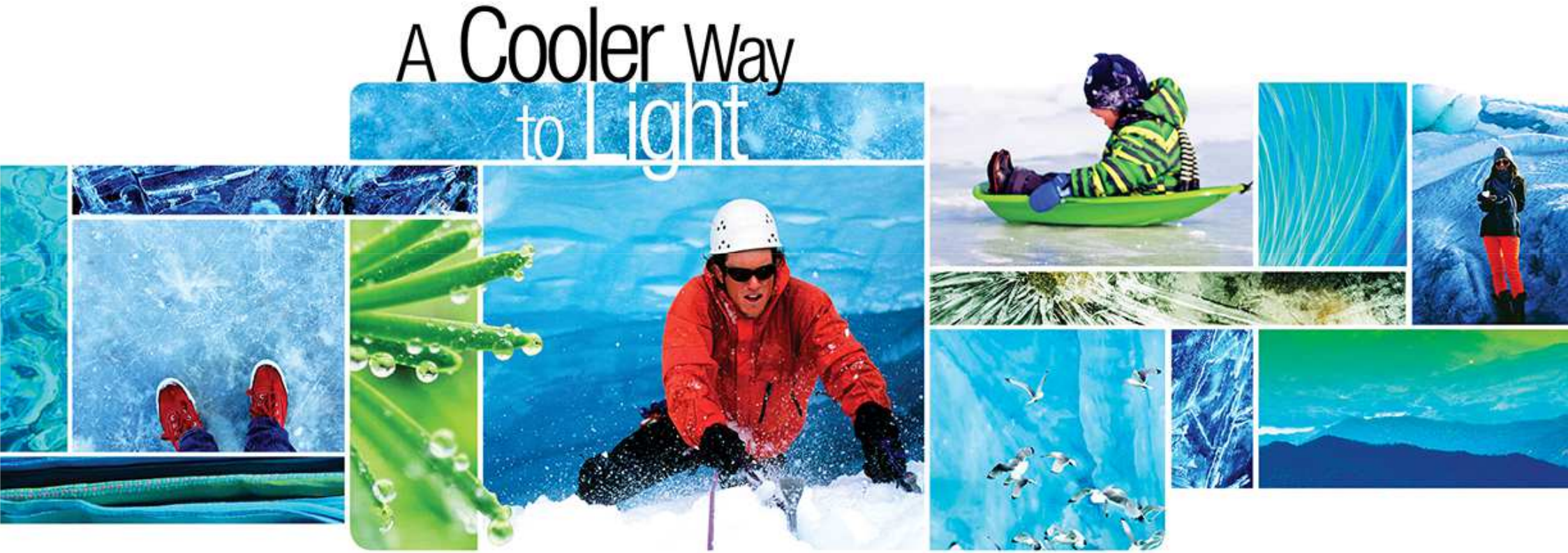
3M Optical Systems Division

Light Extraction Films for OLED Solid State Lighting

Fred B. McCormick – 1/29/14 – DOE SSL Workshop – Tampa, FL



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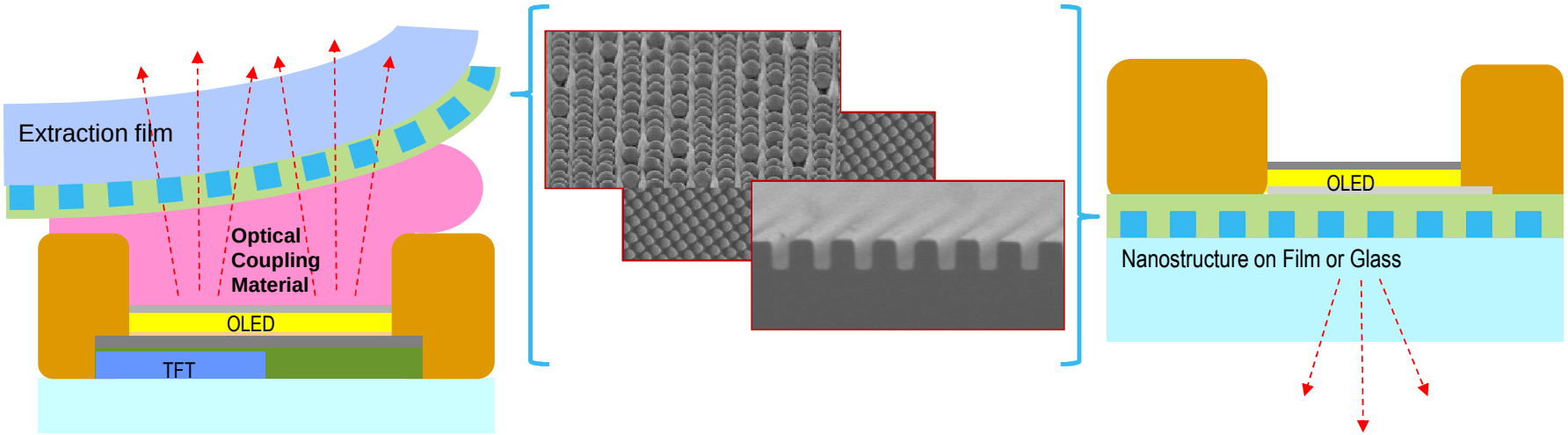
3M Extraction Films for Top & Bottom Emitting OLEDs



- *Manufacture extraction features in a separate, scalable R2R process. No need to pattern extractor features on the pixel*
- *Film-based nanoreplicated low index structures backfilled with high index planarization material*
- *Compatible with either glass or flexible encapsulation; can be combined with 3M Barrier Film*
- *Great level of control of nanostructure parameters affecting gains, angular luminance, color and polarization properties*

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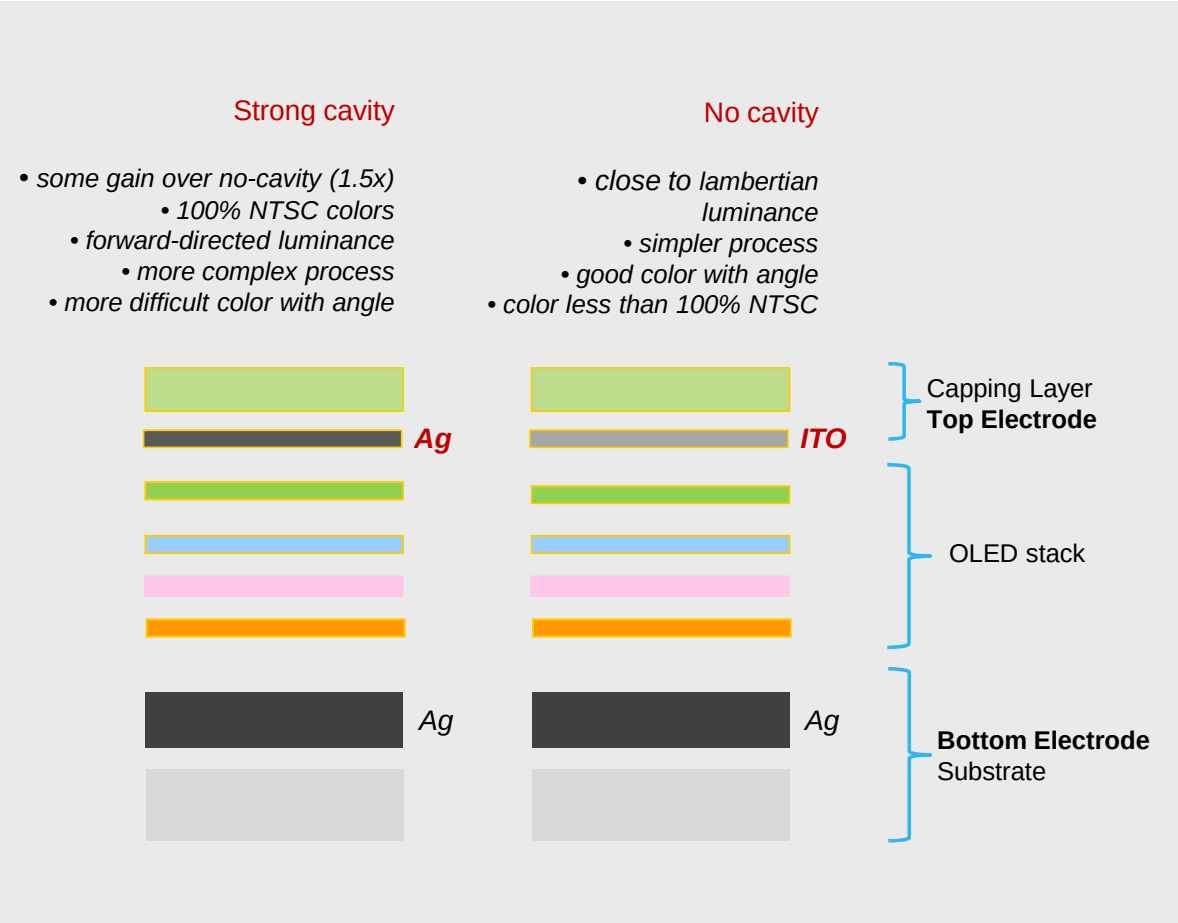
Key Factors that Influence Extractor Efficiency

- OLED stack design
  - *Strong microcavity vs. weak/no-cavity*
  - *Stack optimization:*
    - *Affects distribution of radiated/guided (incl. SPP) modes*
    - *OLED layers - index, thickness*
    - *Top electrode construction*
    - *Capping layer index and construction*

- Extractor design
  - *Random vs. regular nanostructure*
  - *Nanostructure pitch: single pitch, multipitch*
  - *Symmetry: 1D vs. 2D*
  - *Backfill: high-refractive index (e.g. 1.85)*
  - *Optical coupling material*
    - *Index , stability, conformability, thickness*



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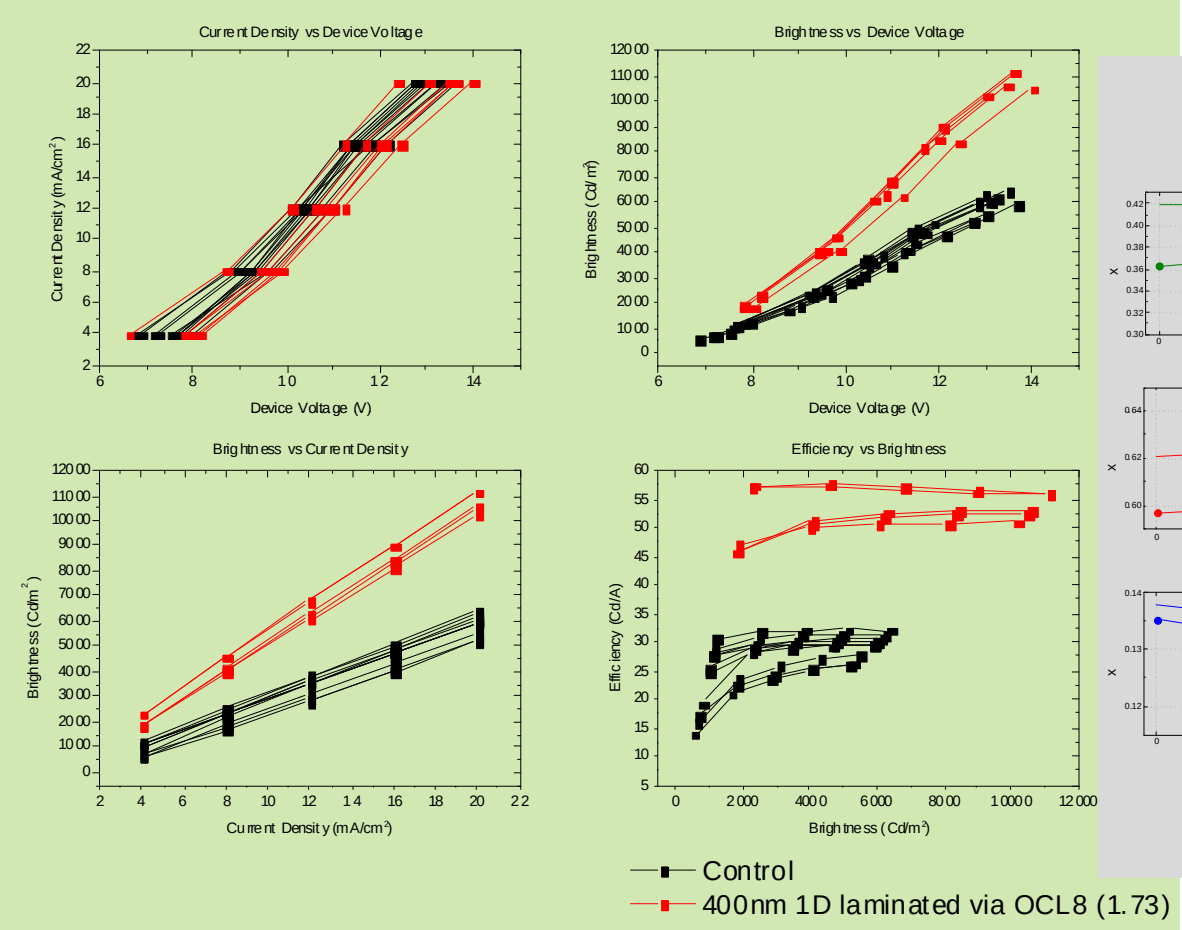
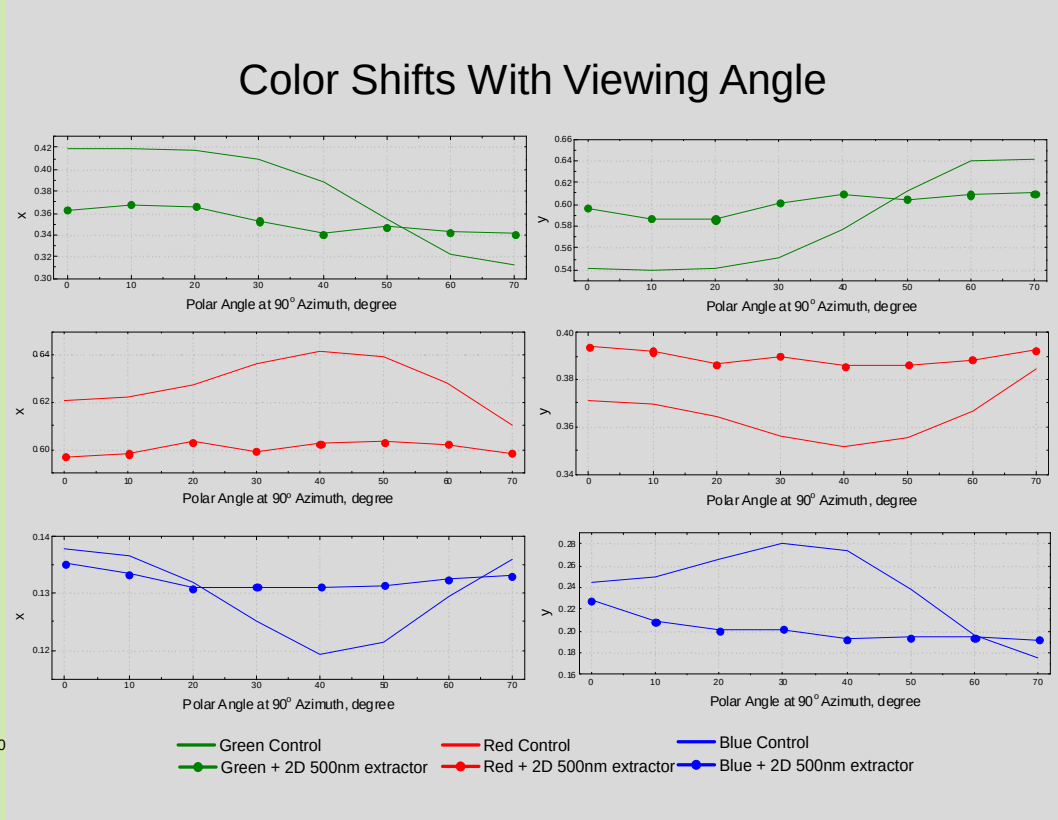
Representative Data on TE No-cavity OLEDs





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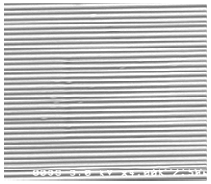
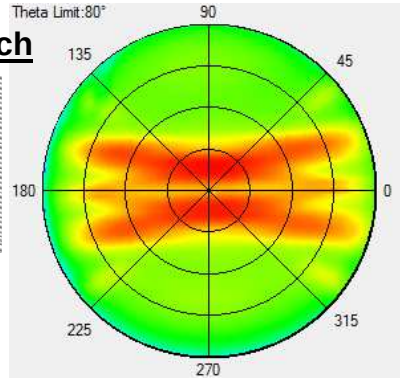
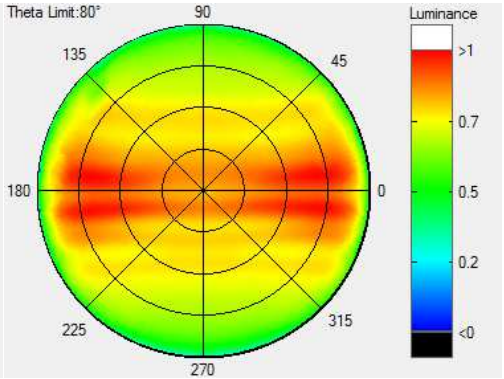
Angular Performance of Extractors -

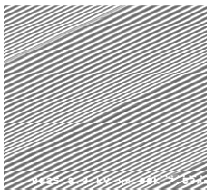
1D single pitch



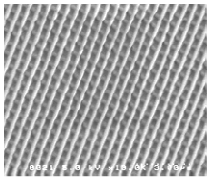


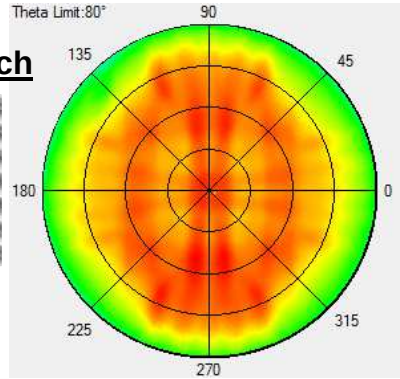


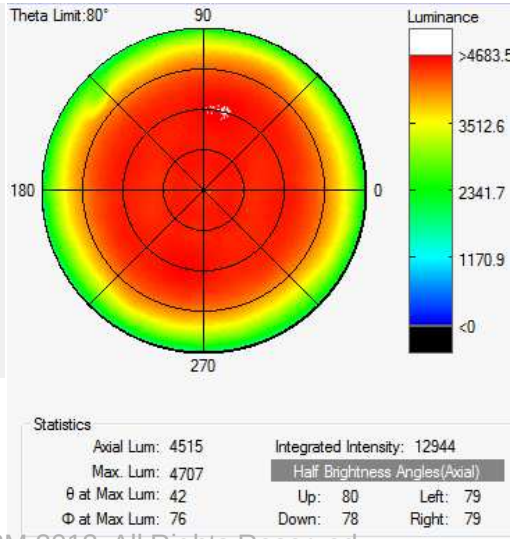
1D multi pitch



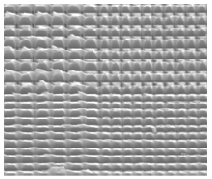
2D single pitch



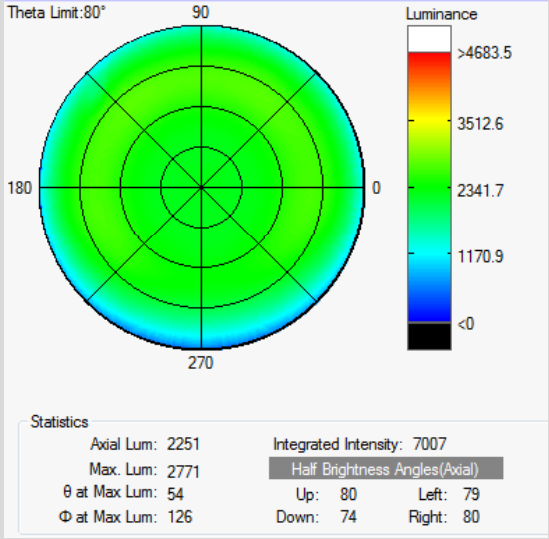




2D multi pitch



Control



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Suggested DOE Research Areas

- Color Angularity
- Large Area Lighting Devices
- Alternate Transparent Conductors
- Fault-Tolerant Architecture
- Color Temperature
- Light Shaping
- Interconnect Stability
- Simple, Low Cost OLED Architectures
- Web Processing

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