Process Tools for Organic Devices

- SID Meeting 2012-
Overview

• Current industry challenges
• System concept proposal
• Introduction of main modules
• Introduction of core process tools
• Summary
### Manufacturing Process...

<table>
<thead>
<tr>
<th>Process Type</th>
<th>Process Step</th>
<th></th>
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</thead>
<tbody>
<tr>
<td></td>
<td>EL Coating</td>
<td>Cathode Deposition</td>
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<tr>
<td><strong>Today</strong></td>
<td>Vacuum</td>
<td>Vacuum</td>
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<tr>
<td><strong>Mid-Term</strong></td>
<td>Ambient</td>
<td>Vacuum</td>
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<tr>
<td><strong>Long-Term</strong></td>
<td>Ambient</td>
<td>Ambient (?)</td>
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Cost savings are expected from cheaper equipment materials for ambient pressure processes are required.
Challenges

Change of focus ...

- **properties**: power efficiency, luminescence, brightness, driving voltage
- **cost**: materials, equipment investment costs, equipment running costs

Manufacturing process has been widely stabilized; manufacturers are seeking for solutions to reduce manufacturing costs
Challenges

Cost saving potentials ...

Cost savings are expected due to cost reductions in the organic coating and encapsulation processes
Challenges

- high running costs
- scale up problems for larger substrates
- high investment costs
- low material usage
- high foot print (cleanroom)

- low running costs
- almost unlimited in substrate size
- low to medium investment costs
- high material usage
- small foot print

ambient process equipment allows cost savings
Low yield due to particle contamination ...

- developed specifically for the demands of the OLED industry
- HPL membrane (in-house development) ensures cleanroom class < 1
- qualified by the Fraunhofer Institute for Manufacturing Engineering
- featuring proprietary HPL technology
- systems are designed to integrate 3rd party process and handling tools
Main features

- Advanced coating technology (slot-die coating) to increase material yield
- Cleanroom class 1 environment to minimize particle effects
- Coating modules for water based and non-water based materials
- Vacuum cluster tool for organic and metal deposition
- Seal encapsulation module
- Tracking & Tracing (for each substrate a complete history log is created)
- From Process development to production scale
- Extensibility to increase tact time and add future process modules
System Proposal

Material Flow

Module A: Cleanroom Class 1, Cleaning, Coating, Curing
Module B: Cleanroom Class 1, Cleaning, Coating, Curing
Module C: Vacuum Coating
Module D: Cleanroom Class 100; encapsulation
Module A

Coating under Cleanroom Class 1 ambient conditions

Main Features
- Cleanroom Class Level <10
- Integrated Slot-Die Coater
- Vacuum hotplates
- UV-Cleaner
- Robot on linear track
Module B

Coating under Cleanroom Class 1 inert conditions

Convection Oven  UV-Cleaner  Vacuum Hotplate

Robot  Spin-Coater  EBR  Slot-Die Coater
Module B

Coating under Cleanroom Class 1 inert conditions

Main Features
- Cleanroom Class Level <1
- Inert Conditions
- Integrated Twin-Head Slot-Die Coater
- EBR-Tool
- Robot on linear track
Module D

Encapsulation

Main Features
- Inert Conditions
- Vacuum Oven for initial Drying
- UV-Cleaning
- Getter Dispense Platform
- Vacuum Lamination
Slot-Die Coater...

8” glass substrate; plasma treated
Wet film thickness circa 8 µm
Dry film thickness 75-85nm
Cross die head uniformity (top-bottom) +/- 1-2nm
Cross coating width uniformity (left-right) +/- 4-5nm
**Edge bead removal...**

- minimizing trailing edge and leading edge effects of slot-de coaters
- automatic edge detection
- programmable smooth-jet nozzle
- no heat transfer or mechanical damage to substrate
**Vacuum hotplates**

- Temperature range: 40°C – 250°C
- Temperature uniformity: ± 1%
- Vacuum level: 10-2 mbar
- Soft bake function: pins height adjustable in 20 µm steps
- Process modes: ambient pressure bake, vacuum bake, under-pressure purge bake

- No temperature shock; no warping
- Highly uniform and reproducible curing results
Getter Dispense Platform...

- integrated process platform
- cover glass auto-alignment
- up to 4 different process heads can be mounted (ODF capability)
Process Tools

Vacuum Lamination...

- **process modes**: non-contact gas pressurised with decompress function
- **alignment**: mechanical press with decompress function
- **alignment**: automatic glass to glass alignment
- **UV-mask**: masks with optical filter to protect the organics from high intensity UV
- **vacuum level**: 10⁻² mbar
- **UV-source**: high intensity UV-source with Fe doping (up to 480 mW/cm²); URS reflector
Summary

- increase material yield due to advanced coating techniques
- elimination of particle effects on device performance due to laminar flow
- extensibility for future process modules
- system concept is easy to scale-up (from R&D up to production)
- full „tracking & tracing“ for quality control and process improvement
Thank you for your attention