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Design for high out-coupling efficiency of white OLED using CROWM – a combined geometric/wave optics model

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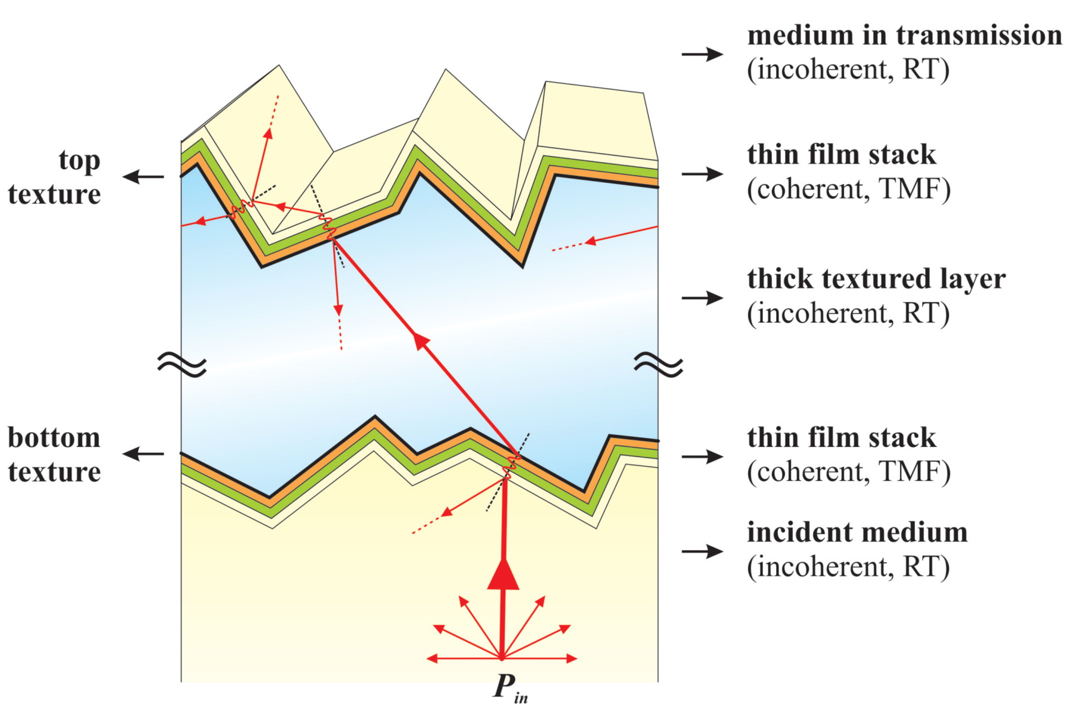
Objectives and Methods

- to improve optical outcoupling efficiency in white (RGB based) OLED
- approaches: micro-textured front glass and antireflecting coatings
- method: 3-D optical simulations with simulator CROWM

Optical Model

Simulator CROWM

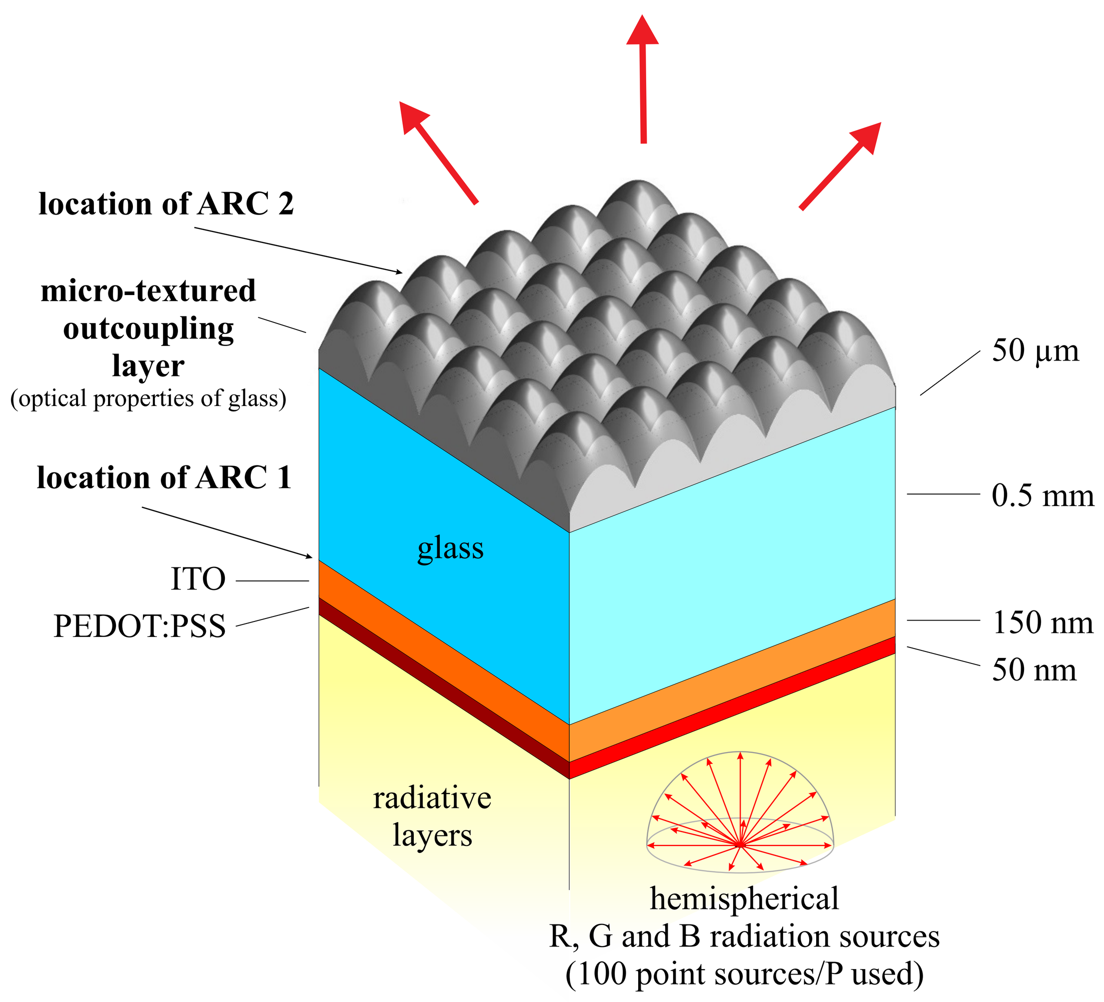
(Combined Ray-Optics / Wave-Optics Model)



Main features:

- **micro-textures** can be applied on both sides of thick layer
- 3-D **ray tracing** (RT) is used in thick layer (incoherent propagation of light)
- **transfer matrix** (TM) formalism is used in thin layers (coherent propagation of light)

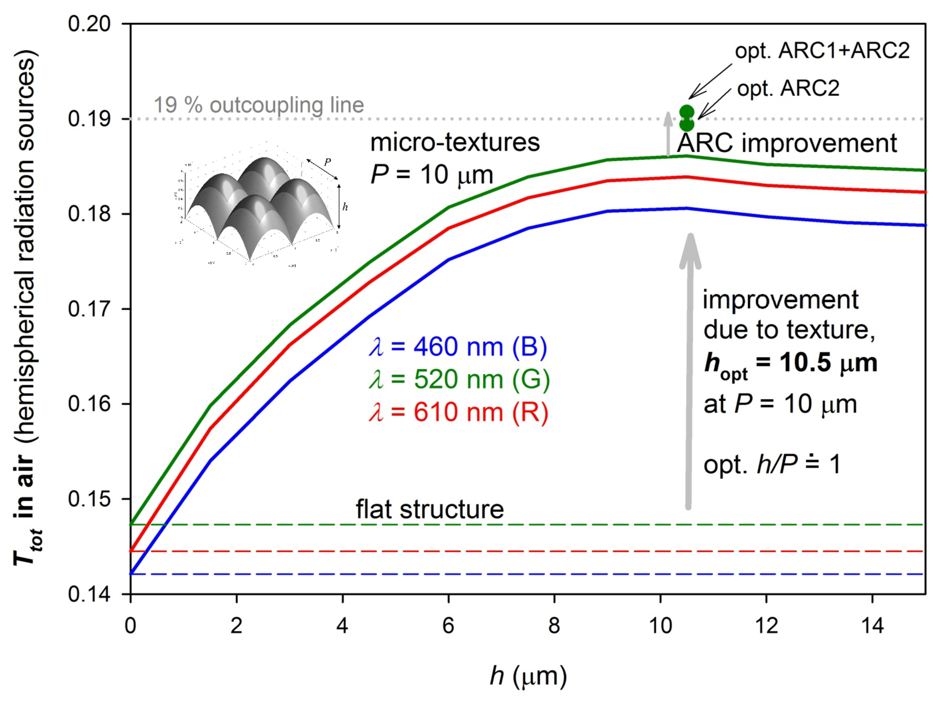
Structure



- one period *P* of the micro-texture was simulated, periodic boundary conditions were considered

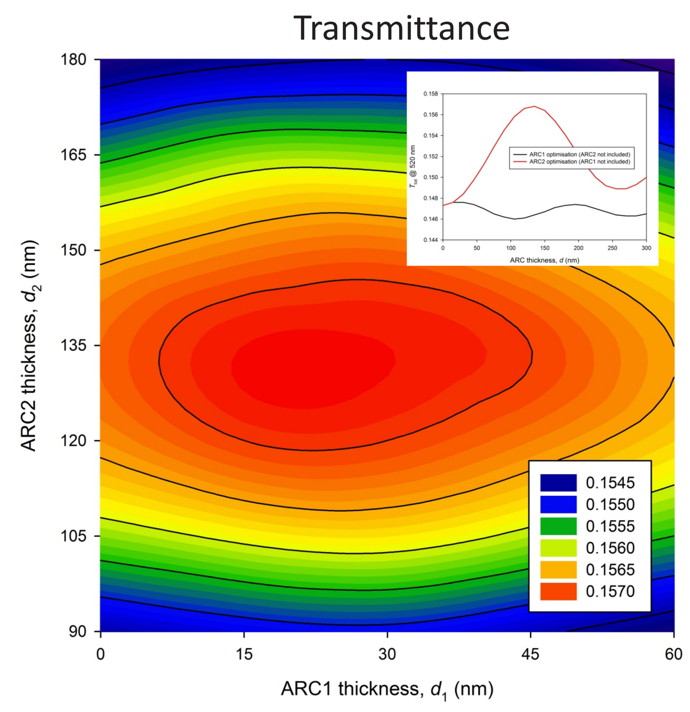
Results

Total transmittance in air vs *h* of texture:



- different levels of T_{tot} for R,G, and B are related to absorption losses (see below)observations

ARC optimisation:

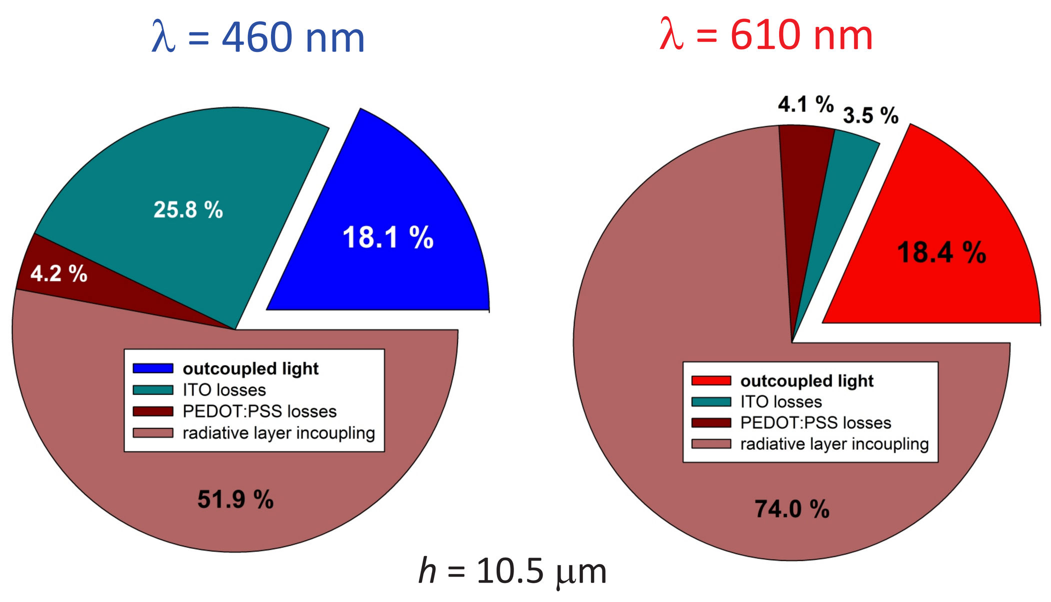


ARC1:
n = 1.69
d_{opt} = 30 nm

ARC2:
n = 1.24
d_{opt} = 135 nm

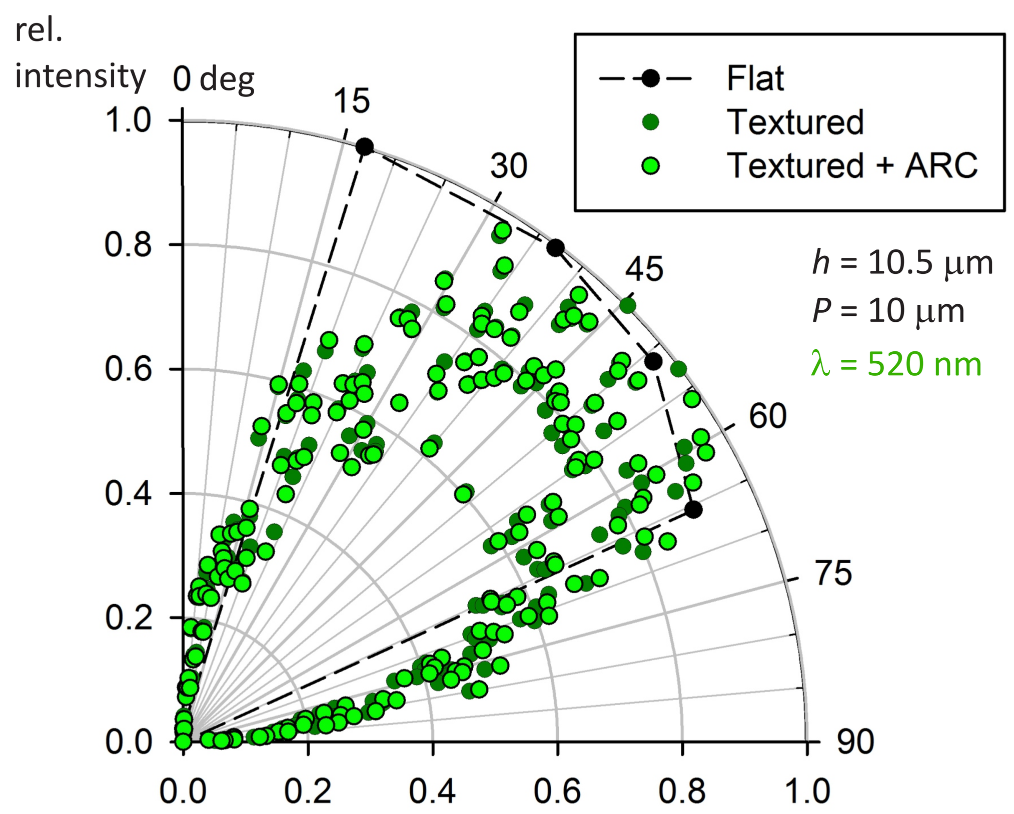
- results of optimisation of ARCs thickness shown for the flat structure case

Loss analysis:

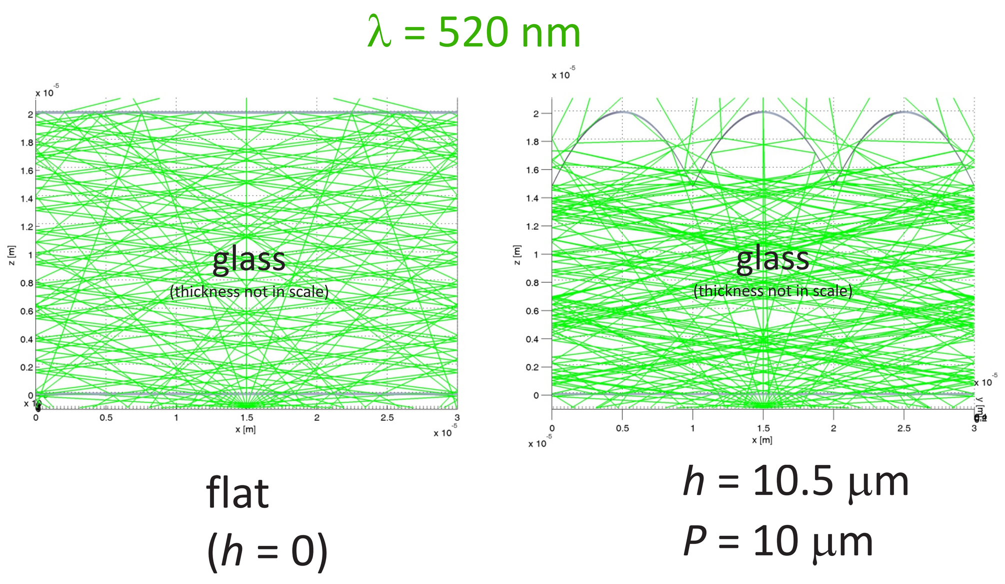


- ITO has highest absorption coeficient for B component
- However, in case of R more light returns to rad. layer

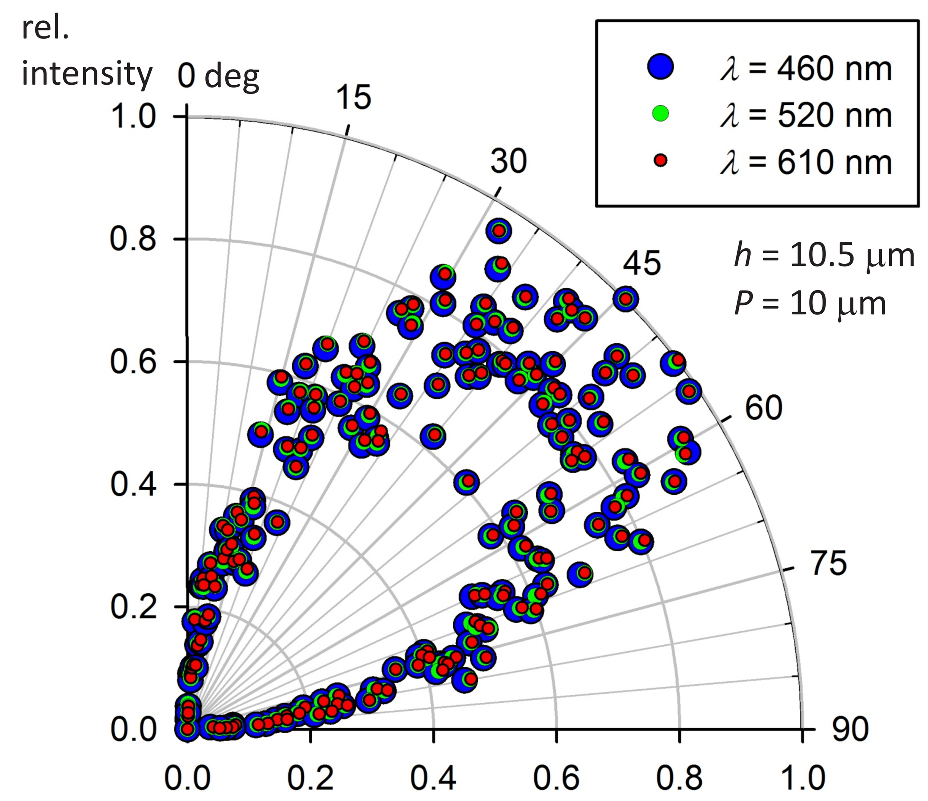
Angular intensity cross-sections (in air):



Ray tracing cross-sections:



- around 5.000-times more initial radiation rays were applied in simulations than shown in figures above



- textures shift intensities from small angles towards larger ones
- wavelength independent distributions

Conclusion

- Optimised micro-textures in combination with ARCs enable > 19 % transmission of light through the front OLED stack
- Simulator CROWM was applied successfully for optical analysis and outcoupling design of OLED

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