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/m²-day)
  - ≤1 x 10⁻³ warranted (Mocon Permatran 700)
  - 10⁻⁴ to 10⁻⁵ 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

FTBA-25 (Samples Available)
“Flexible Transparent Barrier Adhesive”
- 25 µm standard thickness, ~10-50 µm also possible
- 2-4 g/m²-day bulk adhesive WVTR

FTB-50a and FTB3-125a (Samples Available)
- Adhesive laminated to barrier film
“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 T₀ using flatbed optical scanner (transmission mode)
4) Place in 60°C/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

50 x 50 mm glass
40 x 40 mm barrier & adhesive
7 x 7 mm Ca pads, 1000Å thick

50 x 150 mm glass covered by
50 x 150 mm barrier & adhesive
44 x 144 mm Ca pad, 1000Å thick
3 mm bondline
Ca Test Examples – WVTR & Edge Ingress

Time to 50% Ca Optical Density

Hours at 60/90

10^{-5} \text{ g/m}^2\text{-day} \quad 10^{-6} \text{ g/m}^2\text{-day}

Adhesive Comparison

FTB3-50

FTB6-125L

Large area calcium image (144 hours at 60/90)

OCA

FTBA 25

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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