Barrier Films and Thin Film Encapsulation

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2014 DOE SSL R&D WORKSHOP
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• Status
• Display vs. SSL Encapsulation
• Challenges
The first two products with flexible high resolution AMOLED displays are on the market!

- The displays have the same quality as displays on glass.
- Two different encapsulation strategies: TFE and barrier on foil.
Display flexibility

Flexible Display Category

1. Plane
   “Unbreakable”
   \[ \varnothing \geq 2 \text{-cm} \]

2. Bendable
   \[ \varnothing \leq 0.5 \text{-cm} \]

3. Foldable
   \[ \varnothing \approx 1 \text{-cm} \]

4. Rollable
   \[ \varnothing \approx 1 \text{-cm} \]

Samsung Create: Flexible Future Business Plan
Contest RFP, August 2013

2014 DOE SSL R&D WORKSHOP
## Display vs. SSL

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<th>Display</th>
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<tr>
<td>Flexibility</td>
<td>High flexibility</td>
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<td>Edge width</td>
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<tr>
<td>Cost</td>
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Defect density

Estimated particle density yielding one defect per display:
- Acceptable particle densities for manufacturing are significantly below the line.
Defect tolerance

• Laminated OLED with 50-100 micron black spots (diameter) after 1,000h at 60C/90% RH.
• The defects are invisible at some distance.
• Note3 has a pixel density of 386 pixel per inch (65micron). At Samsung Analyst Day announced Samsung has announced that AMOLED smart-phone displays with 2560×1440 resolution will arrive sometime in 2014.
Transparent OLED. Structure is TFE Barrier-OLED - glass substrate.
Foldable displays in 2015???

IMOLA (Intelligent light Management for OLED on foil Applications) EU Project, Press Release by TNO/Holst
- Adhesives
  - WVTR and bezel
  - Flexibility
  - WVTR vs. Flexibility
- Face sealant for flexible display
- Adhesive key properties:
  - Good adhesion
  - Transparency
  - Haze
  - Clarity
  - No yellowing
For full and widespread deployment of TFE and barrier on foil, marketing and technical challenges must be overcome.

- Some say that there is no strong evidence that a market large enough to justify investments in TFE and barrier on foil will develop in the short term.

- Several barrier technologies are viable, but the current challenges poorly addressed include:
  - Handling during fabrication;
  - Fabrication and inspection tools;
  - Light extraction functionality.