DuPont delivers a unique liquid printing process and advanced materials optimized for OLED display manufacturers.

DUPONT OLED TECHNOLOGY ENABLES NEXT-GENERATION, LARGE-FORMAT DISPLAYS WITH SIGNIFICANT MANUFACTURING COST SAVINGS
Organic light emitting diode (OLED) technology enables more vivid color, higher contrast, faster response, thinner panels and a wider viewing angle than traditional liquid crystal displays (LCDs), while consuming less power. To date, OLED technology has been well received for small-size displays such as those used in mobile phones, but manufacturing cost has been a major barrier to the adoption of OLED technology for large-format televisions. Now, that’s all about to change.

**DUPONT HELPS MAKE OLED A COST-EFFECTIVE CHOICE**

Drawing on experience gained through collaborations with multiple leading display manufacturers and building on core competencies in solid-state materials science, functional polymers, organic and organometallic materials synthesis, film coating and formulations, DuPont has developed a unique liquid printing process and a suite of innovative, high-performance, solution-based materials that will enable display manufacturers to deliver superior OLED device performance with lower manufacturing costs for large-format displays.

**SCALABLE, LIQUID PRINTING PROCESS DESIGNED TO REDUCE COSTS**

Unlike OLED technology that uses thermal evaporation and fine-metal masks to deposit emissive materials, DuPont has developed a liquid printing process that enables higher material utilization, can be scaled to any size motherglass and helps eliminate the need for fine-metal shadow masks, which can be costly and must be cleaned, inspected and replaced.

With the DuPont low-cost, liquid printing process technology, non-patterned OLED layers can be deposited using existing slot-die coating technology and patterned layers are deposited using a high-speed printer developed specifically for printing OLEDs.

The simple control requirements of this equipment allow excellent uniformity to be achieved. Deposited volume is dependent only on flow rate—which is held constant—and speed, which are both readily controllable.

**FIGURE 1.**

The DUPONT LIQUID PRINTING PROCESS IS DESIGNED TO SIGNIFICANTLY REDUCE PRODUCTION COSTS FOR LARGE-FORMAT TELEVISIONS.
OPTIMIZE YIELDS WHILE ENHANCING DISPLAY PERFORMANCE

By closely tailoring the materials and process to work together, DuPont has optimized color saturation, current efficiency, voltage and lifetime to address the needs of the active matrix OLED (AMOLED) display market.

Specifically, DuPont is able to tune ink formulations and process conditions to optimize intra-pixel and long-range uniformity. In addition, DuPont has developed techniques to characterize the uniformity from subpixel to subpixel to significantly minimize luminance stitching, a common challenge for printing technologies.

Using the DuPont liquid printing process and suite of innovative, high-performance, solution-based materials, display manufacturers may achieve an in-pixel thickness aperture of >95% and a thickness variation of ~2 nm across the plate with long-range uniformity >90%.

FIGURE 2.
SHORT-RANGE UNIFORMITY OF PRINTED DISPLAYS USING THE DUPONT OLED LIQUID PRINTING PROCESS EXCEEDS THE PERFORMANCE OF COMMERCIAL LCDs ($U_{\text{sh}}=0.93$).

<table>
<thead>
<tr>
<th>COLOR</th>
<th>$U_{\text{sh}}$</th>
</tr>
</thead>
<tbody>
<tr>
<td>BLUE</td>
<td>0.94</td>
</tr>
<tr>
<td>GREEN</td>
<td>0.94</td>
</tr>
<tr>
<td>RED</td>
<td>0.95</td>
</tr>
</tbody>
</table>

FIGURE 3.
PRINTED LIFETIME—EVEN FOR BLUE, THE MOST CHALLENGING COLOR—EXCEEDS 30,000 HOURS AND SHOULD BE SUFFICIENT FOR OLED TVs.
ACHIEVE SIGNIFICANT COST SAVINGS

The cost of OLED manufacturing, utilizing the DuPont liquid printing process and advanced materials, is projected to be approximately 30% below incumbent LCD costs and nearly 50% below equivalent evaporated panels. When costs for full Gen-8 solution processing are compared to those for cut-down processing for evaporation, the differential may increase to nearly 60%.

Why? The DuPont liquid printing process technology is scalable to large motherglass size—one of the major drivers of manufacturing cost reduction in the display industry. Scalability may result in lower material consumption. Printers also cost less to purchase, maintain and operate than evaporators, so capital and fixed costs are reduced.

Taking a closer look at material consumption, it is easy to see the distinct advantage of using DuPont technology versus thermal evaporation, which remains a relatively inefficient deposition technique. Specifically, the layers processed with the liquid printing process consume only 1-1.3 grams for coated layers and 0.6-2.0 grams for printed layers, depending on the selected architecture. In sharp contrast, 5-10 grams of OLED material are consumed for each gram of material evaporated onto the area of the substrate when thermal evaporation process is used.

55" DISPLAY OLED FABRICATION COST

6 UP ON 2.2 X 2.5 METER BACKPLANE

FIGURE 4.
SIGNIFICANT COST SAVINGS CAN BE ACHIEVED BY USING LIQUID PRINTING PROCESS TECHNOLOGY.*

* Cost comparison for evaporation shows full and cut-down substrates. Reference LCD comes from third-party industry cost models.
HIGH-PERFORMANCE OLED MATERIALS

DuPont offers a suite of innovative, high-performance, solution-based materials that can be printed and coated at high speeds. All the materials are designed to work together to provide excellent device performance, quality, efficiency and lifetime. This suite of materials includes:

- DuPont Hole Injection Layer (HIL)
- DuPont Hole Transport Layer (HTL)
- Emissive Layer (EML)
- Electron Transport Layer (ETL)

REALIZE THE BENEFITS OF DUPONT OLED TECHNOLOGY

DuPont offers highly engineered, next-generation materials and a scalable, liquid printing process that is making the promise of lower cost OLED technology commercially feasible for large-format displays.

With these advancements from DuPont, manufacturing cost should no longer be a major barrier to the adoption of OLED technology for large-format televisions. DuPont is enabling manufacturers to deliver the many benefits consumers want—more vivid color, higher contrast, faster response, thinner panels, wider viewing angle and less power consumption while significantly reducing manufacturing costs. The time is now to realize the benefits of DuPont OLED technology.

For more information about DuPont OLED technology, please visit: oled.dupont.com