

3M Optical Systems Division

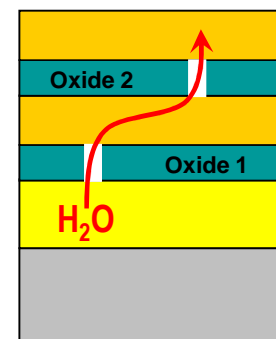
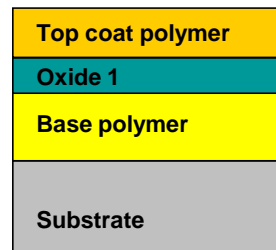
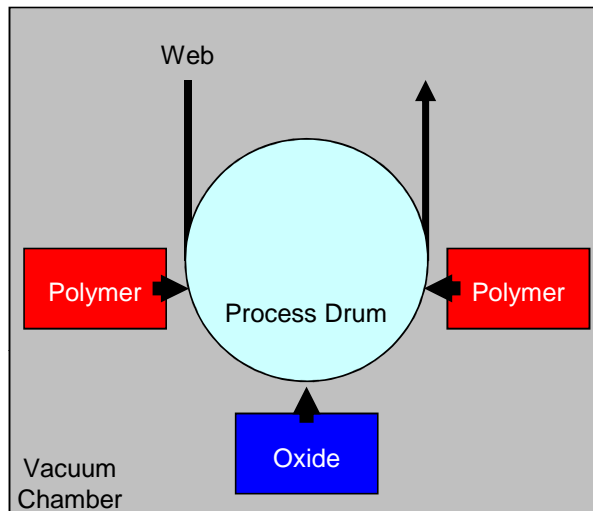
# Barrier Films and Adhesives for OLED Solid State Lighting

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

## A Cooler Way to Light



# 3M Vacuum Processed Barrier Films



- Multilayer Construction
  - *Substrate*
  - *Polymer layers*
  - *Oxide layers*
- Oxide provides barrier
  - *High transparency & clarity*
  - *Low haze*
  - *Good flexibility*
- Tortuous path from Multi-dyads
  - *Can increase barrier performance:*

# Initial Product Offerings

## FTB3-50 and FTB3-125 (Commercially Available)

### “Flexible Transparent Barrier”

- WVTR (g/m<sup>2</sup>-day)
  - ≤1 x 10<sup>-3</sup> warranted (Mocon Permatran 700)
  - 10<sup>-4</sup> to 10<sup>-5</sup> typical (Ca test, HTO test)
  - Can work for OLEDs with thin film encapsulation
- PET substrate used in current commercial products
  - PET OK for backside of OLED displays and OLED SSL
  - OLED displays may require non-birefringent barriers

FTB3-50 and FTB3-125

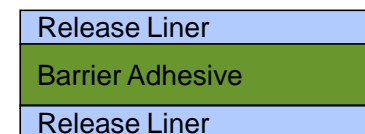


## FTBA-25 (Samples Available)

### “Flexible Transparent Barrier Adhesive”

- 25 μm standard thickness, ~10-50 μm also possible
- 2-4 g/m<sup>2</sup>-day bulk adhesive WVTR

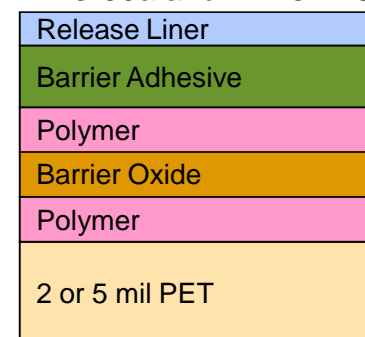
FTBA-25



## FTB3-50a and FTB3-125a (Samples Available)

- Adhesive laminated to barrier film

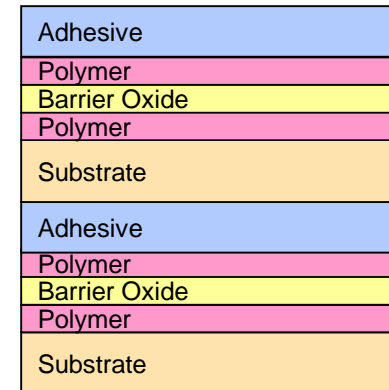
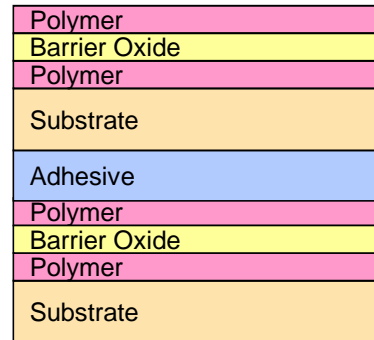
FTB3-50a and FTB3-125a



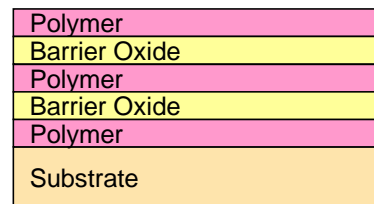
# “OLED Grade” Barriers *(In Development)*

## “FTB6-125L” (Samples Available)

- Laminate two FTB3-50 films together with FTBA-25
  - $10^{-6}$  to  $10^{-7}$  in preliminary Ca WVTR testing
  - Relatively thick construction



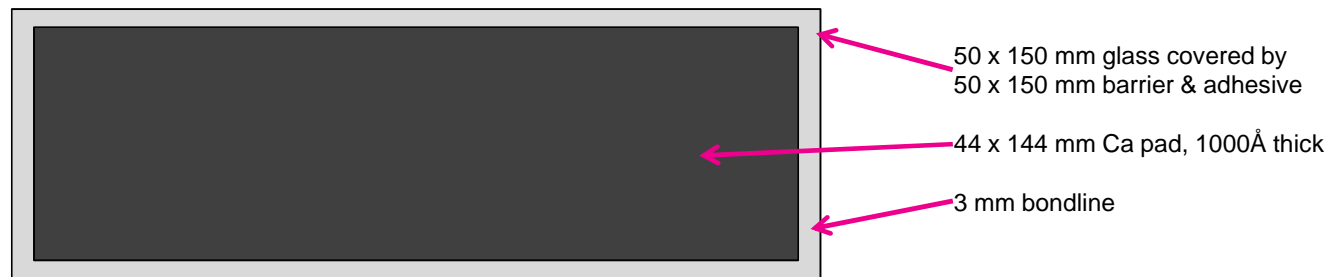
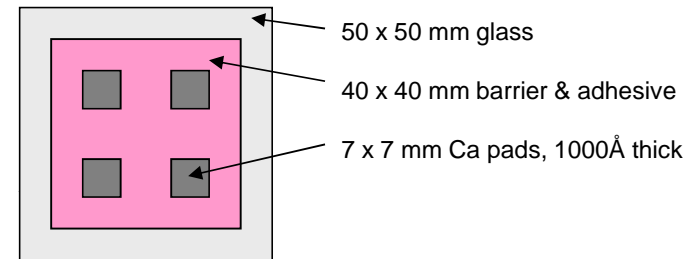
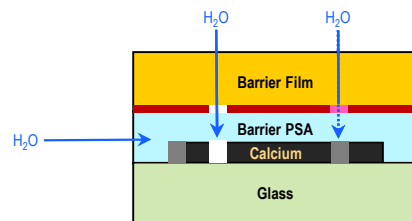
- Long term target – coat multiple dyads directly
  - Thinner and simpler construction
  - Optimizing process conditions



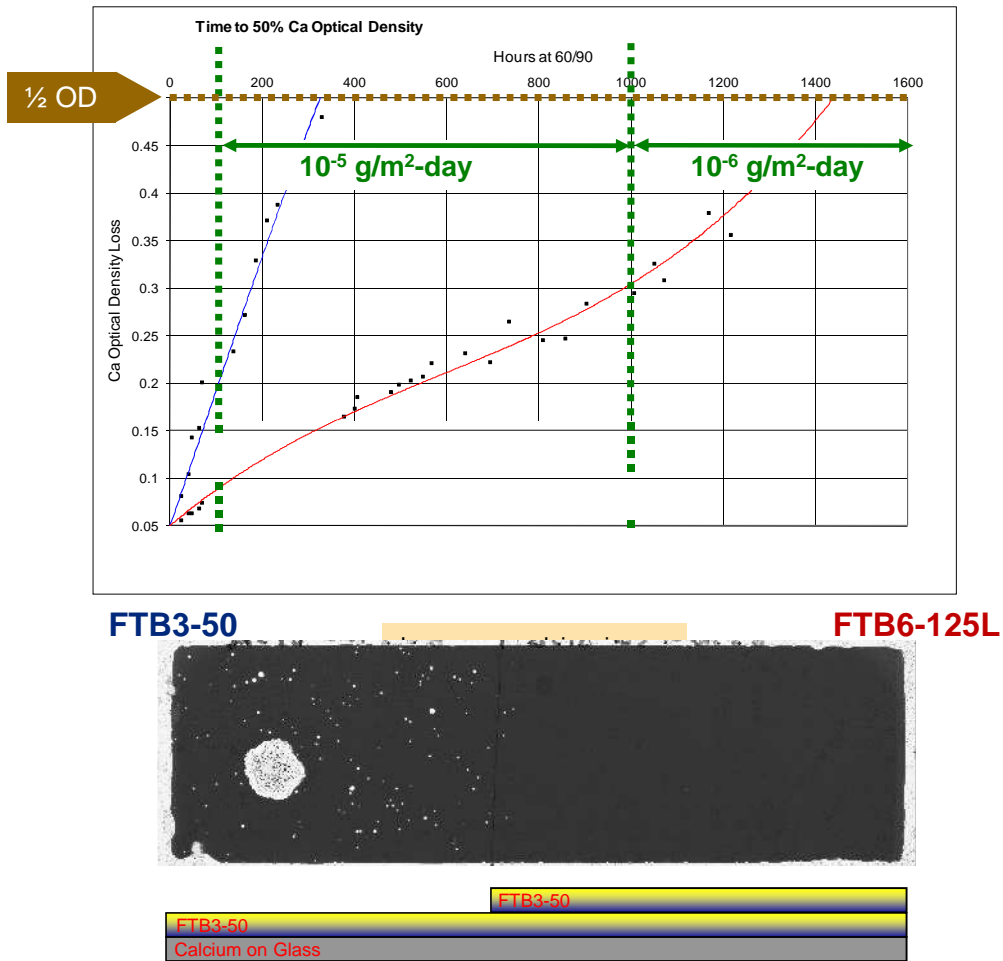
# 3M's Version of the Calcium Test

- 1) Deposit 1000Å Ca as a 44 x 144 mm pad on a 50 x 150 mm glass slide or four 7 x 7 mm pads on a 50 x 50 mm glass slide
- 2) Encapsulate with barrier film and barrier adhesive
- 3) Measure optical density at  $T_0$  using flatbed optical scanner (transmission mode)
- 4) Place in 60C/90%RH chamber and periodically remove for scanning
- 5) Use image analysis software (Aphelion) to track –

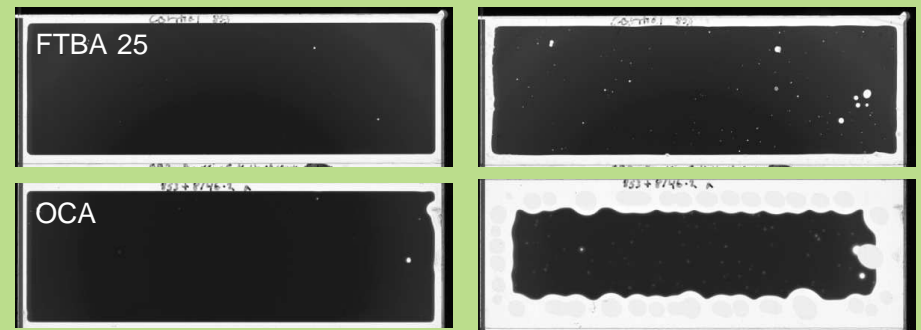
- Optical density,
- Moisture edge ingress
- Point defects
- Scratches & other macroscopic defects
- Barrier uniformity



# Ca Test Examples – WVTR & Edge Ingress



## Adhesive Comparison



3 hours at 60/90

62 hours at 60/90

# Suggested DOE Research Areas

- Defects
  - *Elimination, reduction, rapid detection*
- WVTR measurement techniques
  - *Faster methods with lower detection limits*
- Edge ingress & edge sealing
- Hybrid encapsulation systems
  - *Barrier films & adhesives coupled with thin film encapsulation*
- Lower cost substrates
- Electrical interconnects for flexible devices
- Large area transparent conductors
- Environmentally robust OLED architectures

## Important Notice

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