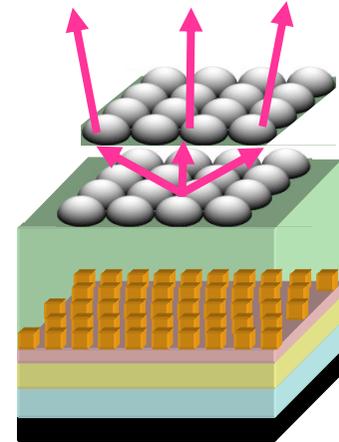


## OLED – Optik

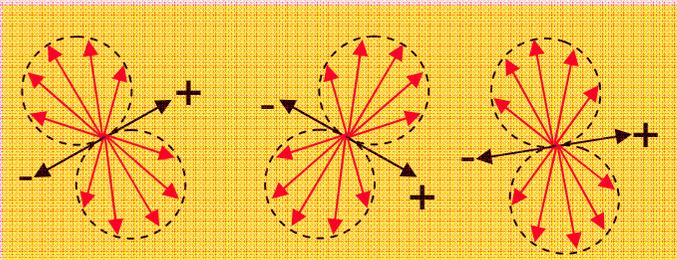
### Charakterisierung des Schichtsystems



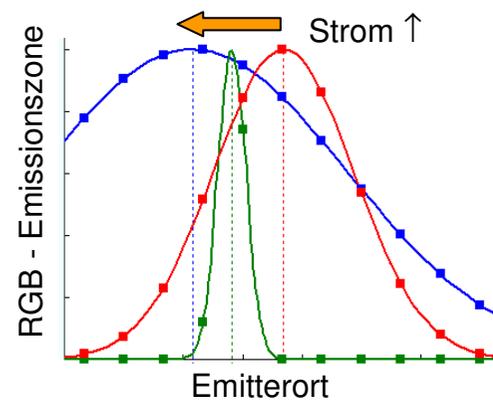
### Lichtmanagement



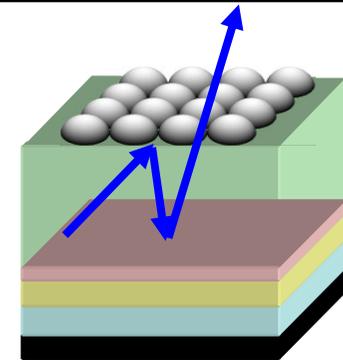
### Charakterisierung des aktiven Materials

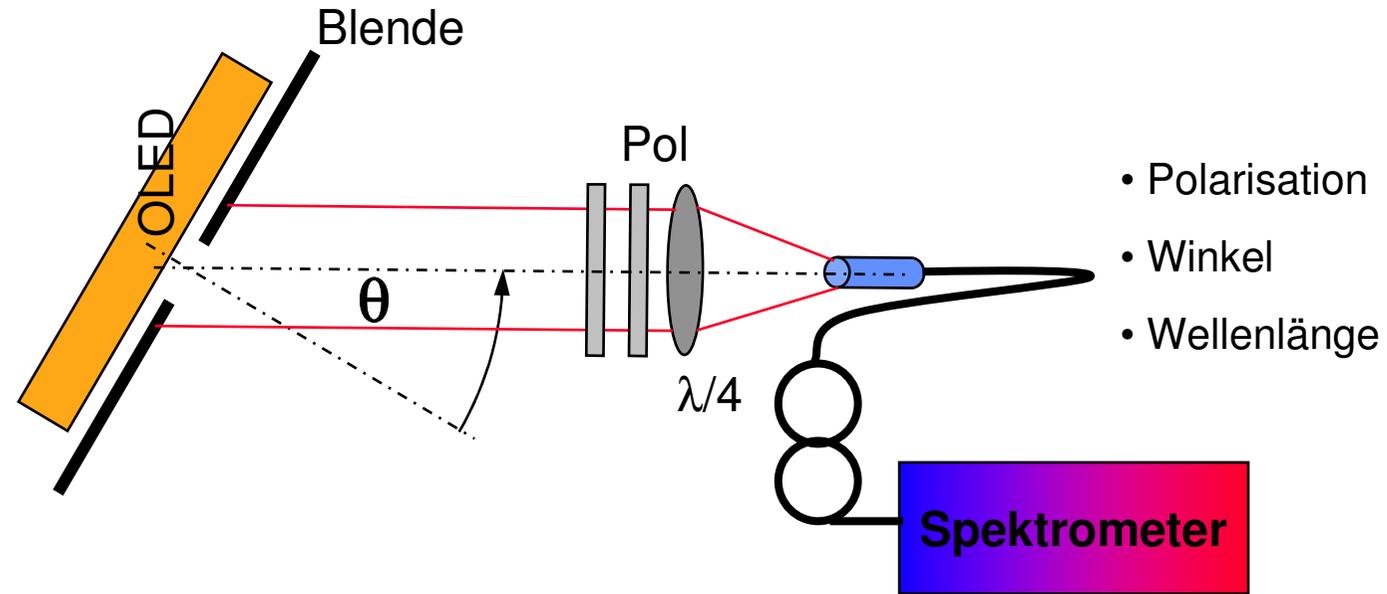


### Beiträge zur Bauteilphysik

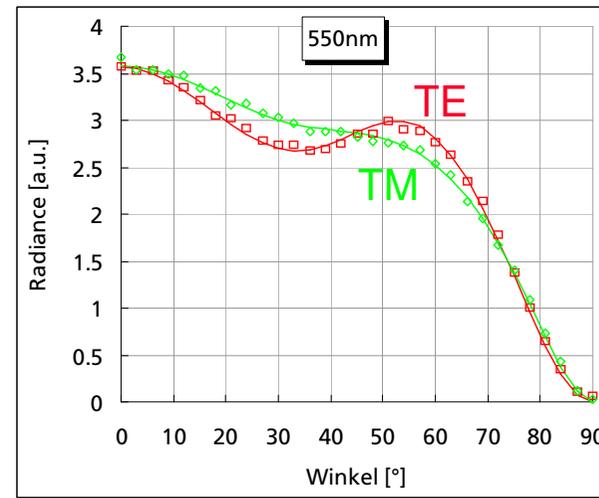
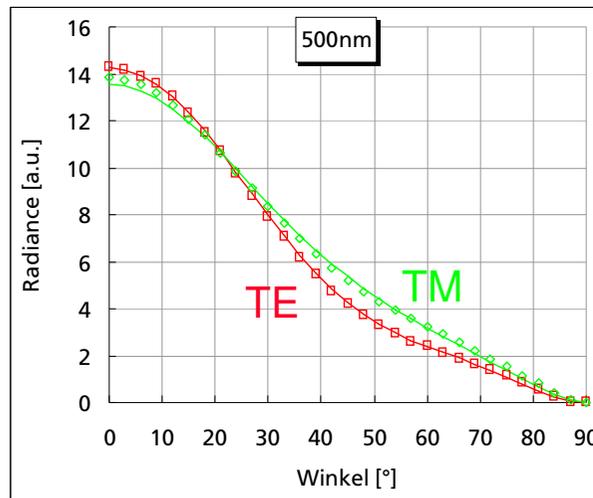


### Lichtauskopplung

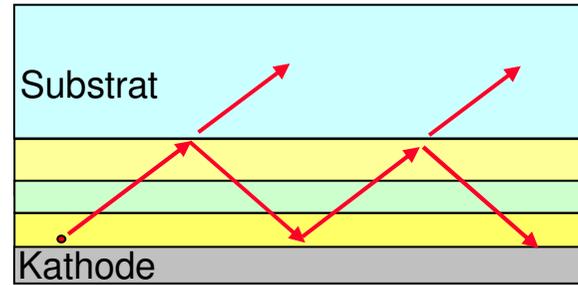
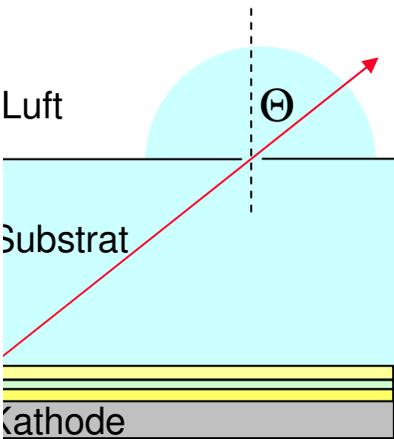




• Vergleich:  
Simulation - Messung



# Winkelabhängige Farbortverschiebung der Substratstrahlung einer weißen OLED



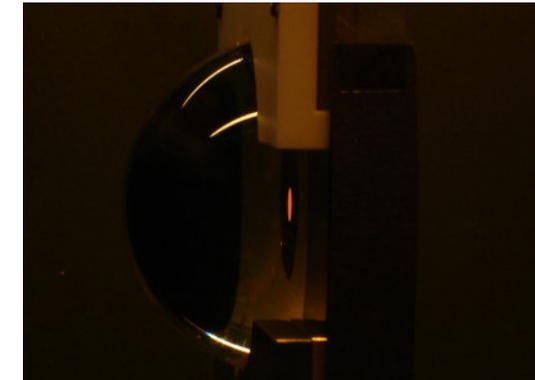
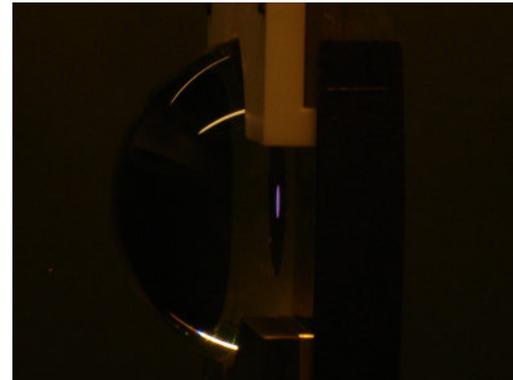
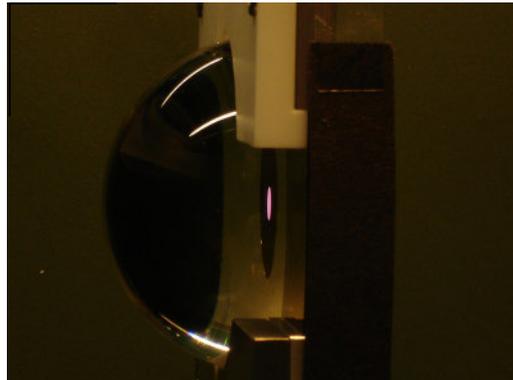
Fabry – Perot – Resonanzen  
= Leckmoden

84 Grad →

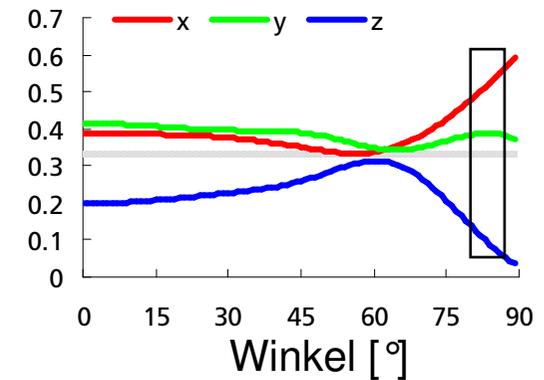
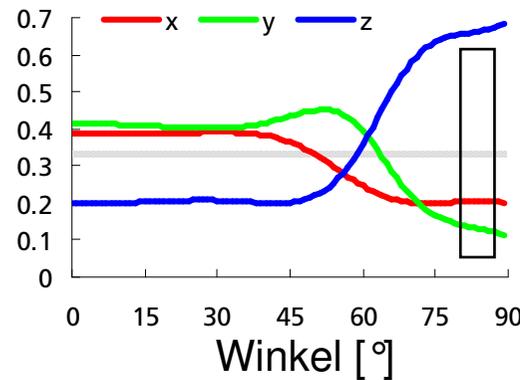
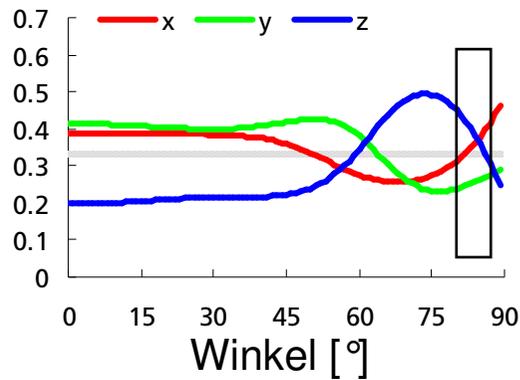
unpolarisiert

TE

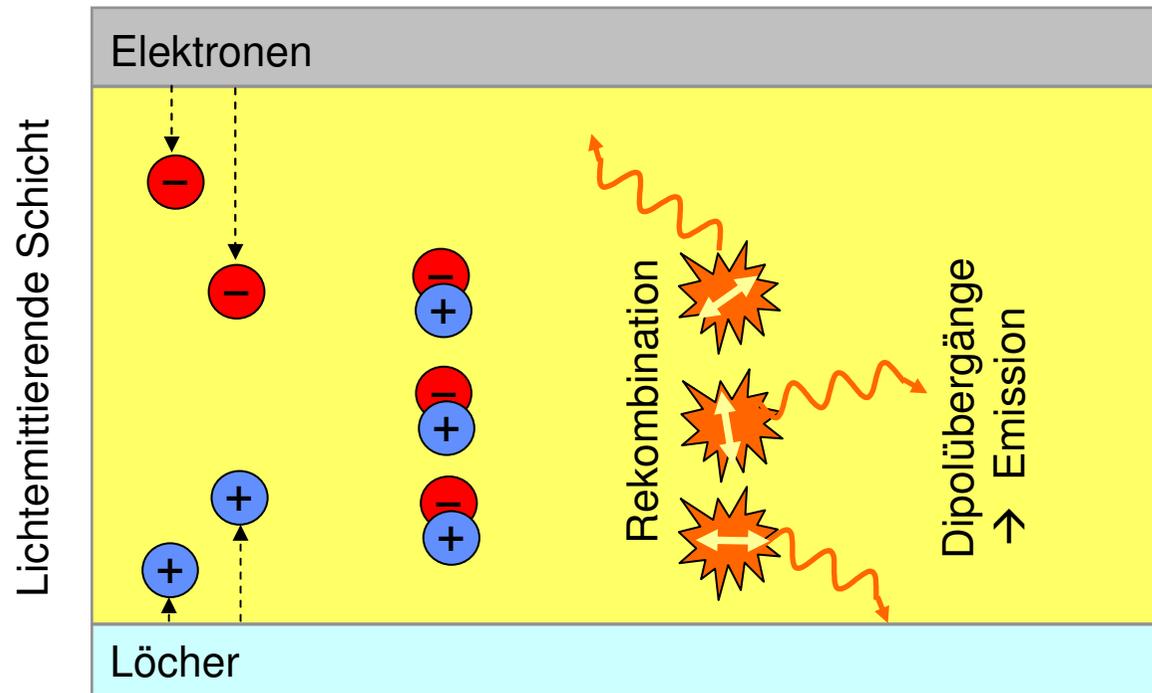
TM



Farbkoordinaten →



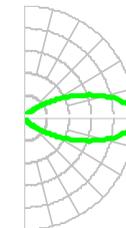
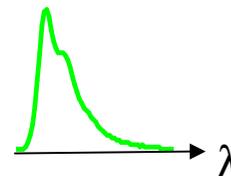
# Optik-Simulation → Eigenschaften von lichtemittierenden Polymeren



Ort der Lichtenstehung  
→ Emissionszone

Spektrum des Lichts  
→ internes EL-Spektrum

Orientierung der Emitter  
→ Dipolorientierungsverteilung



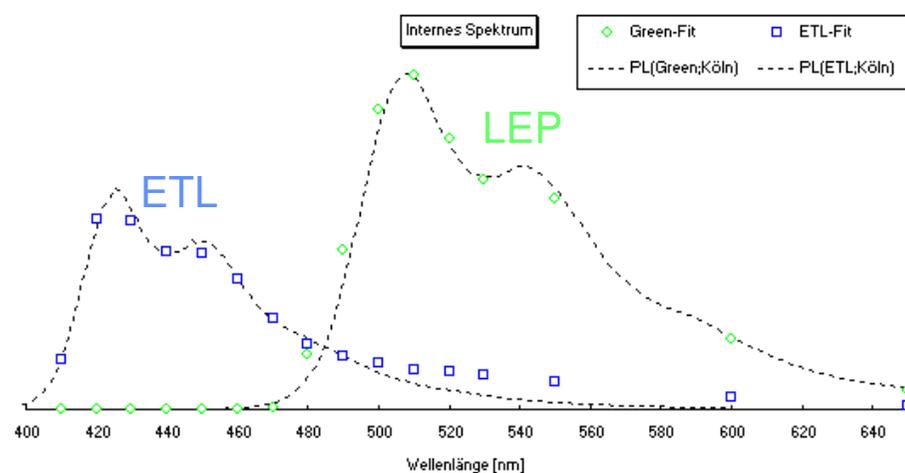
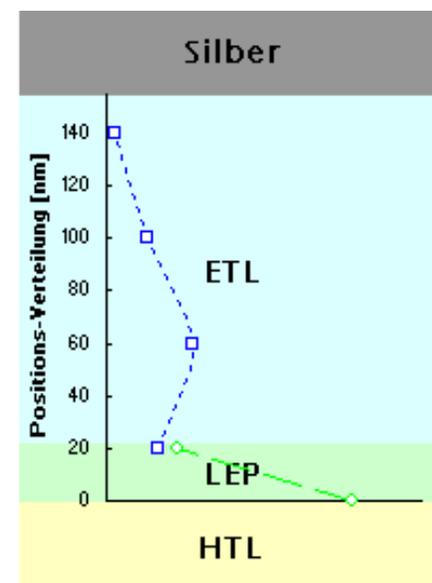
Rückrechnung aus optischen Abstrahlcharakteristiken



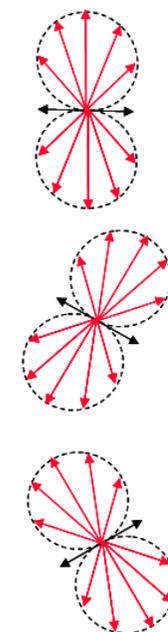
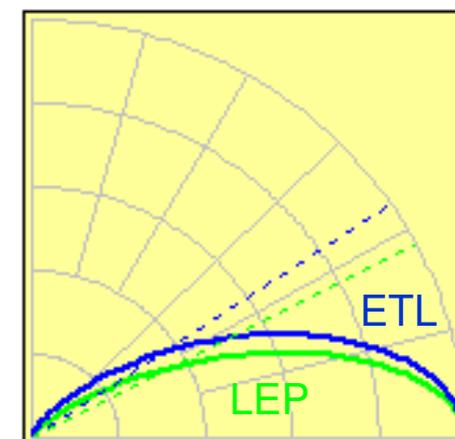
## Norm. Emissionszone

## OLED-interne, normierte EL-Spektren

## Emitterorientierung



## Polardarstellung

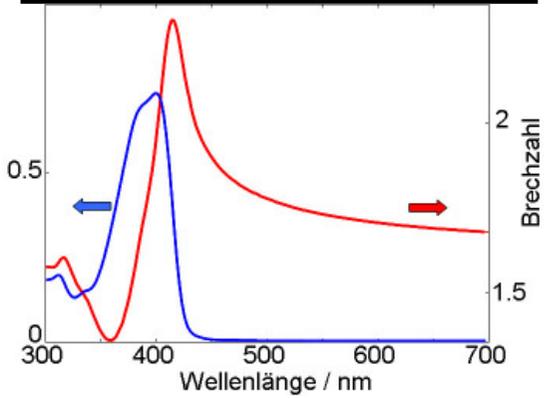


→ Vorzugsrichtung

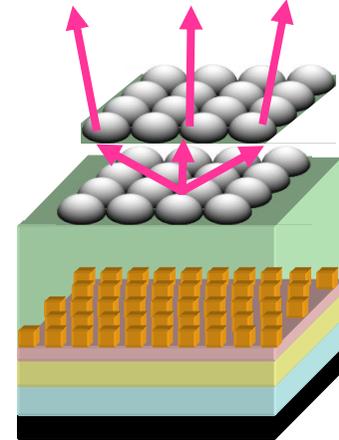
→ Ca. +/- 30 ° Verteilungsbreite

## OLED – Optik

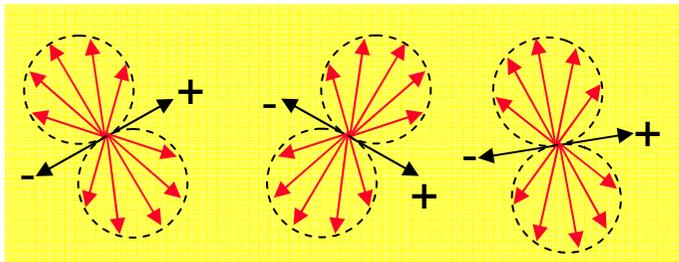
### Charakterisierung des Schichtsystems



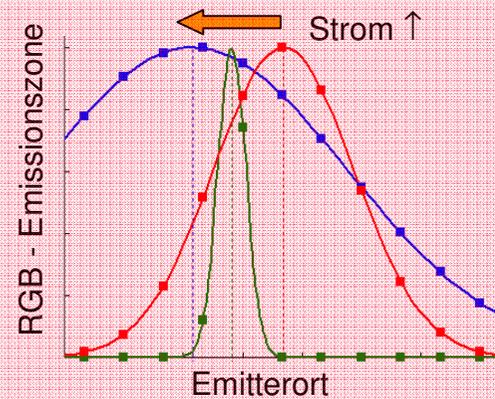
### Lichtmanagement



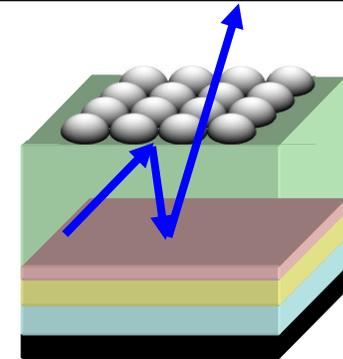
### Charakterisierung des aktiven Materials



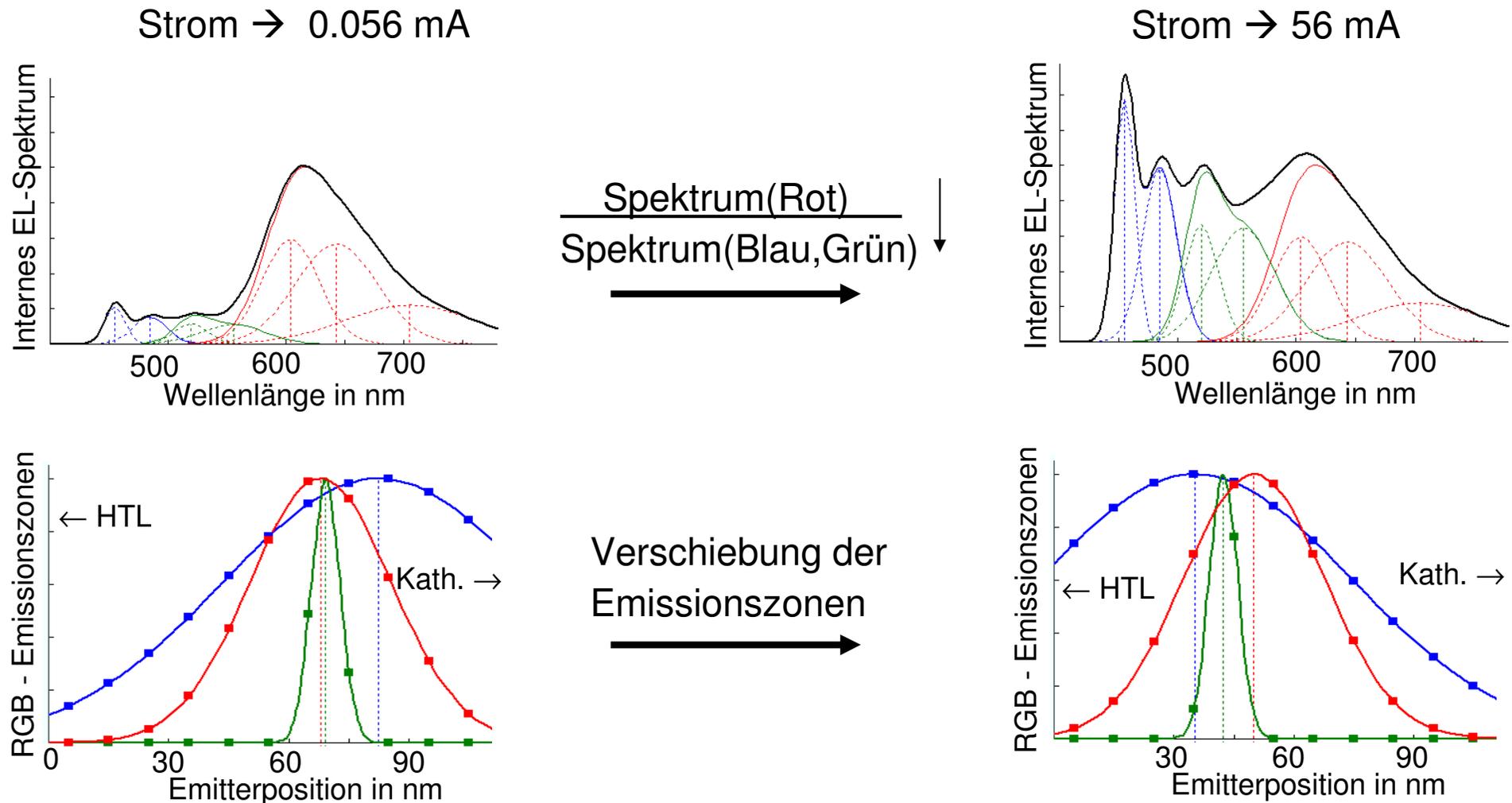
### Beiträge zur Bauteilphysik



### Lichtauskopplung



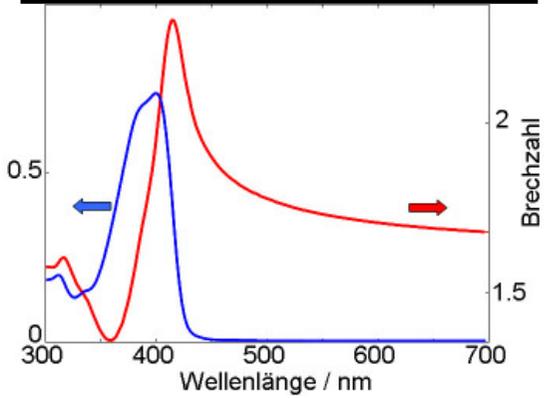
# Stromabhängige Abstrahlung weißer OLEDs



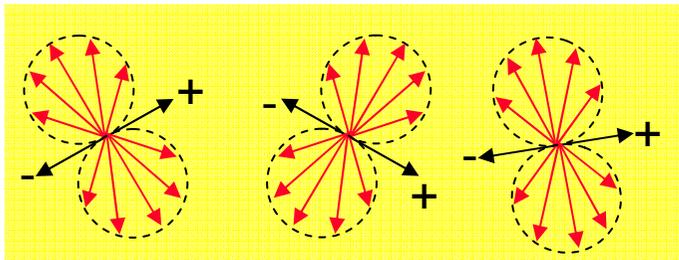
- Informationen für Modellbildung (Elektrik, Energietransfer, ...)

## OLED – Optik

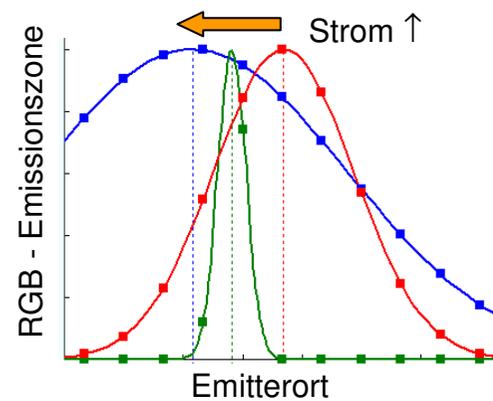
### Charakterisierung des Schichtsystems



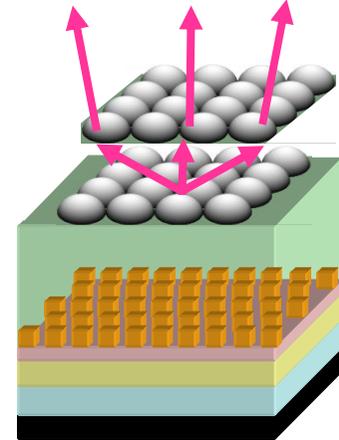
### Charakterisierung des aktiven Materials



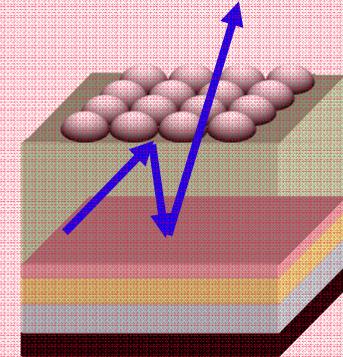
### Beiträge zur Bauteilphysik



### Lichtmanagement

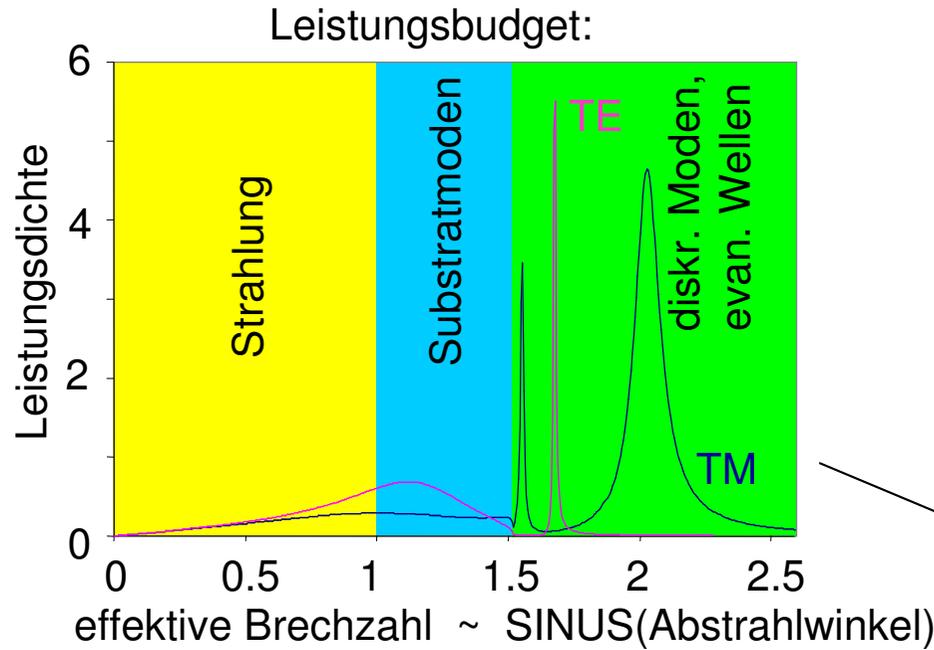


### Lichtauskopplung

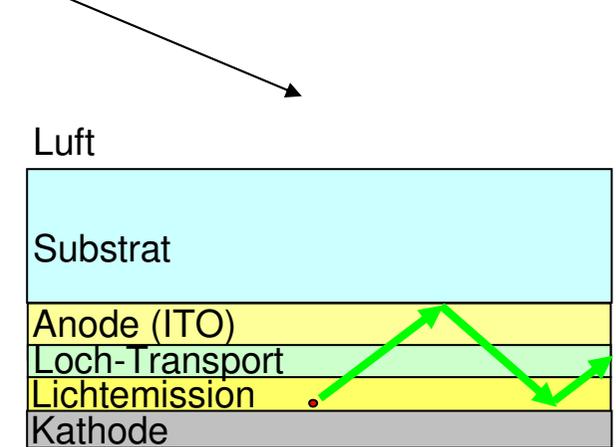
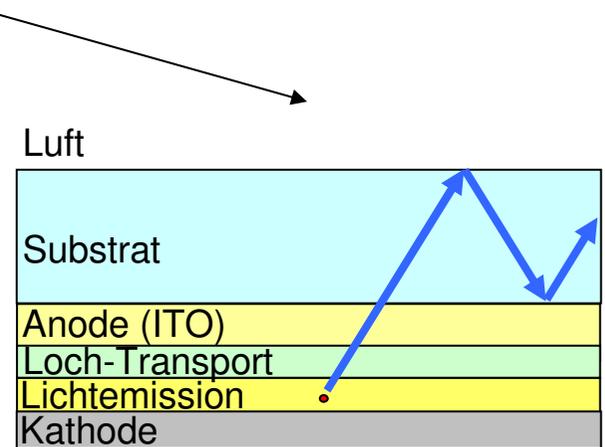
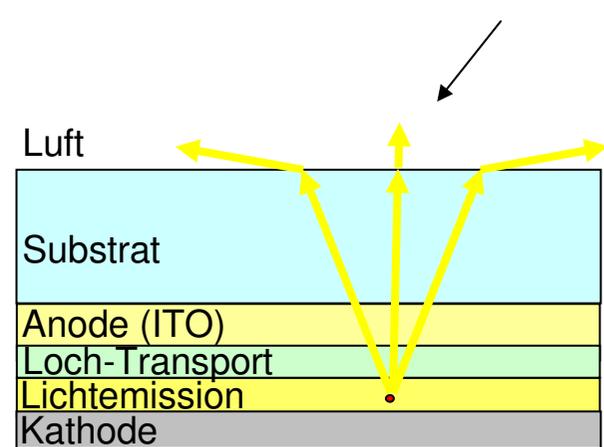


# Leistungsbudget einer homogenen OLED

- Quantifizierung des Leistungsanteils in den verschiedenen Kanälen (Nutzlicht ↔ Verlust)

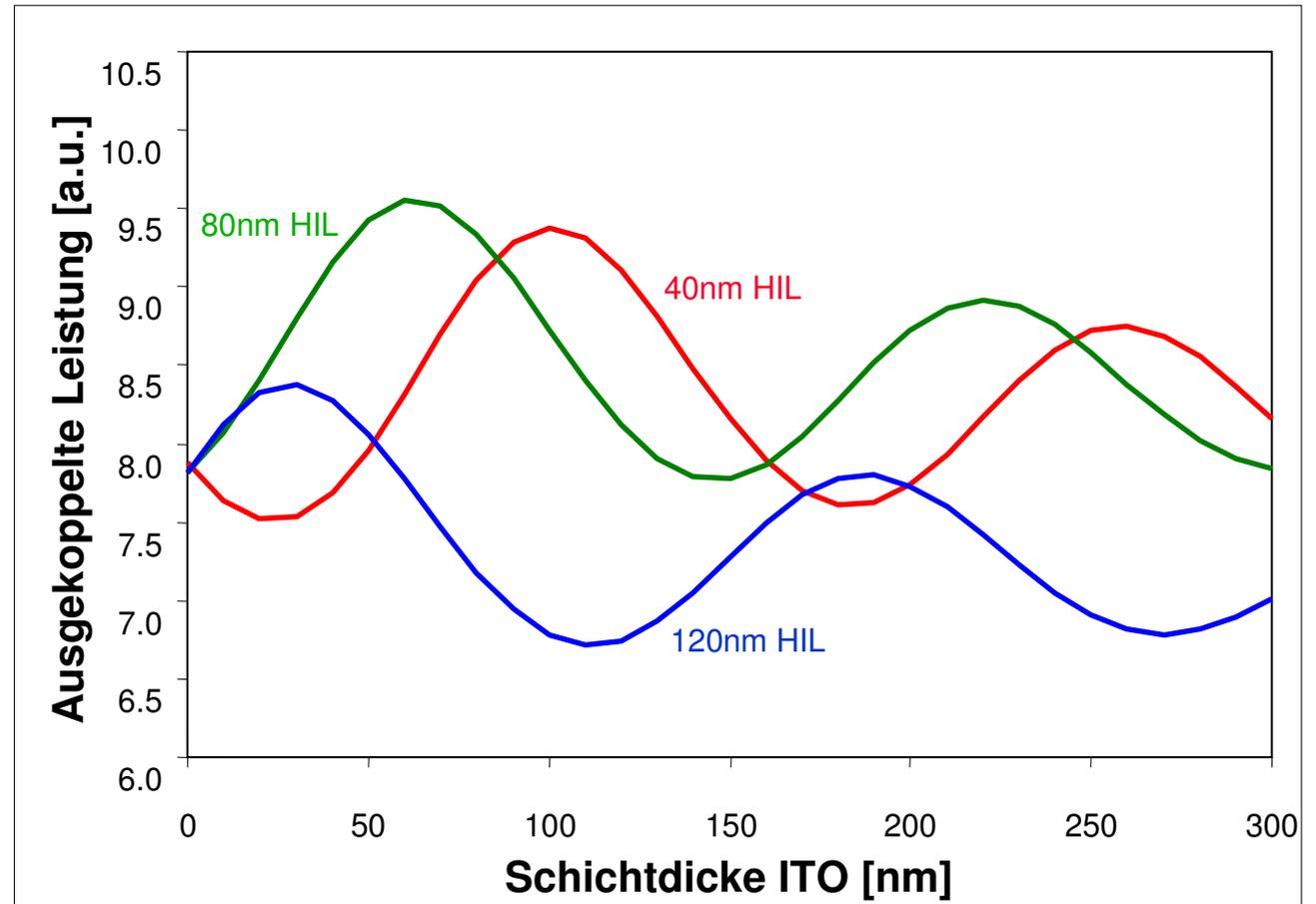
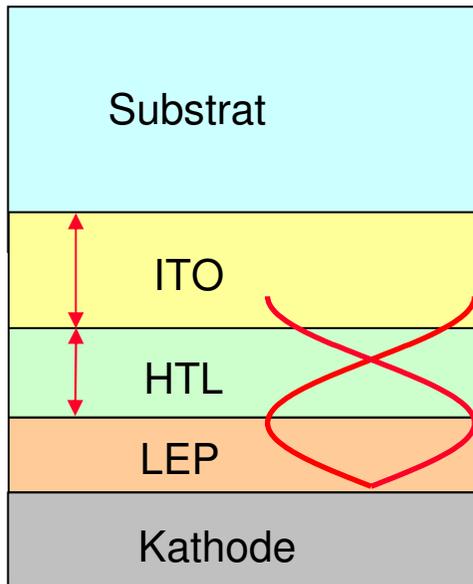


TM: 17% - Strahlung Substrat  
 4% - TM 1 - Mode  
 46% - Plasmonenmode  
 TE: 27% - Strahlung Substrat  
 6% - TE 0 - Mode

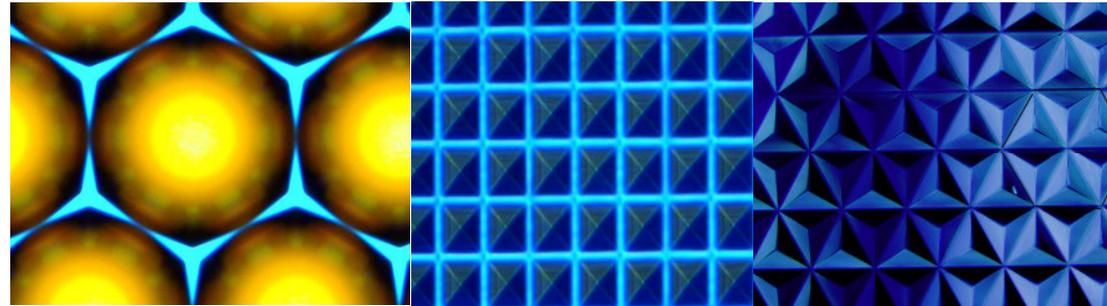


# Interferenzeffekte in homogenen OLEDs

Interferenz – Effekte in OLEDs → Schichtdicken- u. Brechzahloptimierung → Auskopplungserhöhung:

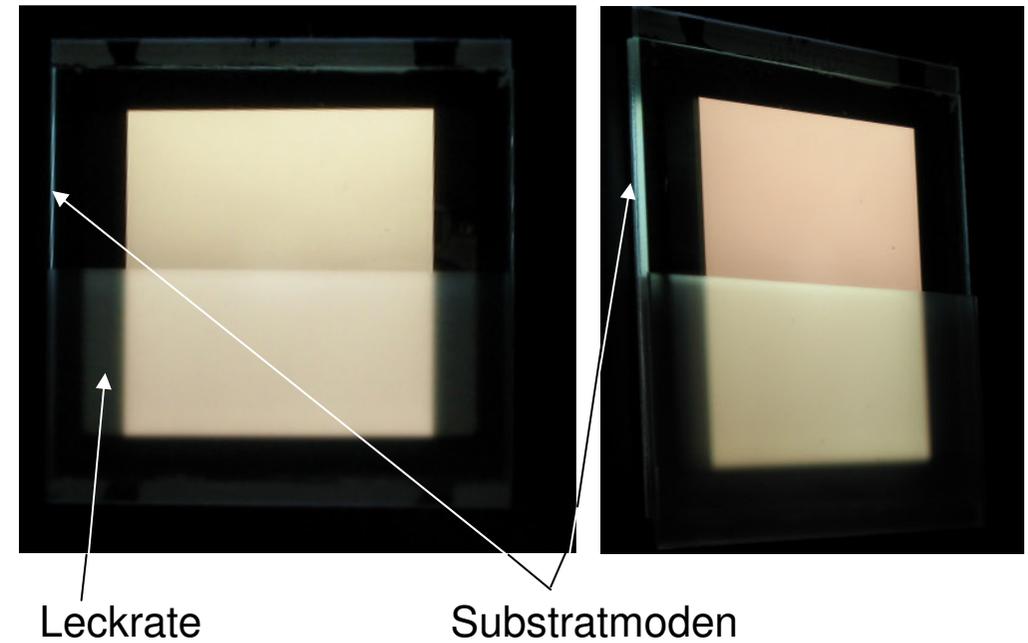
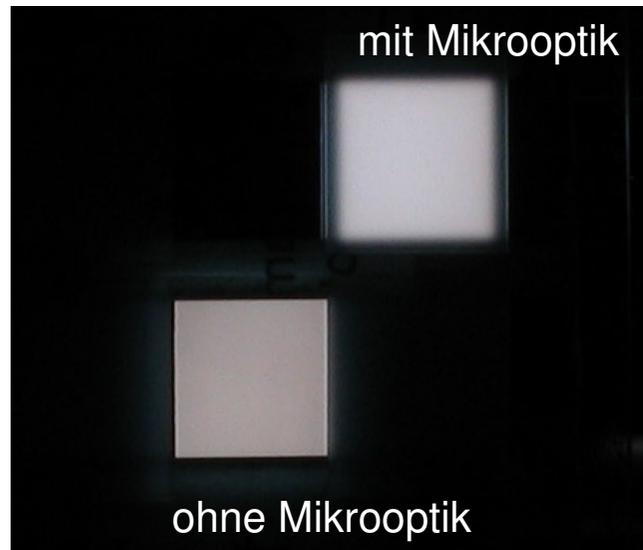


## Beispiele mikro-optischer Strukturen

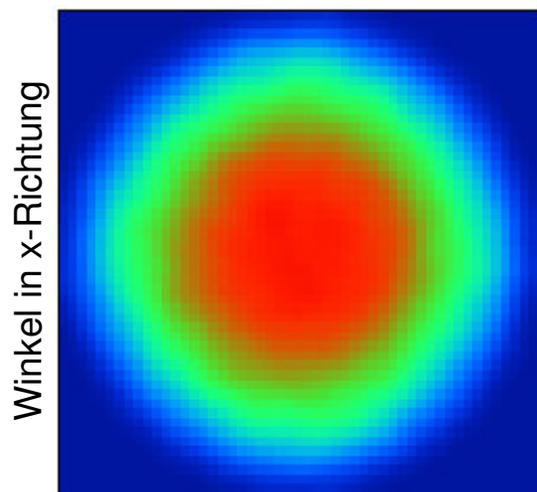
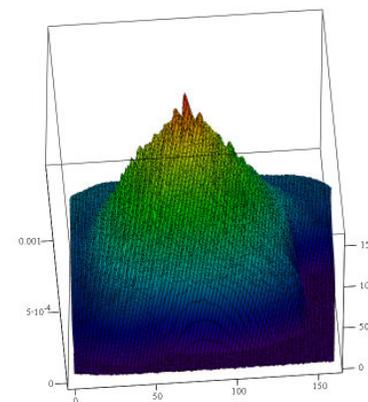
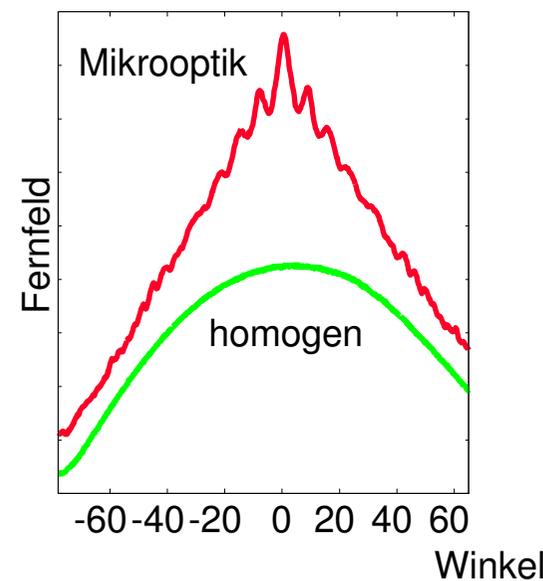
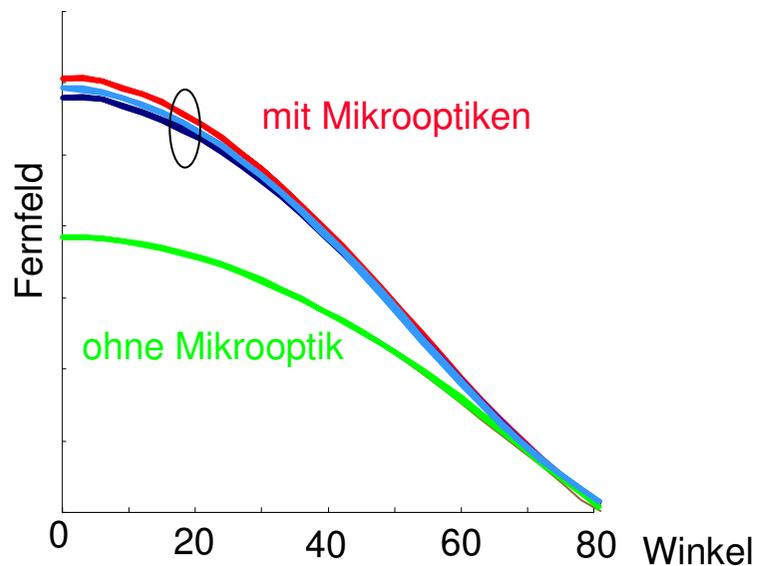


1x1 cm<sup>2</sup> - OLEDs

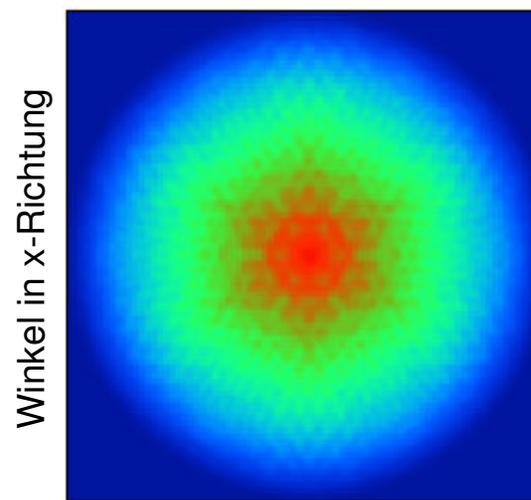
5 x 5 cm<sup>2</sup> - OLED



Abstrahlcharakteristik mit verschiedenen Mikrooptiken:



Winkel in y-Richtung

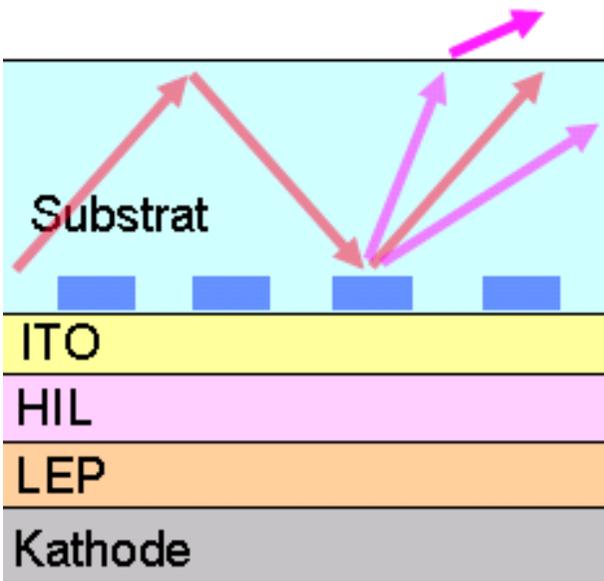


Winkel in y-Richtung

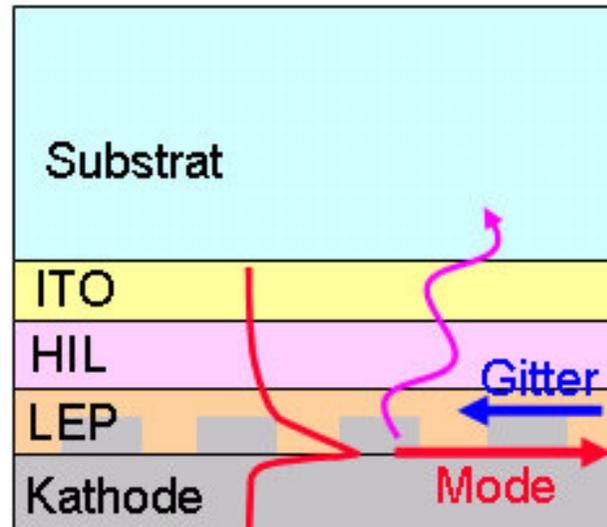


# Wirkung von diffraktiven Strukturen in OLEDs

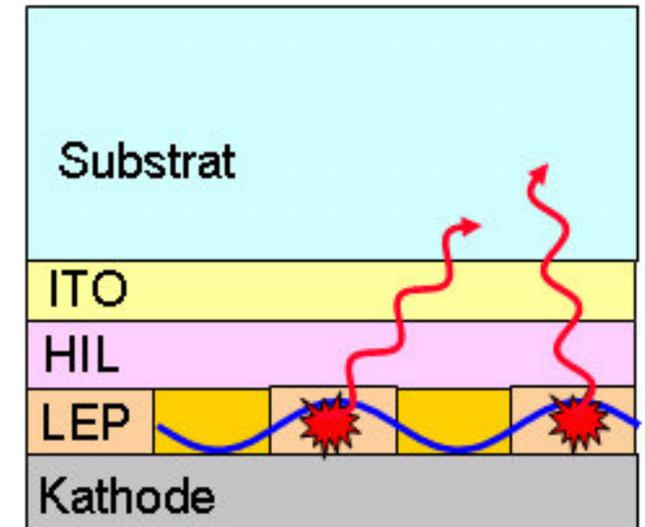
- Substratstreuung:



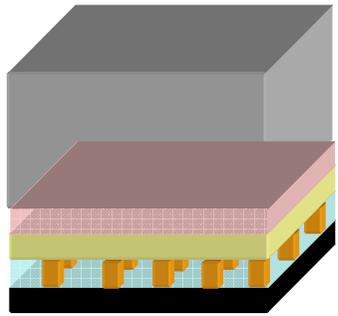
- Fernfeld – Moden – Kopplung:



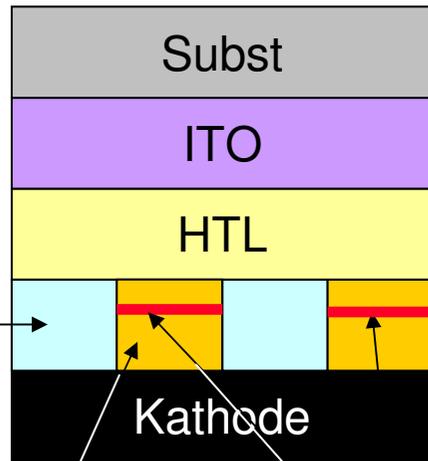
- transversale Feldüberhöhung:



## Aufbau



Rechteck - Symmetrie



nicht-leitend

Subst

ITO

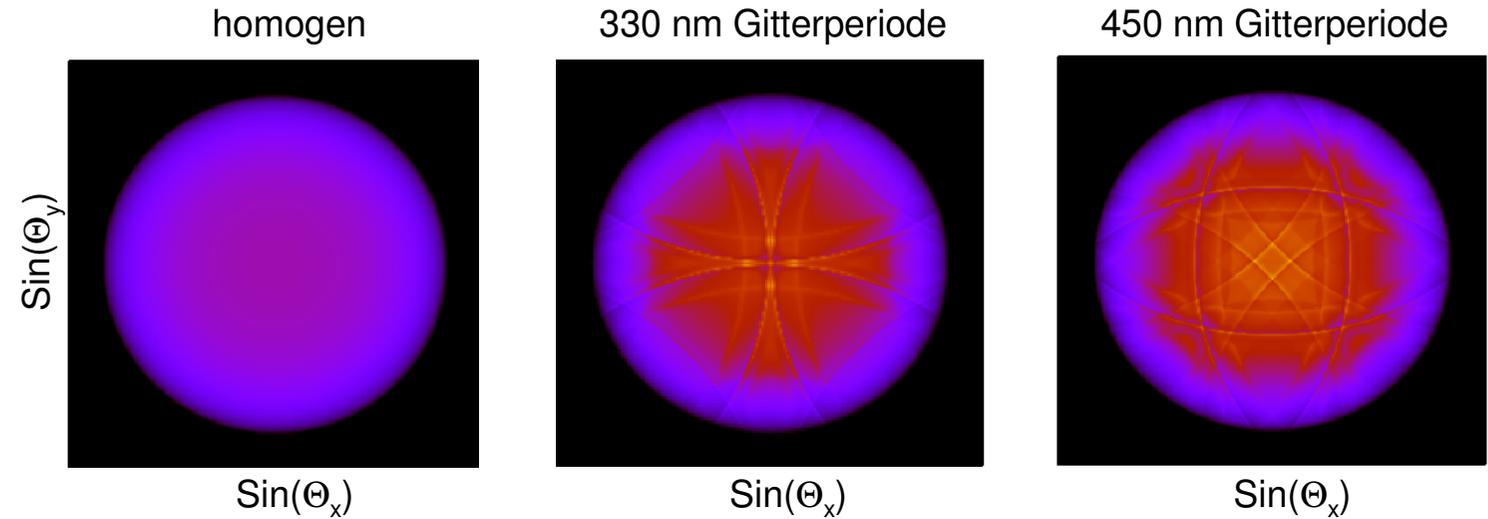
HTL

Kathode

hochbrechend Emission

Emissionszone

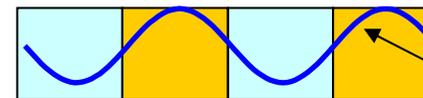
## Abstrahlcharakteristik - Fernfeld



- Substrat – Streuung

- *Feldüberhöhung an Orten der Lichtemission*

→ Eigenmoden = Blochmoden

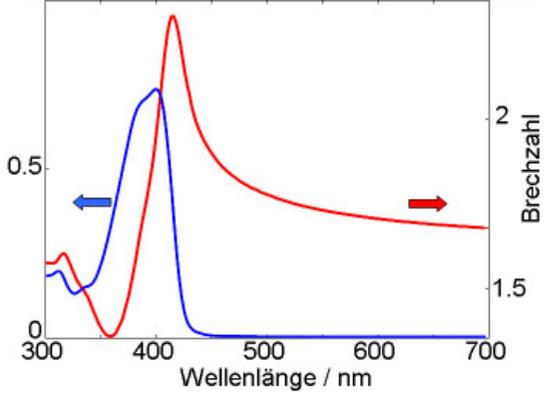


große potentielle Intensitäten

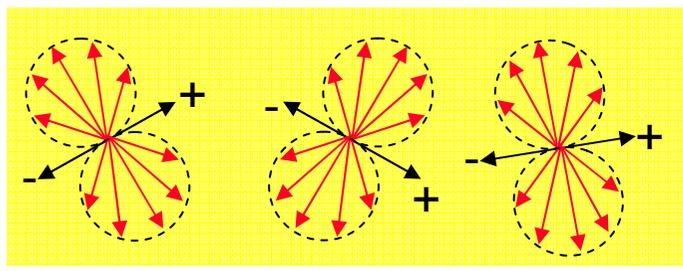


## OLED – Optik

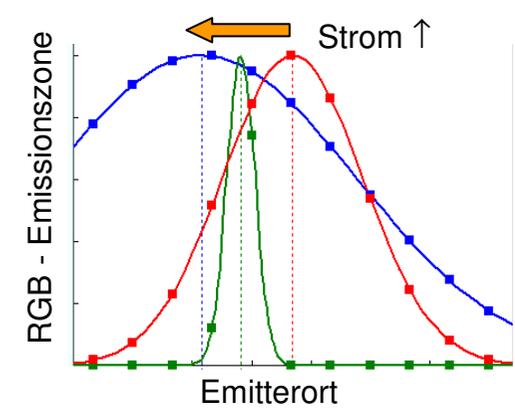
### Charakterisierung des Schichtsystems



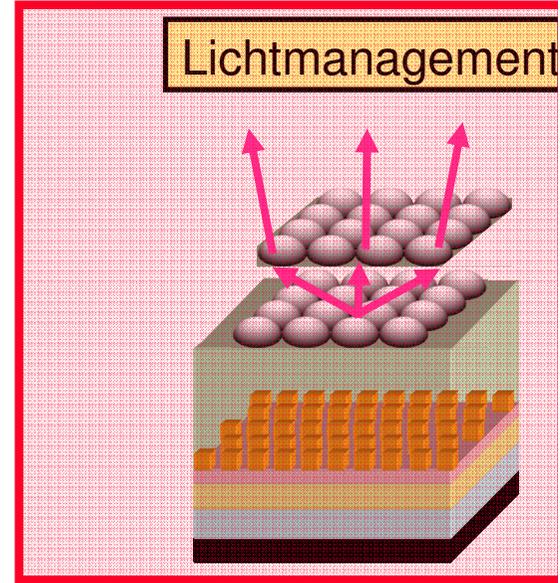
### Charakterisierung des aktiven Materials



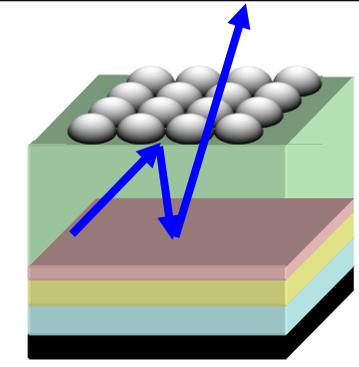
### Beiträge zur Bauteilphysik



### Lichtmanagement

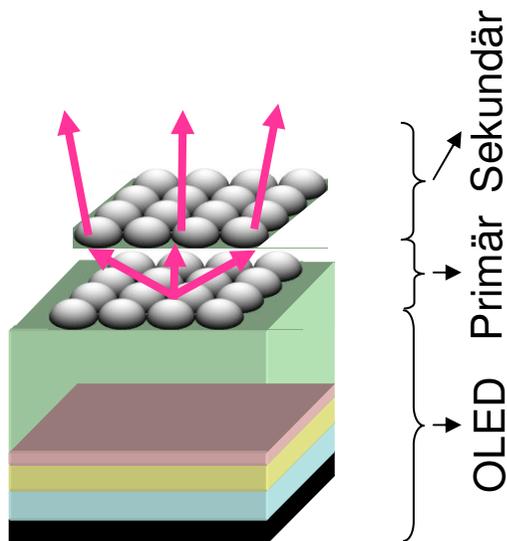


### Lichtauskopplung

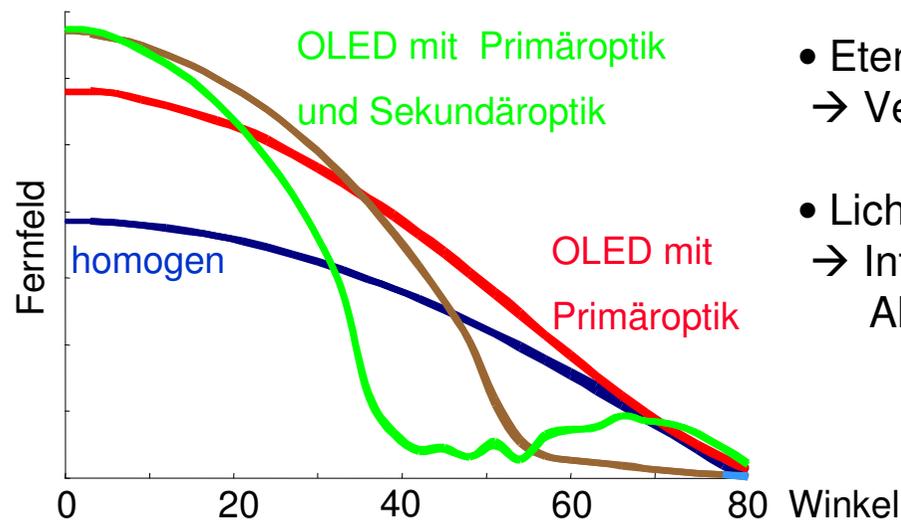


# Lichtmanagement: Weiße OLED mit Primäroptik und Sekundäroptik

Schemaskizze

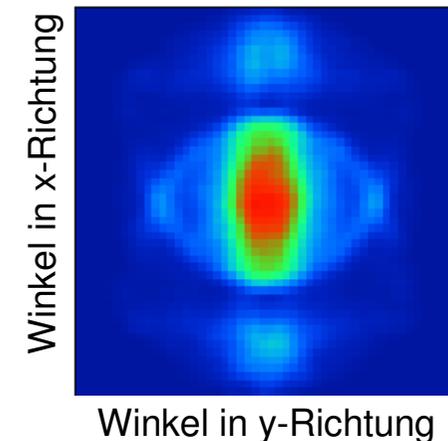
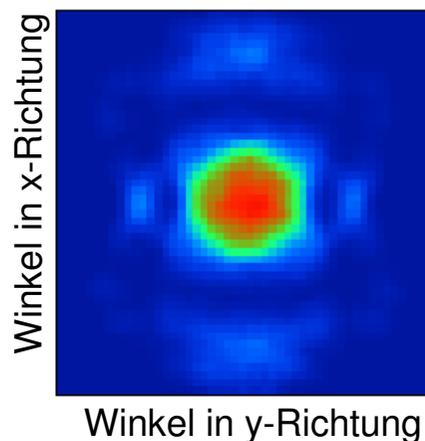
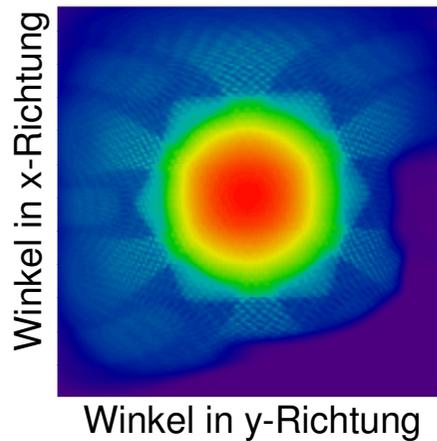


Abstrahlcharakteristik



- Etendue-Erhaltung  
→ Verlust an Gesamtleistung
- Lichtrecycling + „Fokussierung“  
→ Intensitätserhöhung im Akzeptanzwinkelbereich

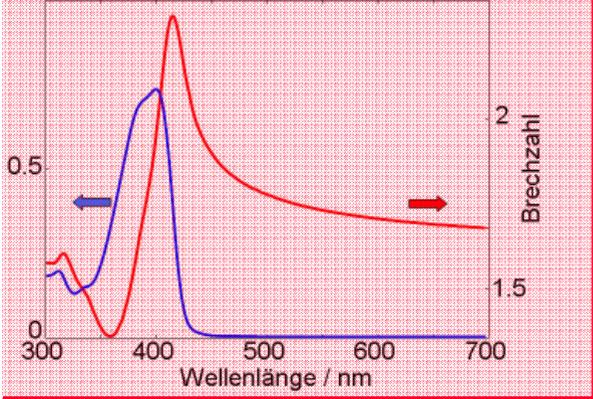
Verschiedene Primär- und Sekundäroptiken



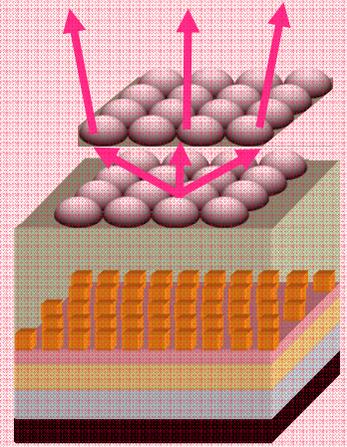
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## OLED – Optik

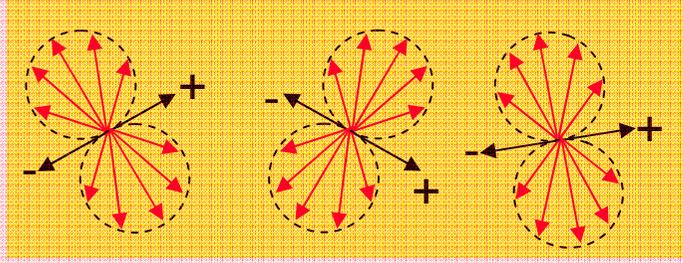
### Charakterisierung des Schichtsystems



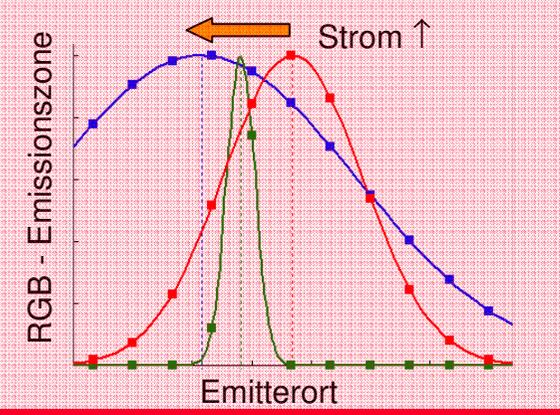
### Lichtmanagement



### Charakterisierung des aktiven Materials



### Beiträge zur Bauteilphysik



### Lichtauskopplung

