ITO-free transparent top electrode for top emitting OLEDs

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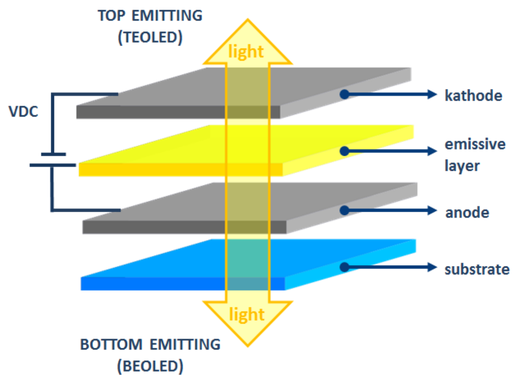
Introduction

Structure Organic Light Emitting Diode (OLED)



Problems with Indium Thin Oxide (ITO) [1]

ITO

- Expensive
- Crack formation
- Can not be a top electrode

Alternatives

Semi-transparent thin metal layers [2]

Metal grids [3]

Experimental

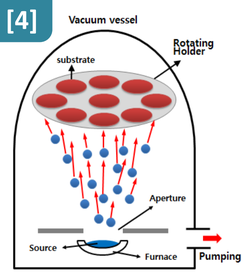
Au layers

Layer thickness: 1; 2,5; 5; 7,5; 10; 15 nm

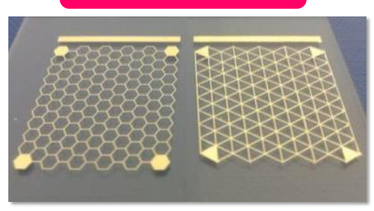
Dimensions:
20 mm by 25 mm

On glass substrates

Thermal evaporation [4]



Ag grids

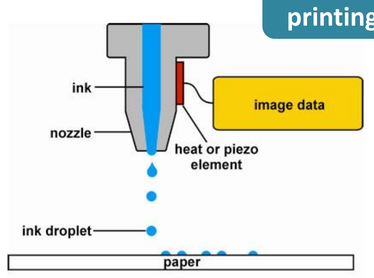


Layers thickness: 150-250 nm

Dimensions:
Hex and tri: $r_{outer\ circle}$ = 0,87-1,25 mm
Line: thickness 10 nm, line spacing of 150-240 nm

On glass substrates

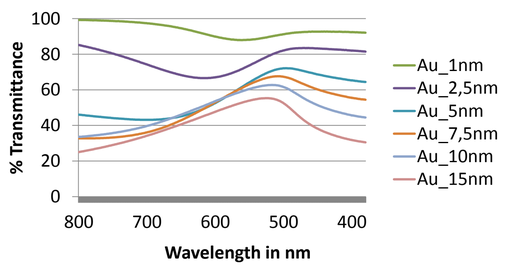
Ink jet printing [5]



Results

Au layers

Transmittance



Conductivity

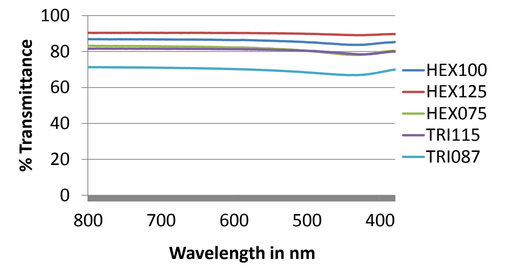
	Rs (Ω/□)
Au 1nm	> 20 M
Au 2,5nm	> 20 M
Au 5nm	> 20 M
Au 7,5nm	123,7
Au 10nm	11,5
Au 15nm	3,2

Layer thickness

1-15 nm

Ag grids

Transmittance



Conductivity

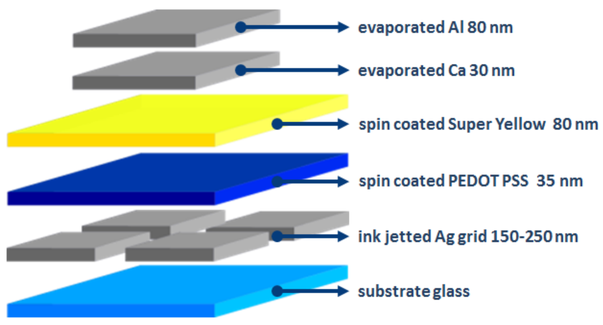
	Rs (Ω/□)
HEX125	2,7
HEX100	1,5
HEX075	1,5
TRI115	1,2
TRI087	0,82

Layer thickness

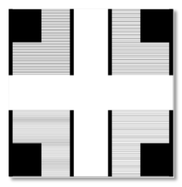
150-250 nm

BEOLED with Ag grid

Structure



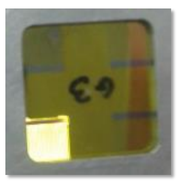
Ag line grid



Patterned grid to prevent shorting
Sintered at 200 °C

Problem with TEOLED!
Other layers damaged by sintering! *

Working OLED



Lower light intensity and efficiency than ITO OLED

Optimization structure and thickness layers necessary!

Conclusions

Au layers ⇔ **Ag grids**

Ag grids: - higher transmittance and conductivity
- faster and less expensive technique (ink jet printing)
Au layers: - thinner and smoother layers

➡ Ag grids best option

BEOLED with Ag grid

BEOLED with grid: - works
- lower light intensity and efficiency than ITO OLED

➡ Optimization structure and thickness layers necessary
➡ Sintering Ag grid without damaging other layers TEOLED

* For more information about sintering and ink jet printing, check out the poster 'Ink jet printing and sintering of silver patterns on several substrates' from Glen Vandevenne

References
[1] Y.C. Han et al. (2013), Organic electronics , 14 (12), pp 3437-3443
[2] G.W. Hyung et al. (2012), Journal of nanoscience and nanotechnology, 12 (7), pp 5444-5448
[3] Hong et al. (2013), ACS Nano, 7 (6), pp 5024-5031
[4] Nalyeon, "Thermal evaporation" [Online]. Available: http://marriott.tistory.com/73
[5] Image Permanence Institute, "Ink jet" [Online]. Available: http://www.dp3project.org/technologies/digital-printing/inkjet

POLEOT printing of light emitting devices on textile
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