TCAD Simulation of AMOLED/TFT Crosstalk & Interference Effects

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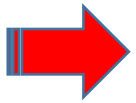
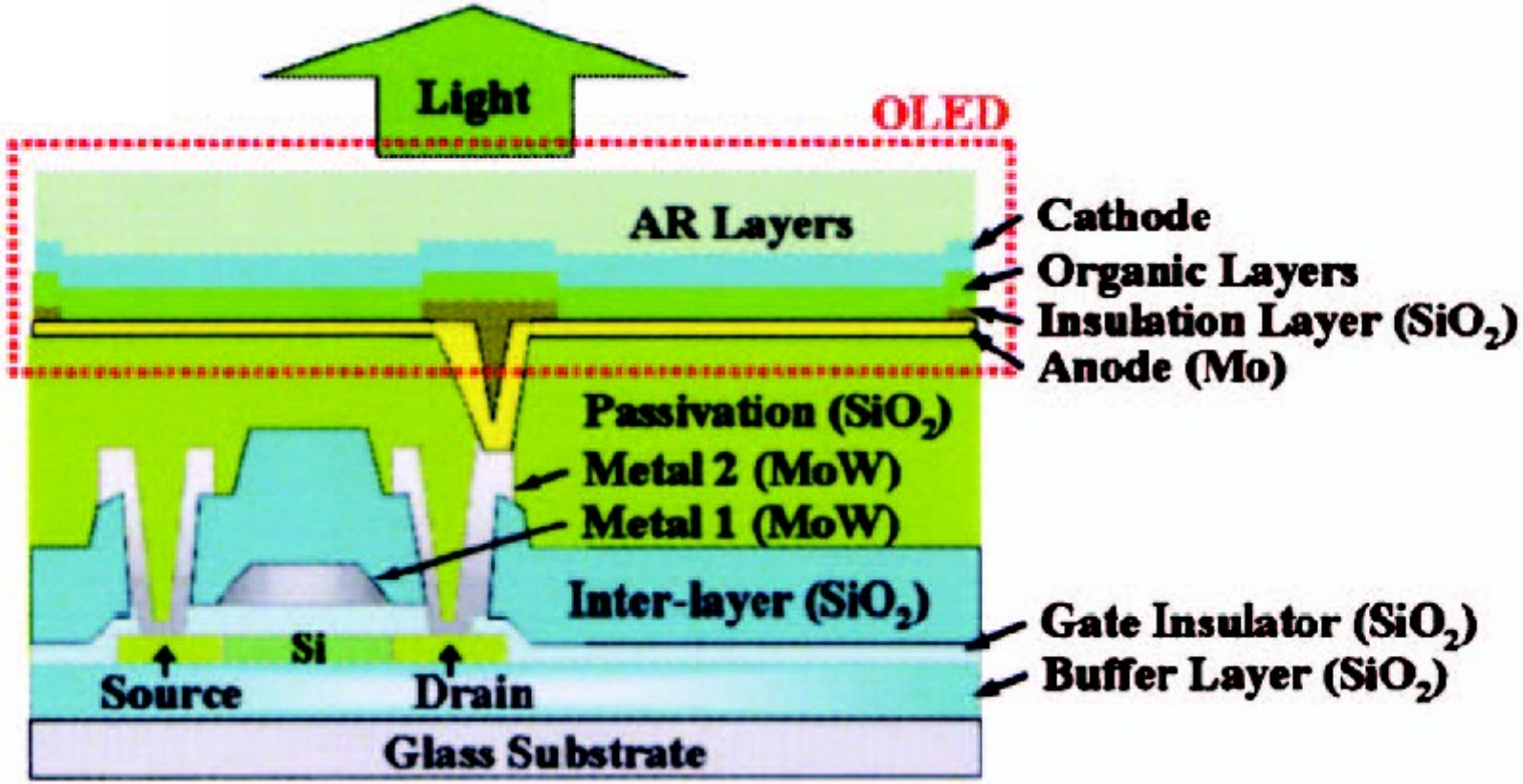
Contents



- Intra-pixel electrical interference in TFT
- Inter-pixel optical interference in AMOLED
- Summary

TCAD tool requirement needs to handle large area device with hundreds or thousands of um in lateral sizes while vertical features are of nm sizes.



Ref: Yang et. al, APL 87, 143507 (2005)

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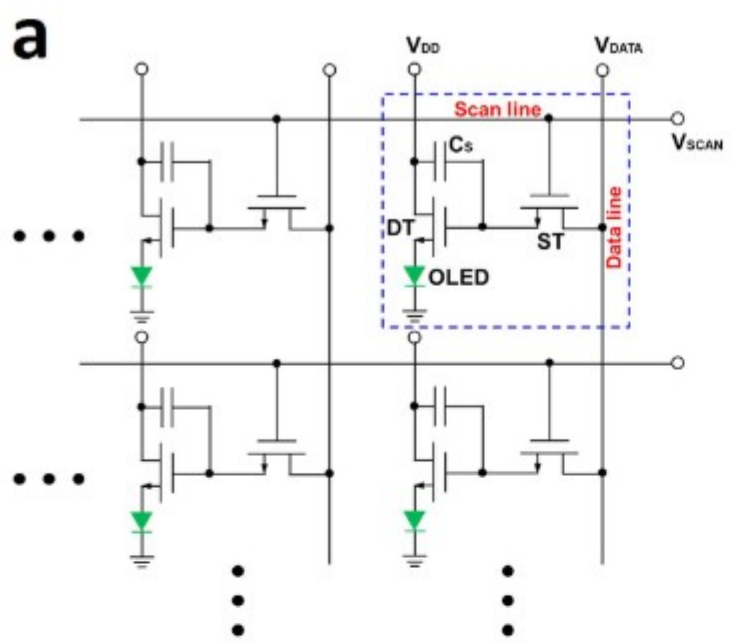
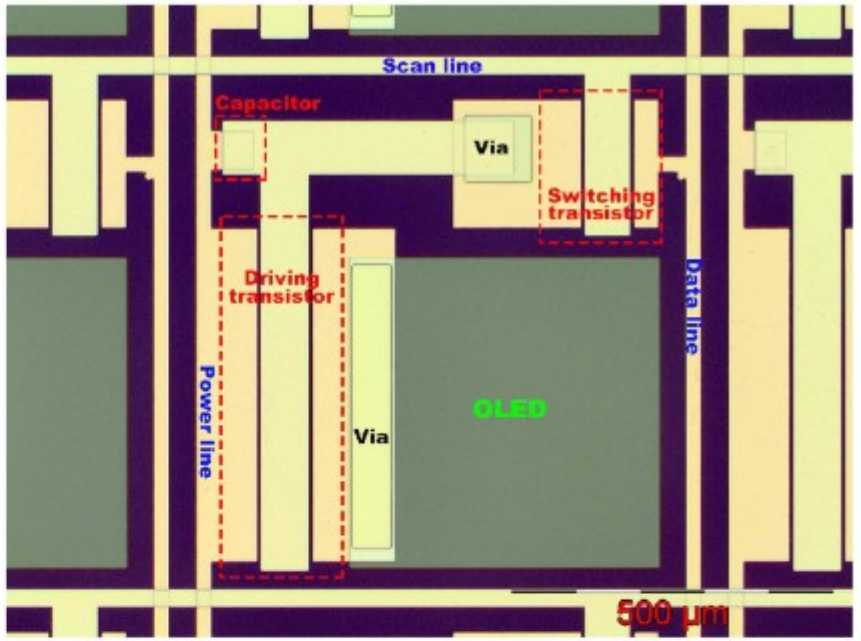
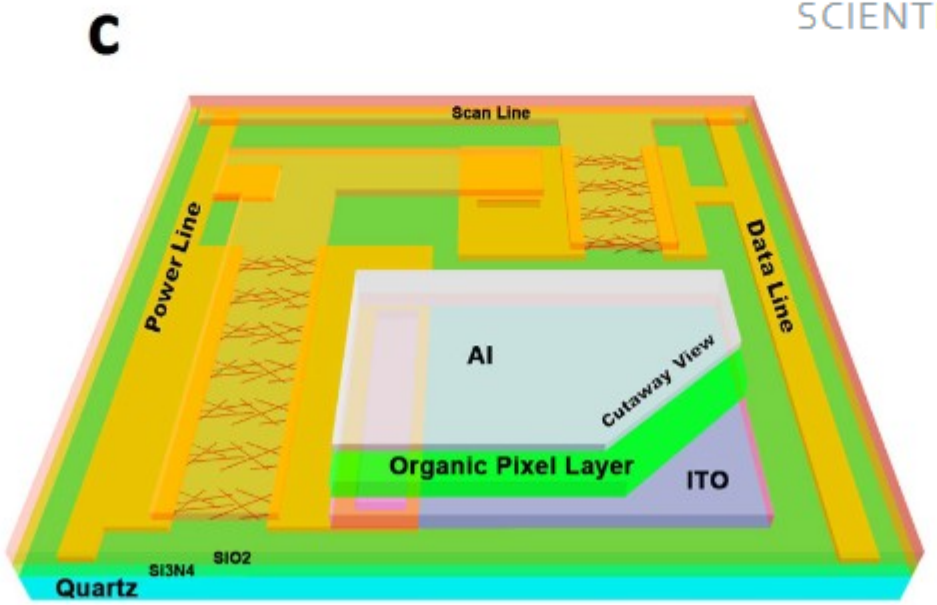
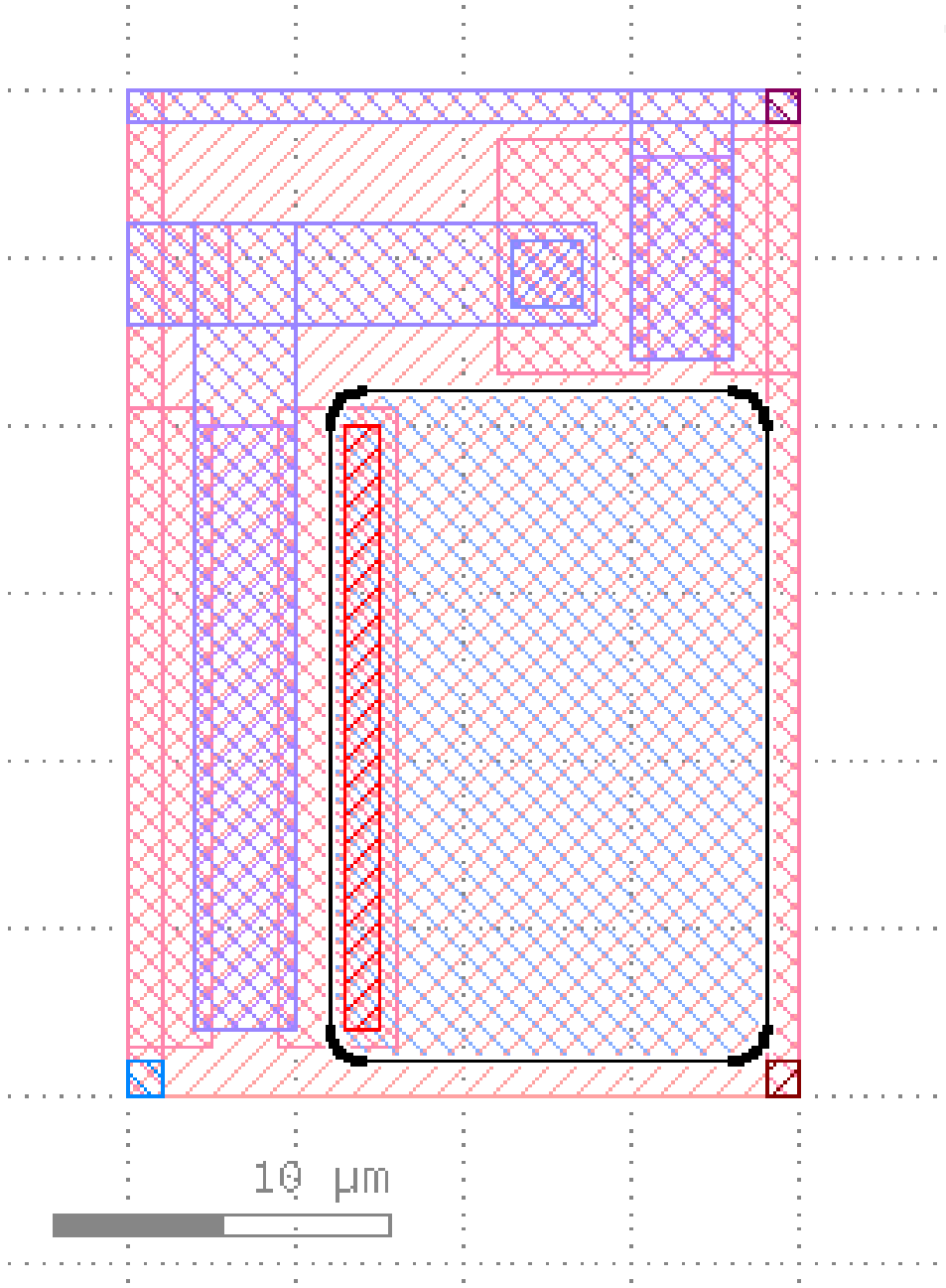




Reference TFT driver circuit for a AMOLED pixel

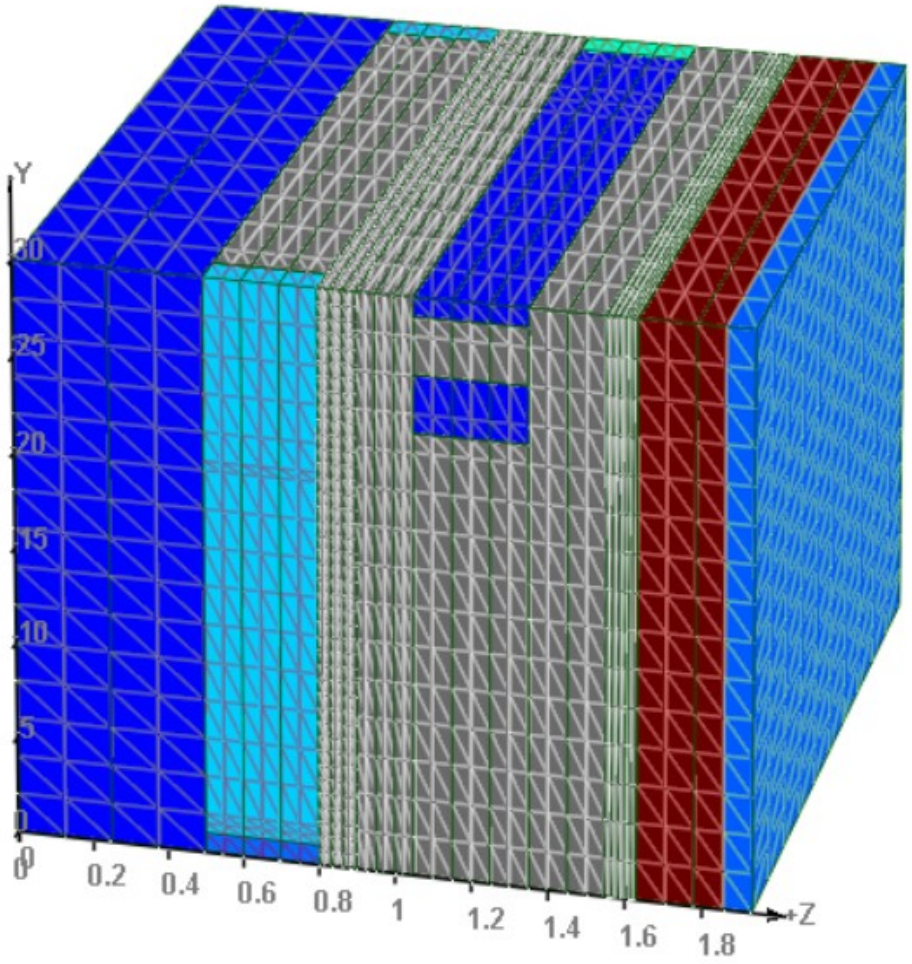


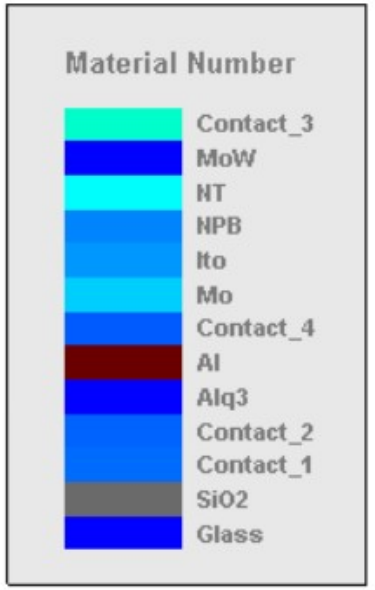
SCIENTIFIC REPORTS | 5:11755 | DOI: 10.1038/srep11755



0/0
1/0
2/0
3/0
4/0
5/0
6/0
11/0
12/0
13/0

lay1=S/D
channel-lay2
lay3=G
lay4=via between SD/G
(S/D also power line and data line, G also scan line)
lay5 OLED(ITO/OL)
lay6 Via between OLED and S/D
lay11/12/13 are contacts





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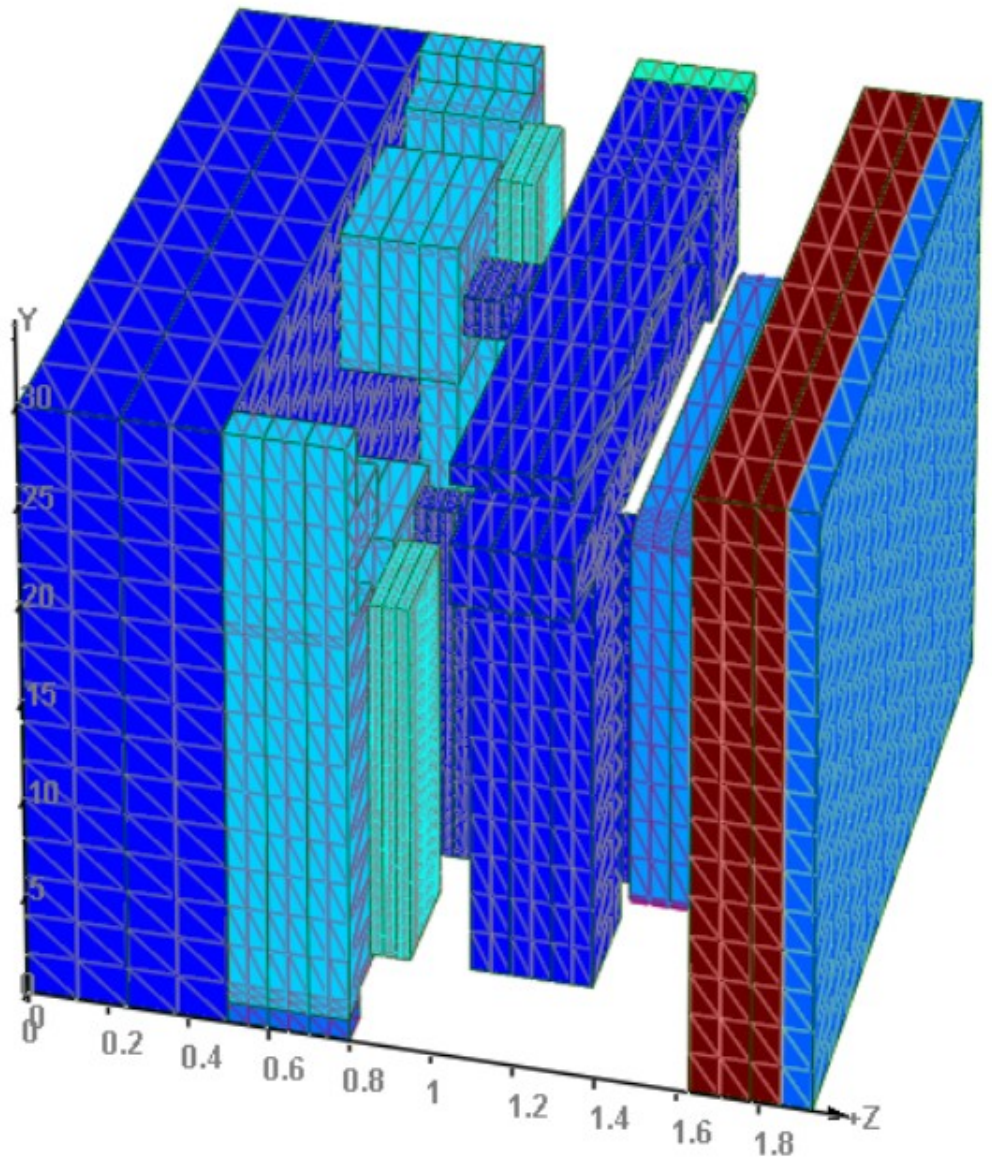

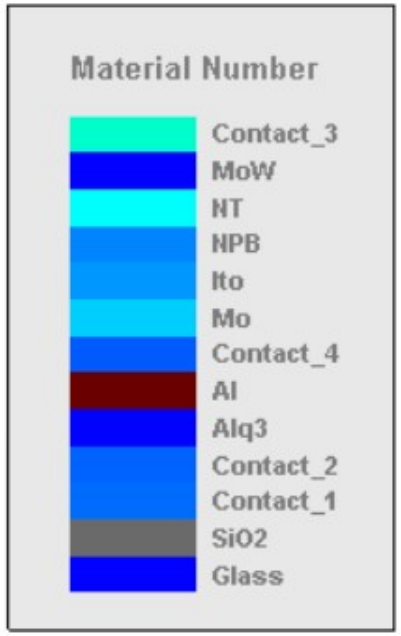

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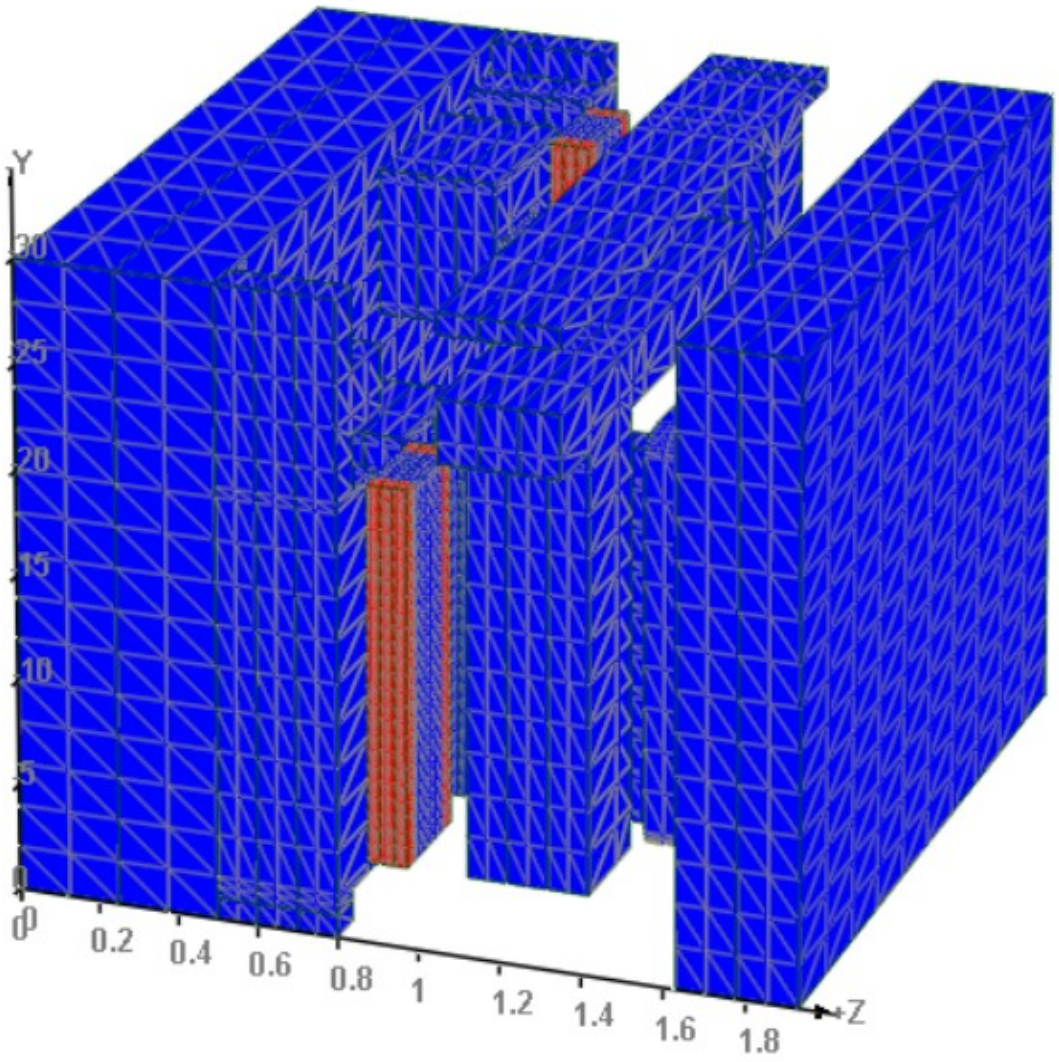

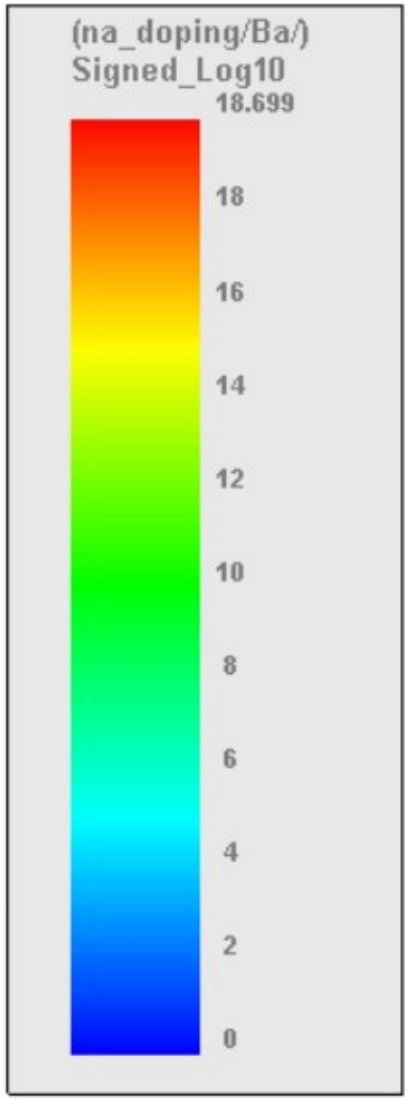

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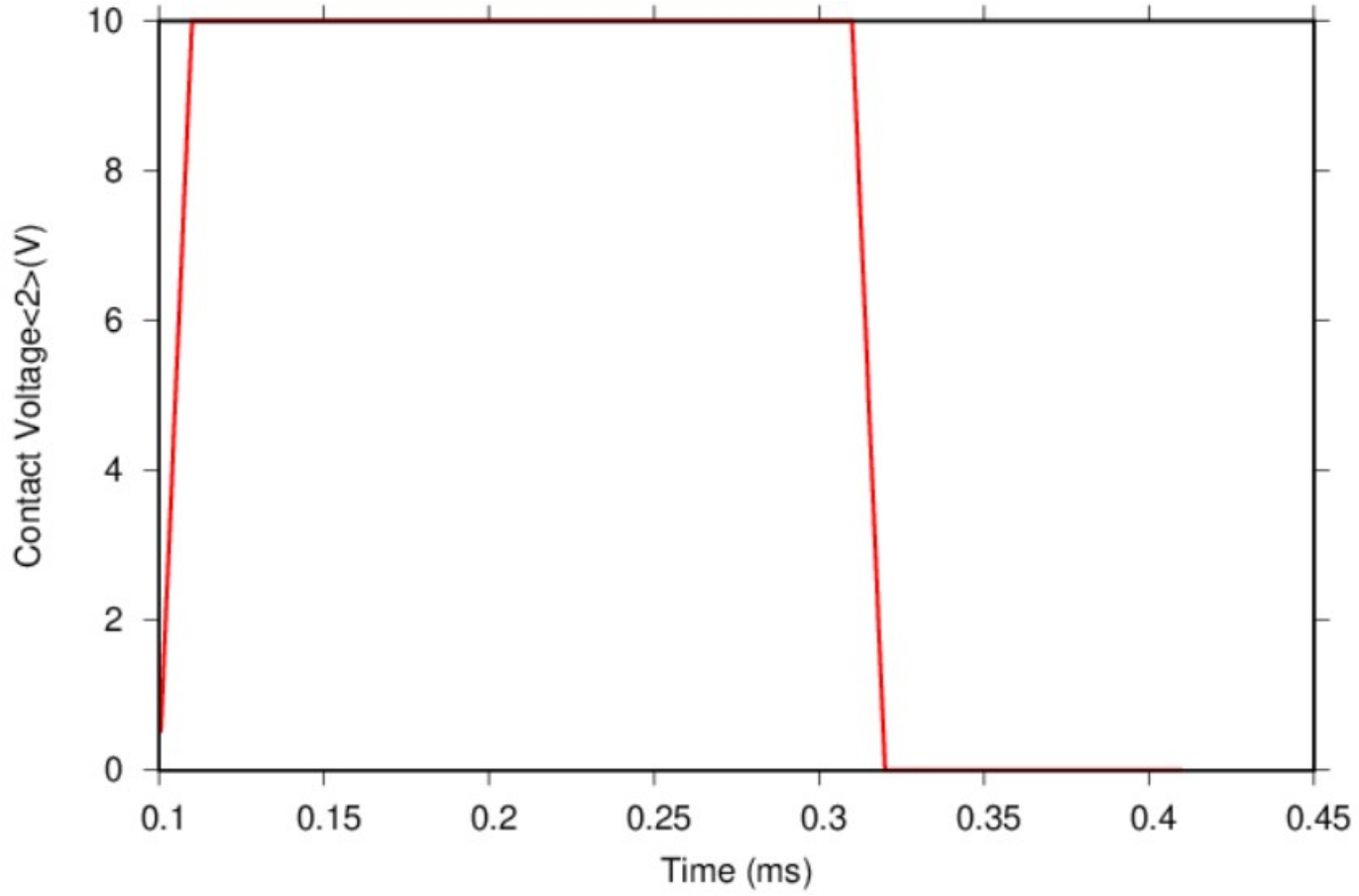
Transient simulation Powerline=10V within 0.1ms, Scanline&Dataline impulse.
Contact4=ground Contact1=Powerline
Contact2=Dataline Contact3=Scanline



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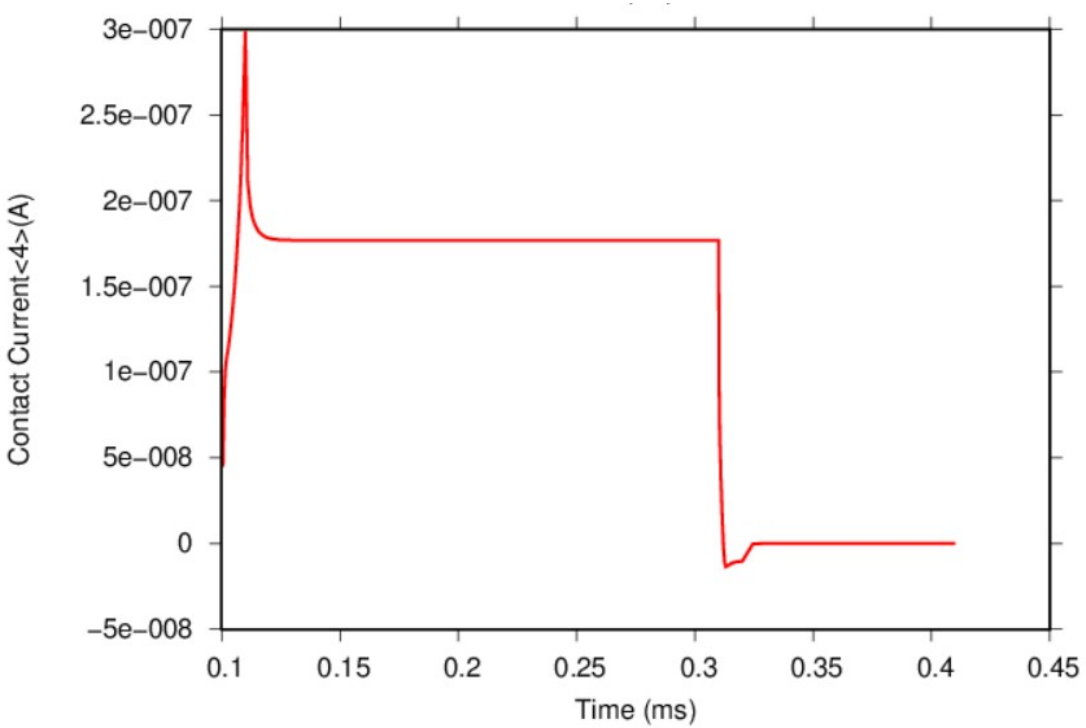
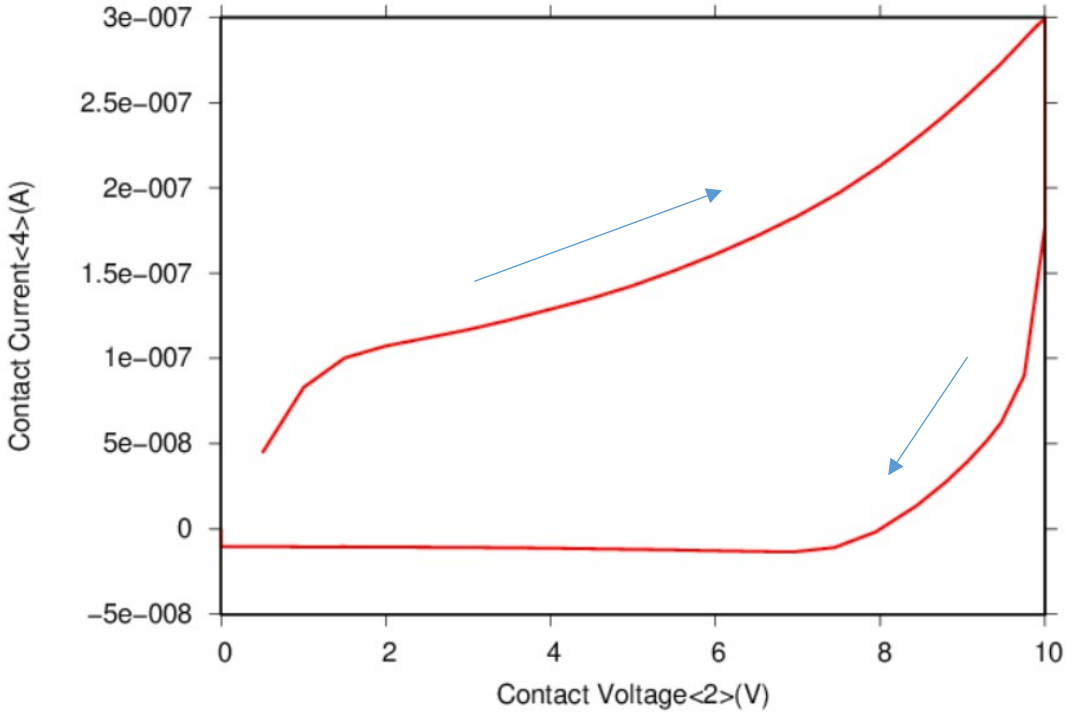
OLED current



OLED current vs. Dataline&Scanline



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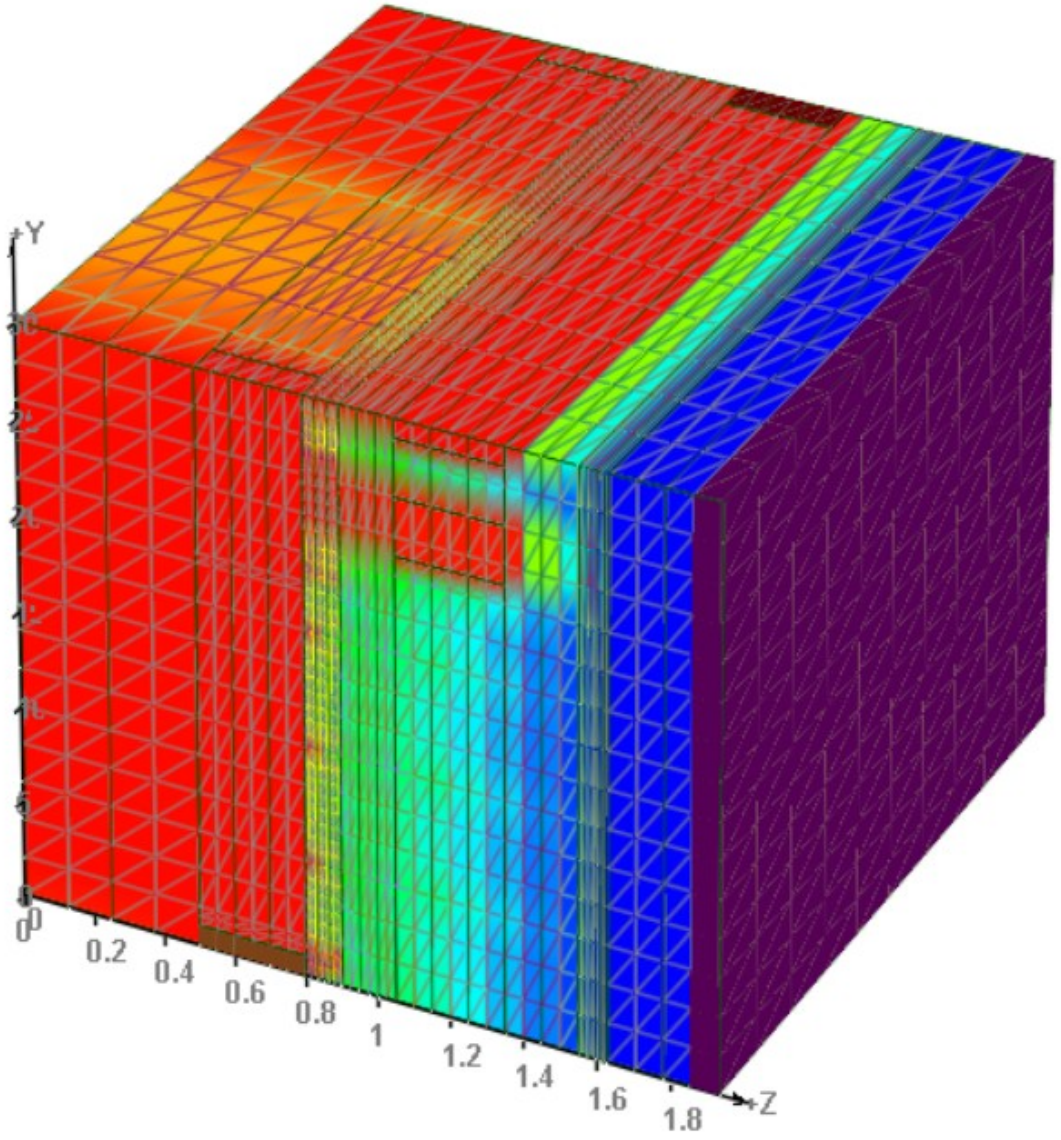
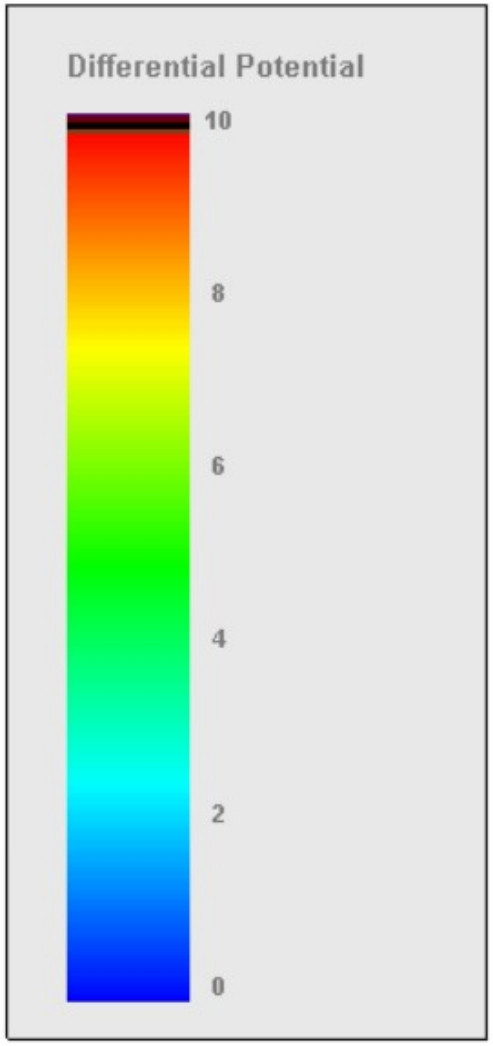
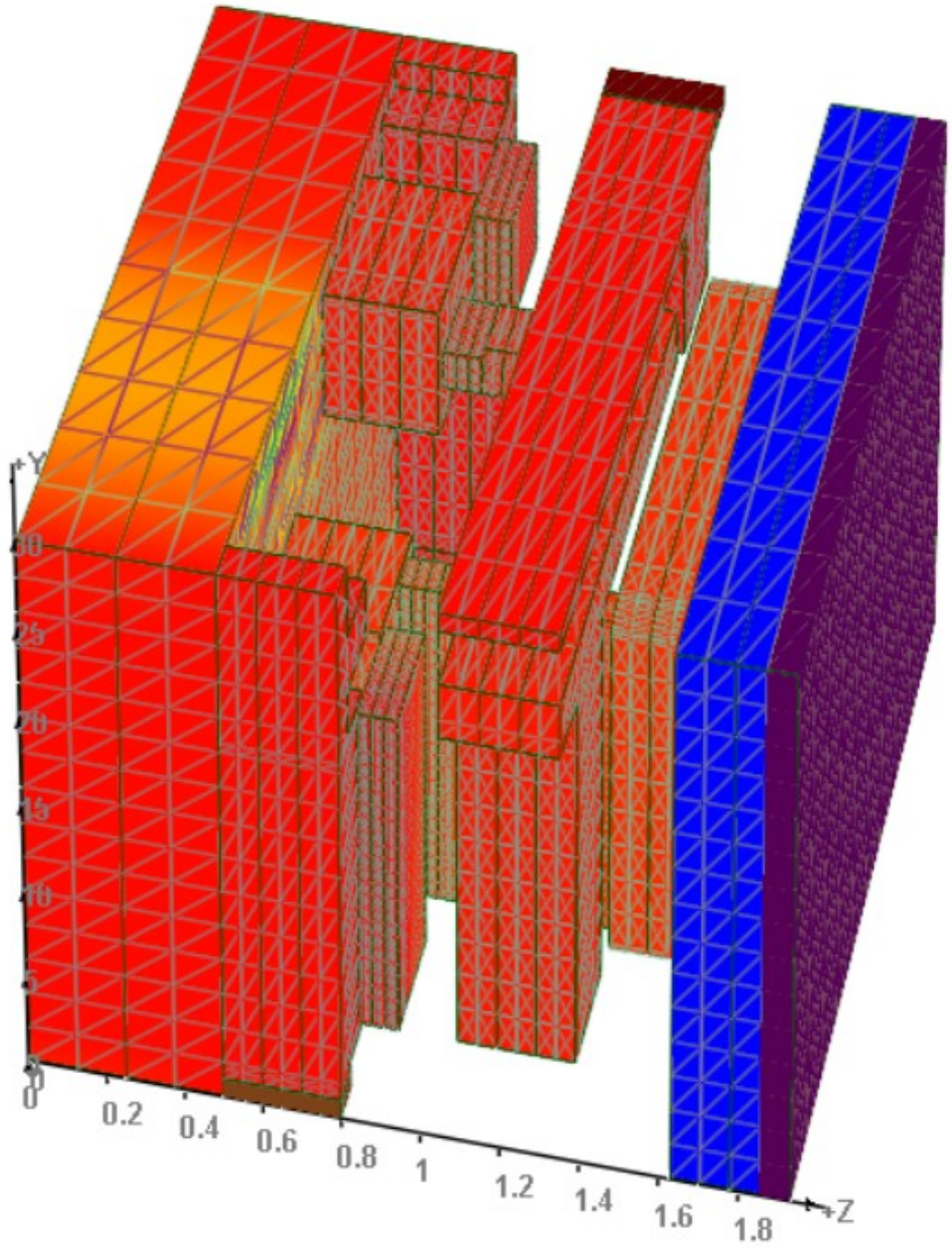
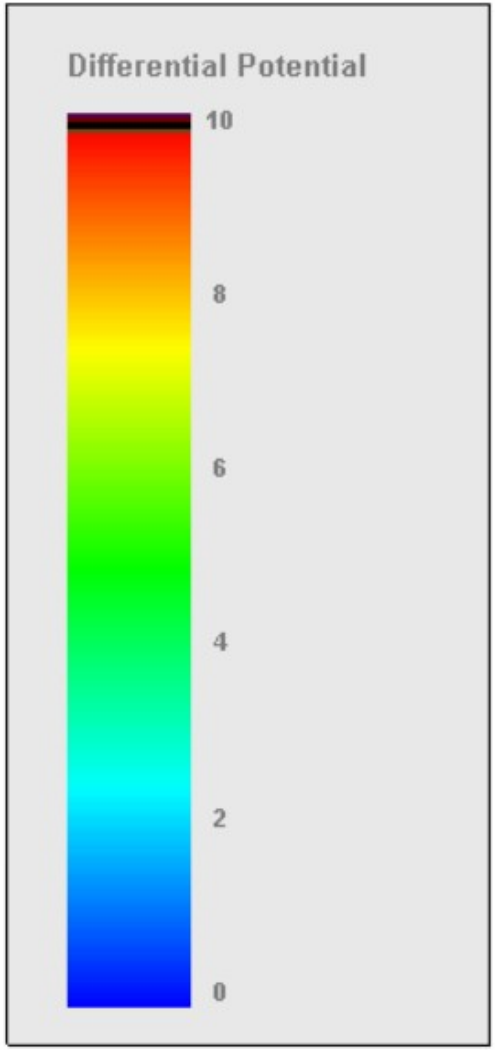
Right after turn-on





Right after turn-on





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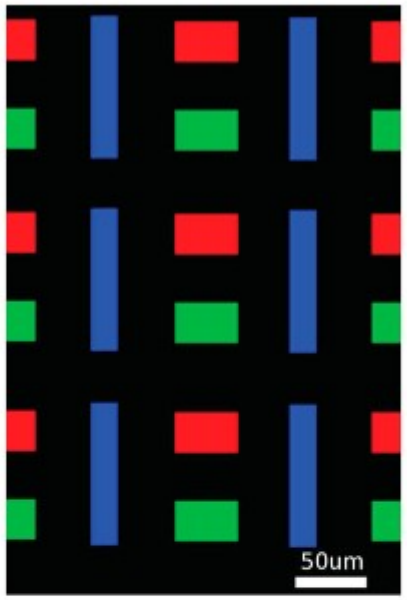
Comment: potential distribution clearly spread across different TFT due to capacitance effects.

Contents



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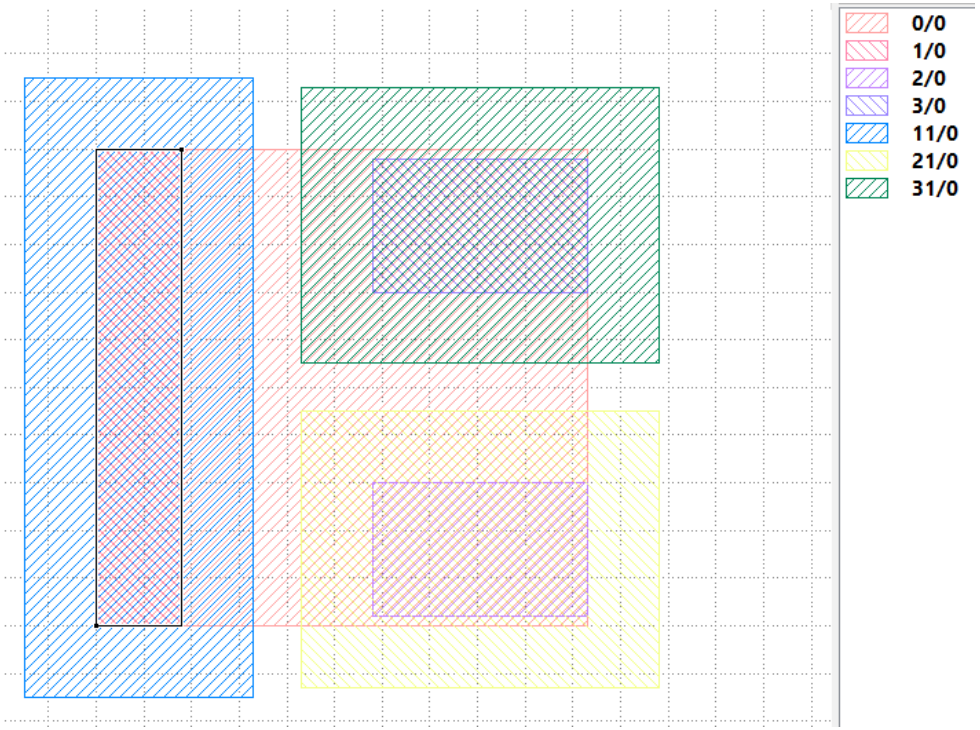

Layer 0: TCAD area
Layer 1/11: blue-flat/above-PDL
Layer 2/21: green-flat/above-PDL
Layer 3/31: red-flat/above-DPL

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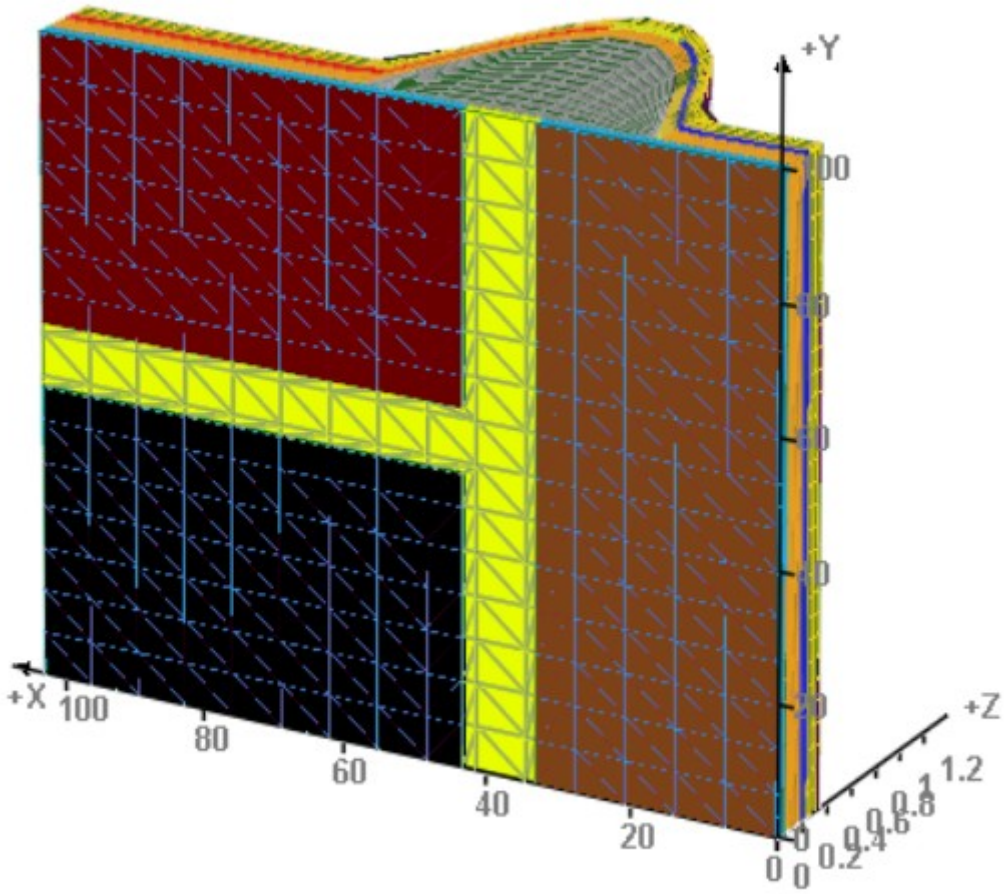

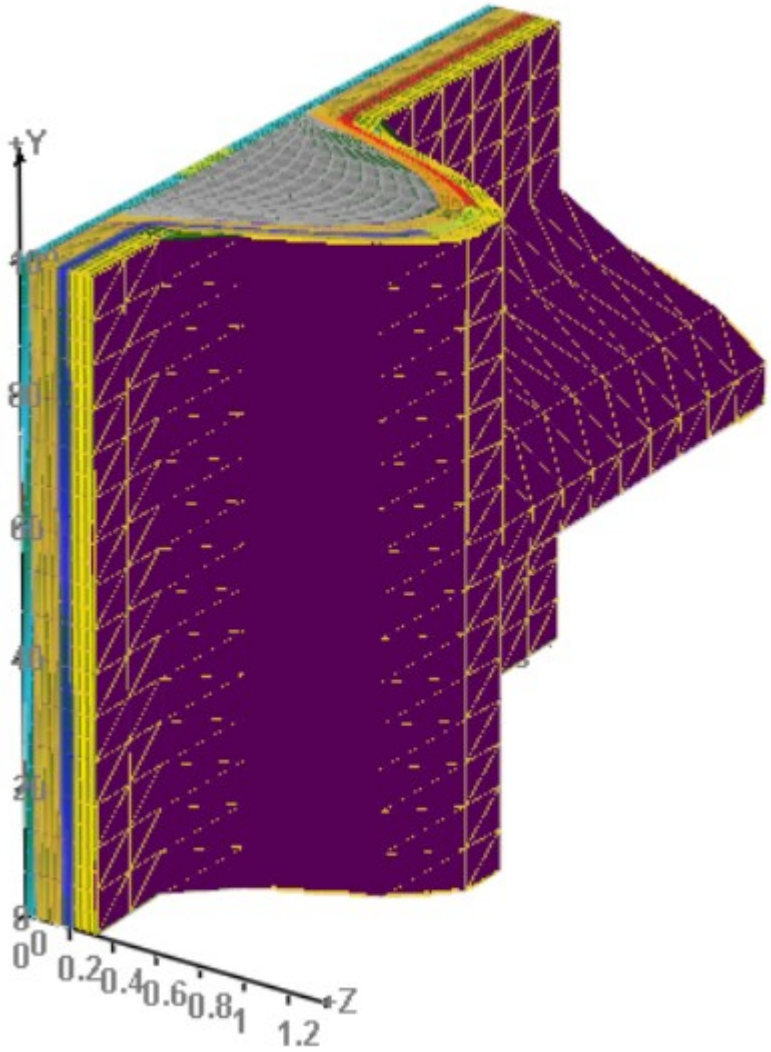

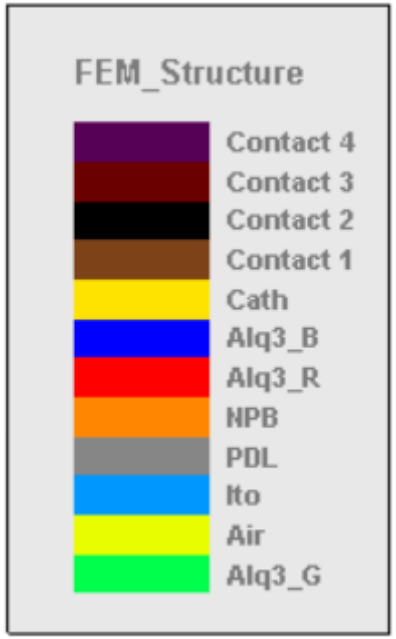

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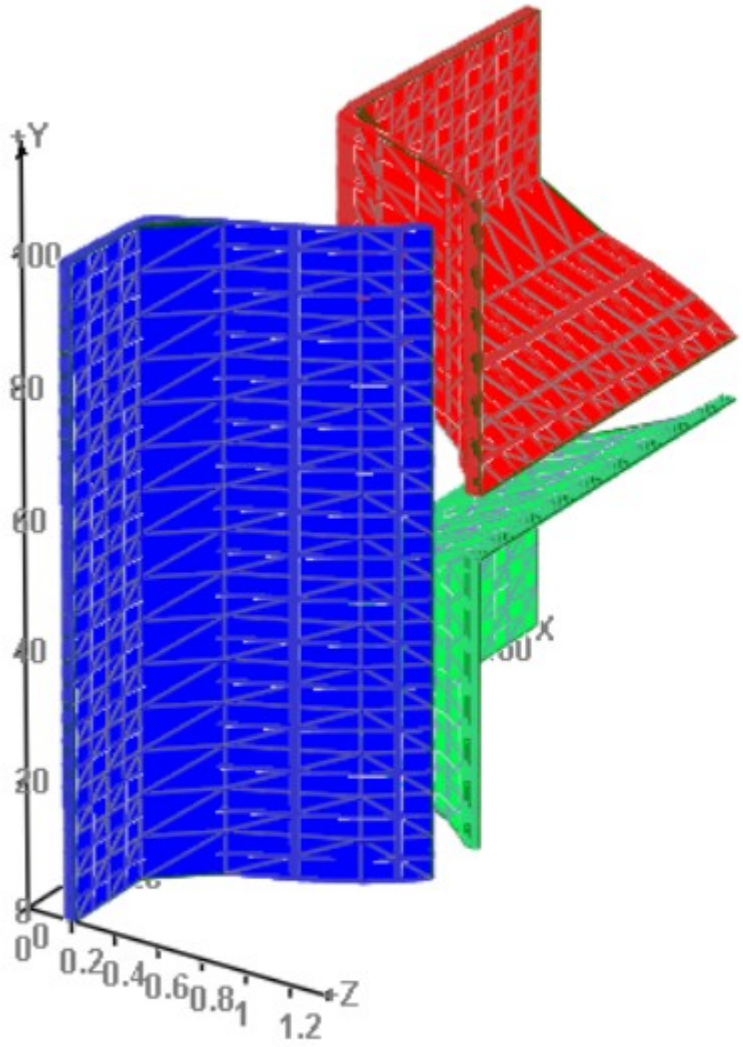
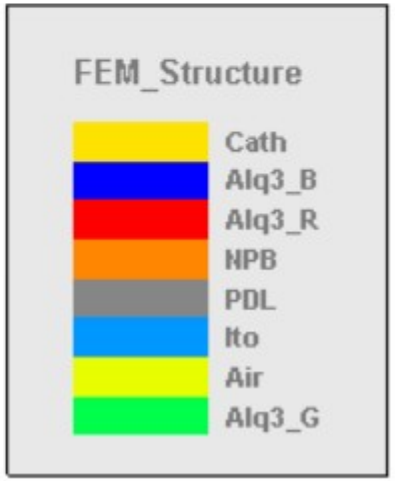
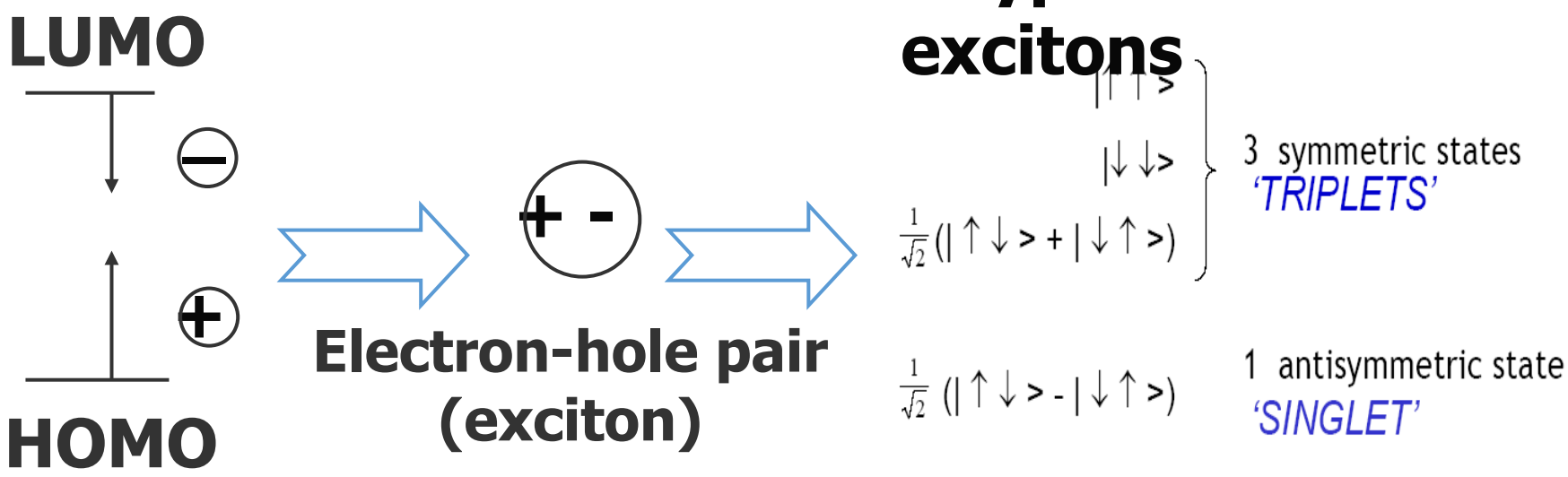

Y
100
80
60
40
20
0
0
0.2
0.4
0.6
0.8
1
1.2
Z
X


FEM_Structure
Cath
Alq3_B
Alq3_R
NPB
PDL
Ito
Air
Alq3_G

TCAD project 1: Bias the blue to 5V and ground all others.

Use of singlet diffusion to study how emitting exciton singlets diffuse to neighboring cells and cause undesired emission or interference.

Formation of singlet and triplet excitons



- ✓ **Singlets may recombine to emit light**
- ✓ **Triplets are normally wasted unless harvested by phosphorescent dopants**

Our model

Basic exciton diffusion equations for both singlet and triplets [1]:

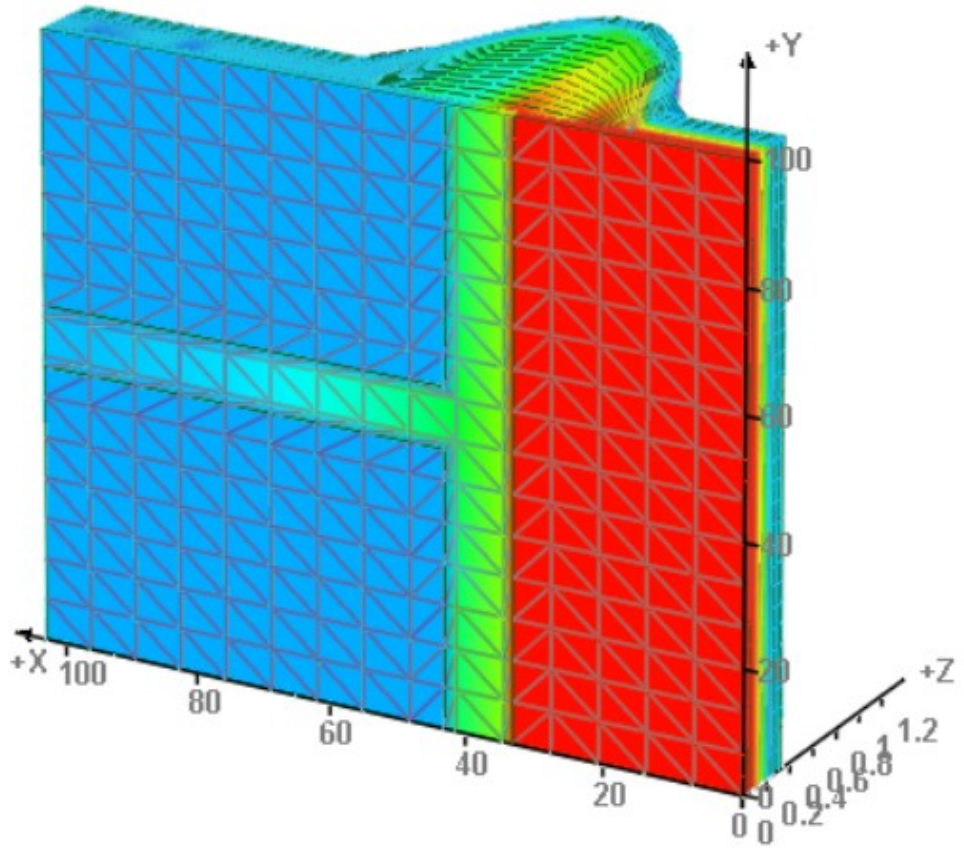
$$\frac{\partial S(x)}{\partial t} = \gamma \cdot r(x) \cdot n(x) \cdot p(x) + D_S \cdot \frac{\partial^2 S(x)}{\partial x^2} - \frac{S(x)}{\tau}$$

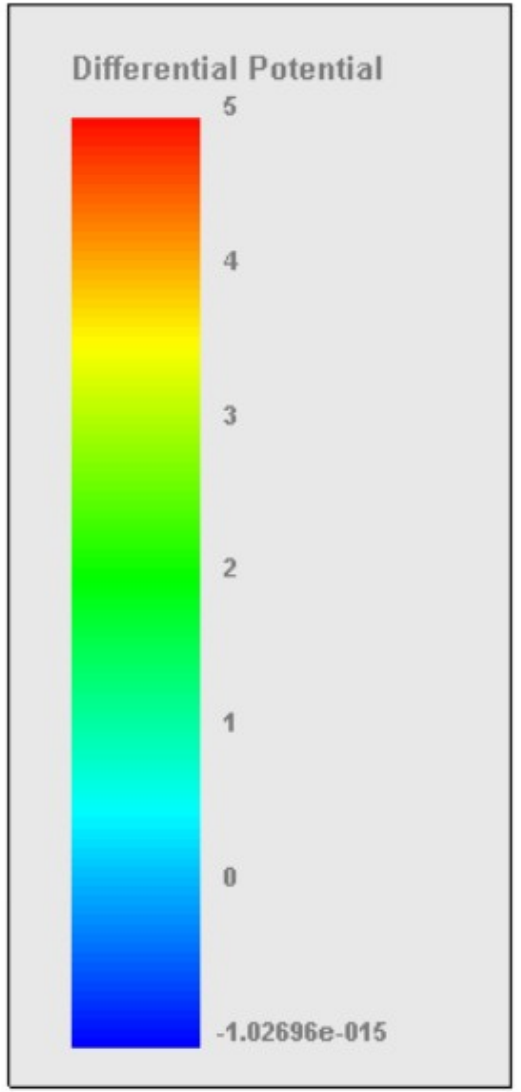
— quenching_terms

Exciton quenching may include bulk/interface quenching and triplet-triplet biexciton quenching [2]

[1]B. Ruhstaller, et.al.,"Simulating Electronic and Optical Processes in Multilayer Organic Light-Emitting Devices," IEEE J. SEL. TOPICS IN QUANTUM ELECTRONICS, VOL. 9,2003,p. 723.

[2] M. A. BALDO, et.al., "Transient analysis of organic electrophosphorescence. II. Transient analysis of triplet-triplet annihilation,"p. 10 967 PRB vol. 62, 2000





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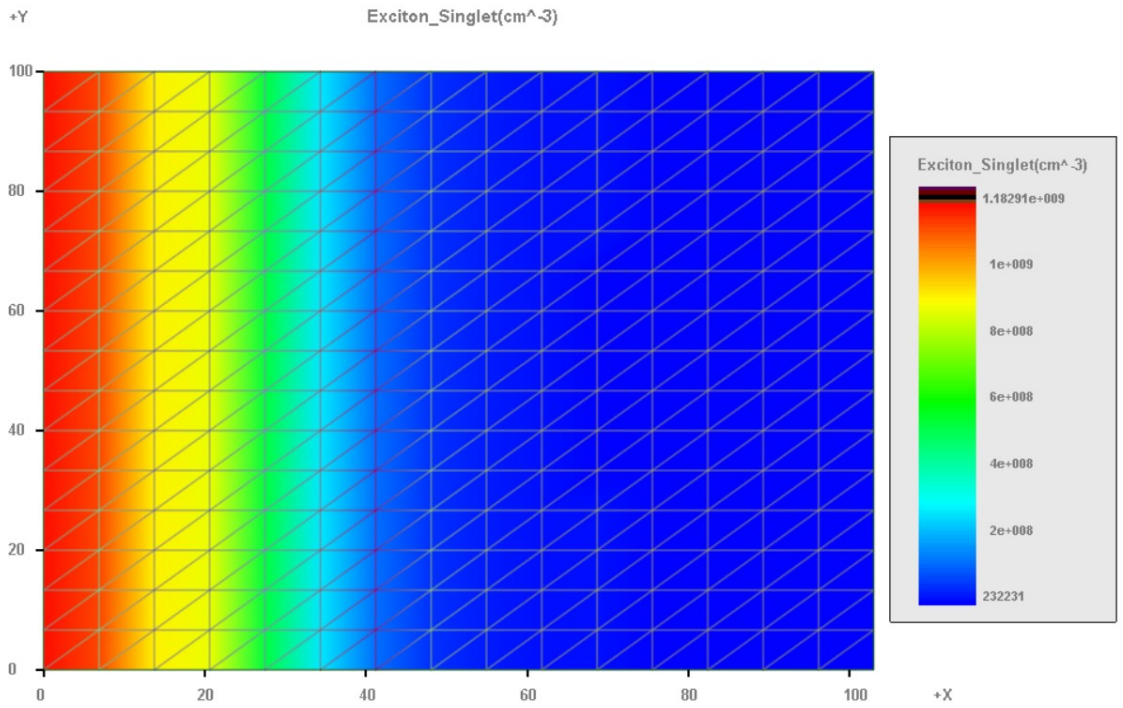
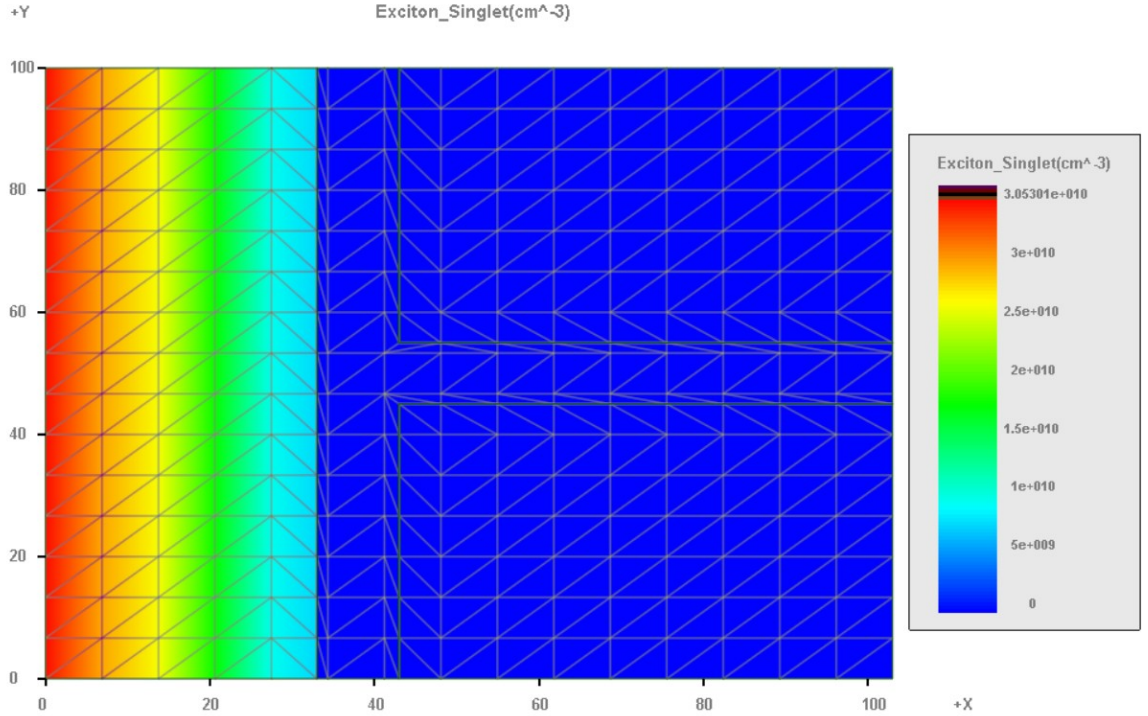
Singlet exciton lateral diffusion profiles

At common HTL layer



At isolated ETL layer



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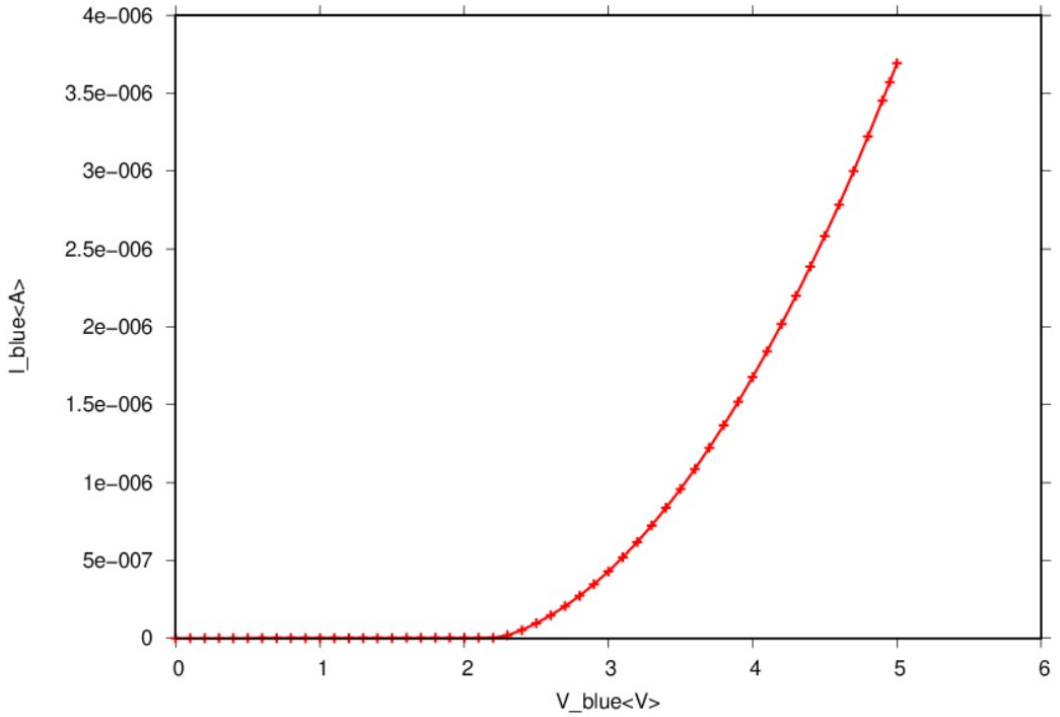
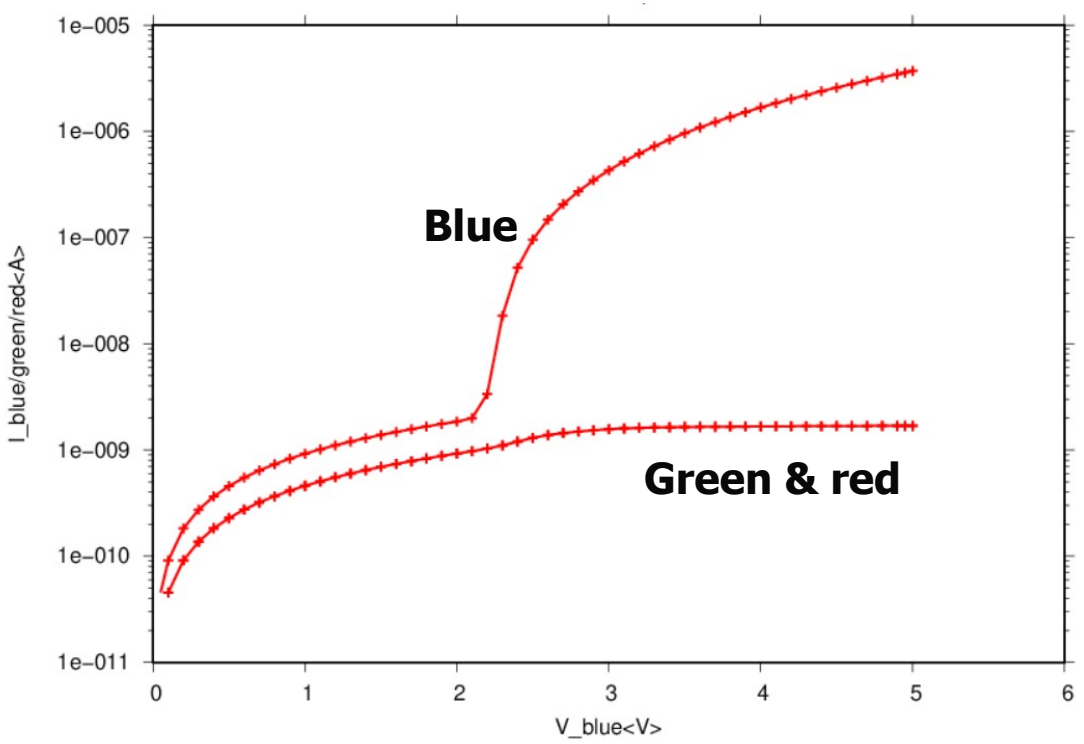
Current crosstalk between pixels





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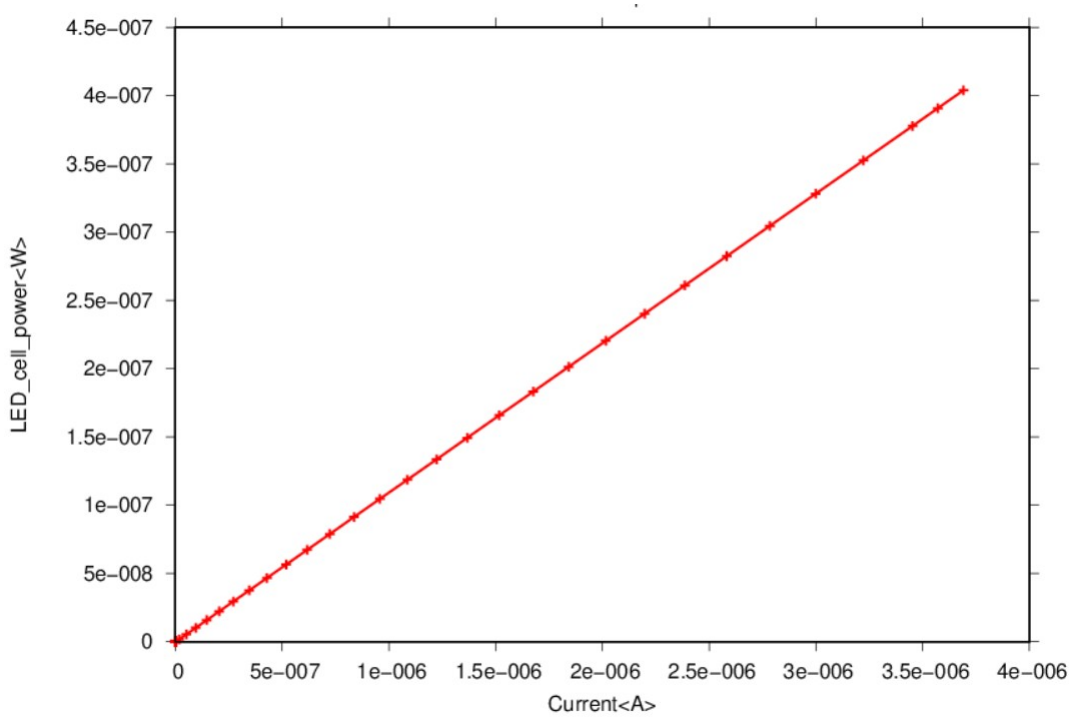
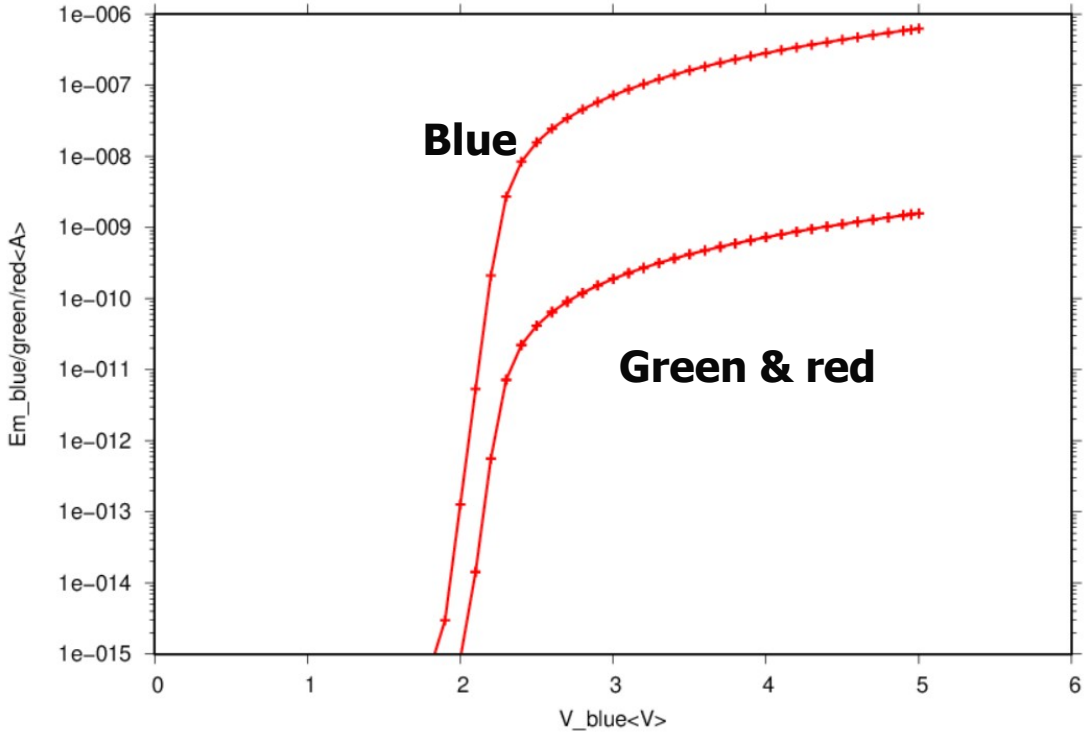
Exciton emission interference between pixels due to lateral diffusion effects





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Summary

- Crosslight Software offers accurate simulation solution based on quantum physics
- Robust convergence and numerical efficiency make Crosslight tools choice for R & D

Thanks for your attention!

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