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INERTGAS TECHNOLOGY

Process Tools for Organic Devices

- SID Meeting 2012-



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Overview

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- Current industry challenges
- System concept proposal
- Introduction of main modules
- Introduction of core process tools
- Summary



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Technology Trend

Manufacturing Process ...

Process Type	Process Step		
	<i>EL Coating</i>	<i>Cathode Deposition</i>	<i>Encapsulation</i>
<i>Today</i>	Vacuum	Vacuum	Ambient / Vacuum
<i>Mid-Term</i>	Ambient	Vacuum	Ambient / Vacuum
<i>Long-Term</i>	Ambient	Ambient (?)	Ambient / Vacuum



cost savings are expected from cheaper equipment
materials for ambient pressure processes are required

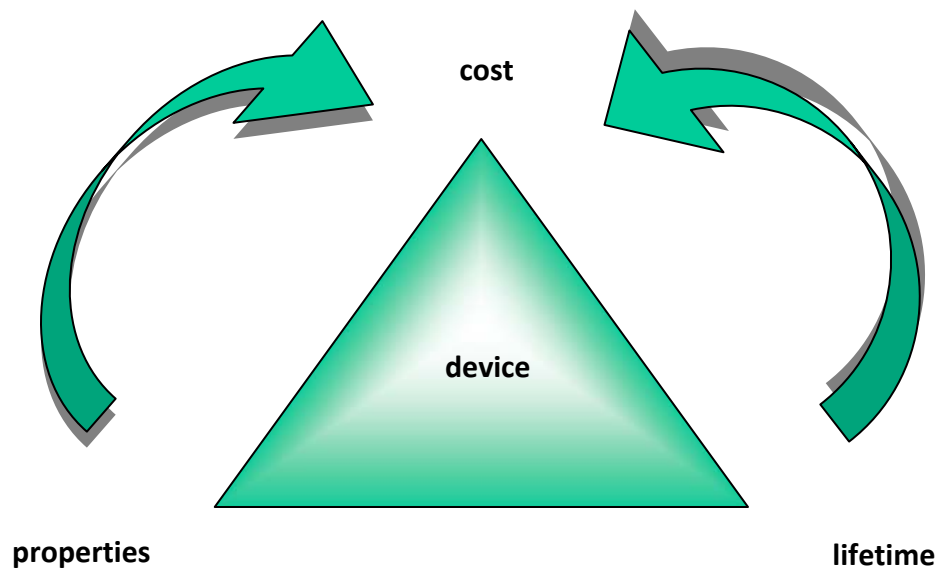


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Challenges

Change of focus ...

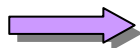


properties

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

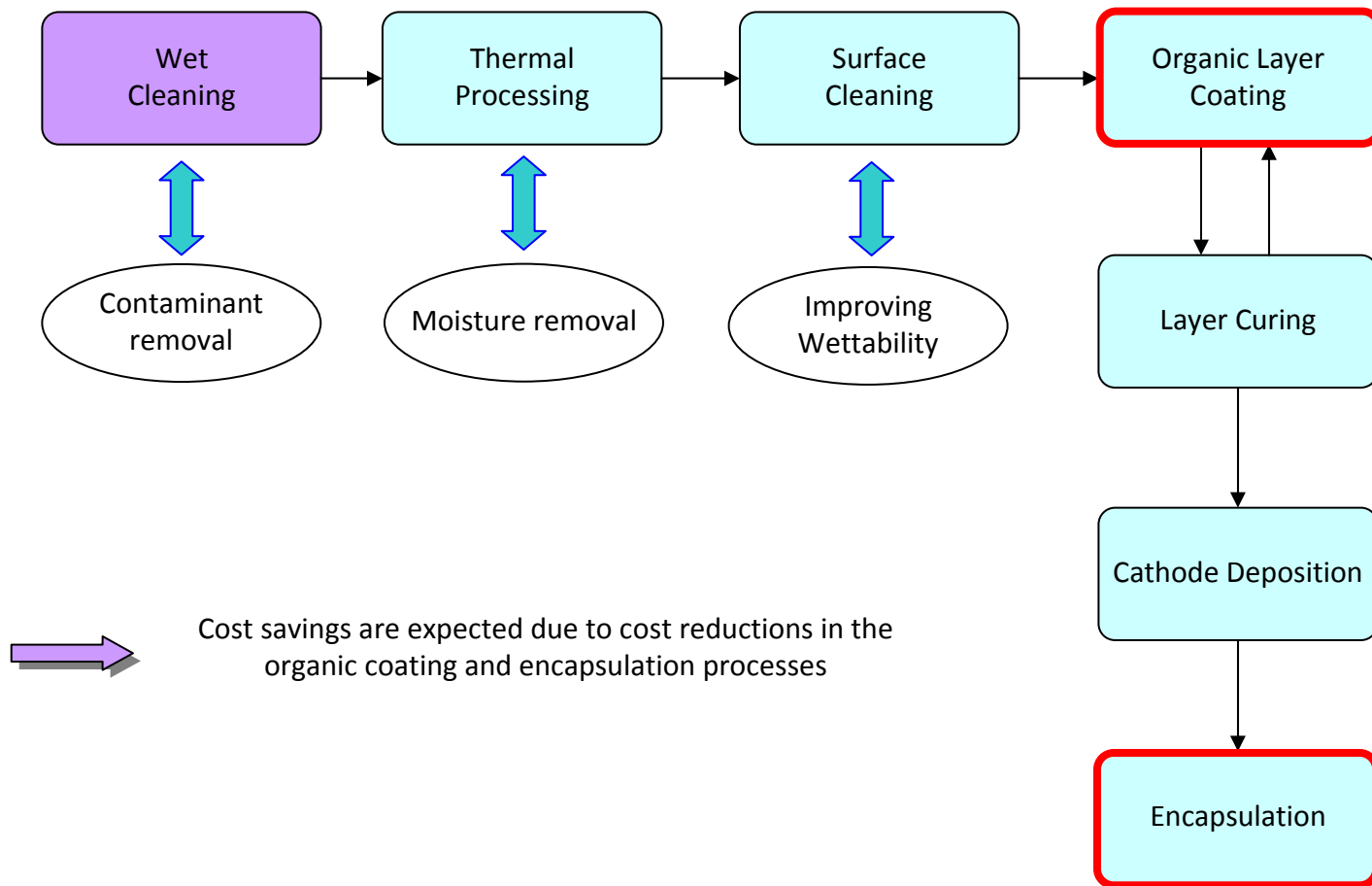


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Challenges

Cost saving potentials ...





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Challenges

Equipment ...



vacuum

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



ambient

- 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

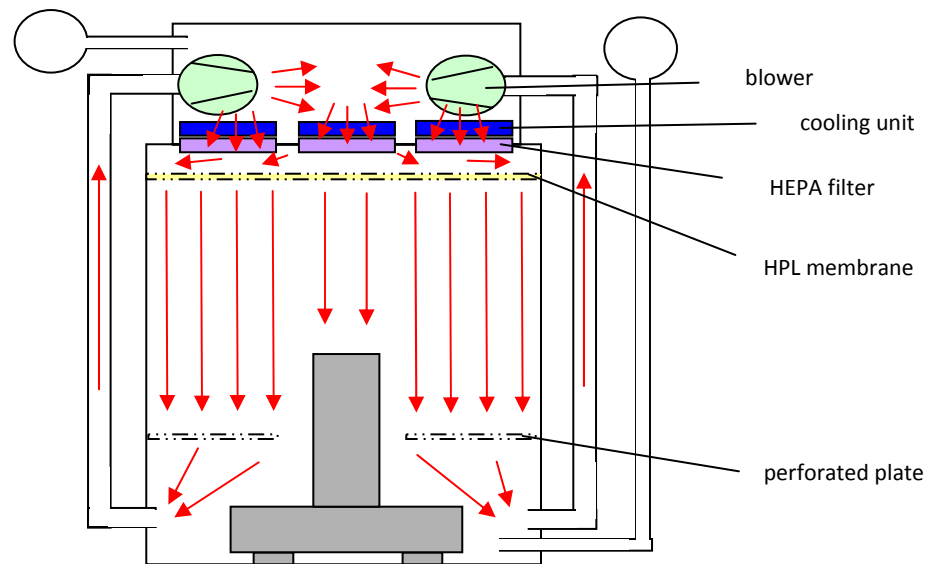


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Challenges

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



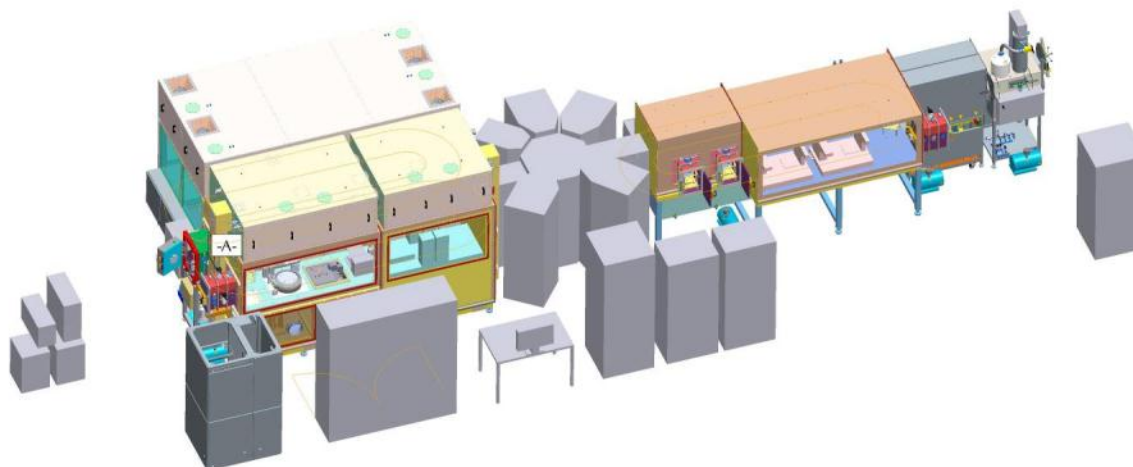


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System Proposal

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

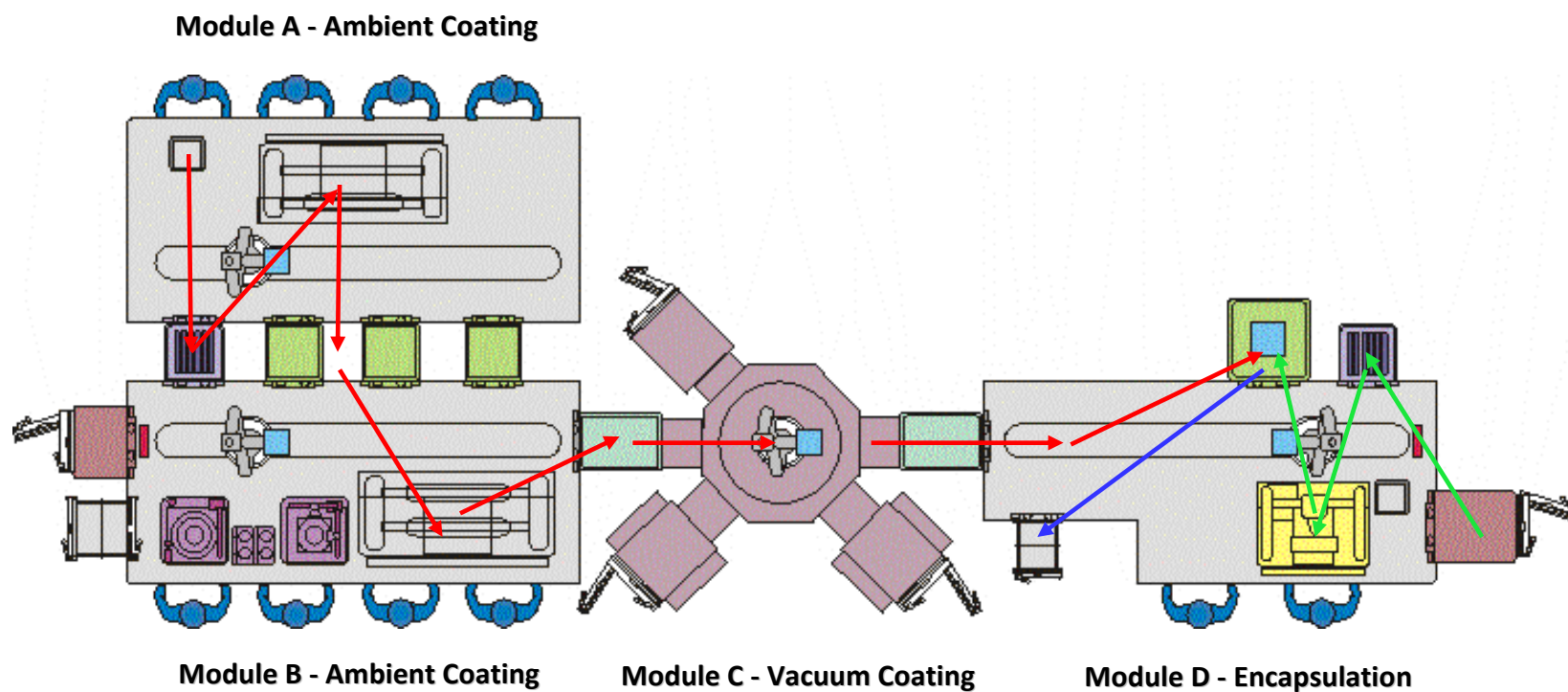


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System Proposal

Material Flow



Module A: Cleanroom Class 1, Cleaning, Coating, Curing

Module B: Cleanroom Class 1, Cleaning, Coating, Curing

Module C: Vacuum Coating

Module D: Cleanrom Class 100; encapsulation



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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

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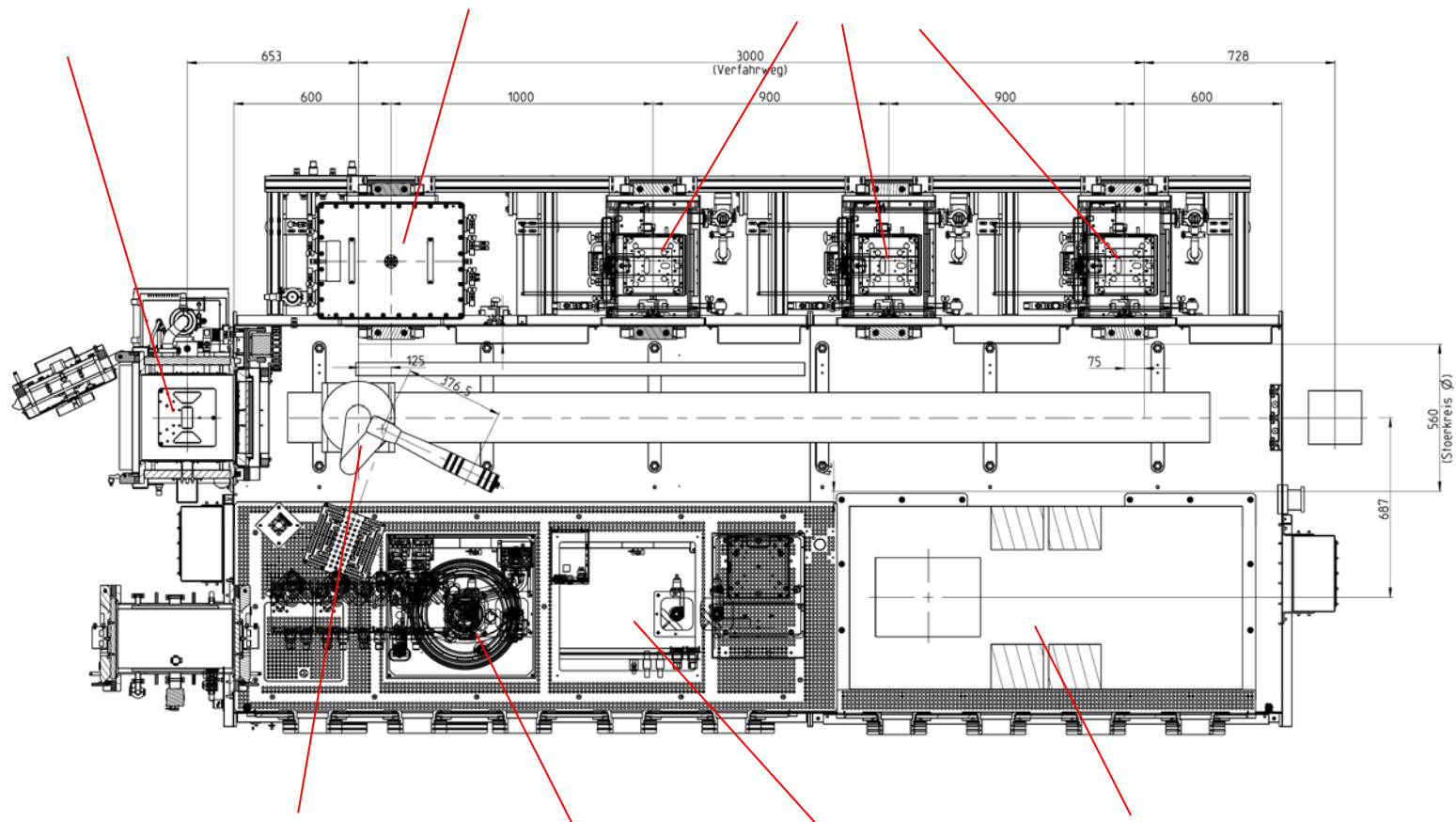
Module B

Coating under Cleanroom Class 1 inert conditions

Convection Oven

UV-Cleaner

Vacuum Hotplate



Robot

Spin-Coater

EBR

Slot-Die Coater

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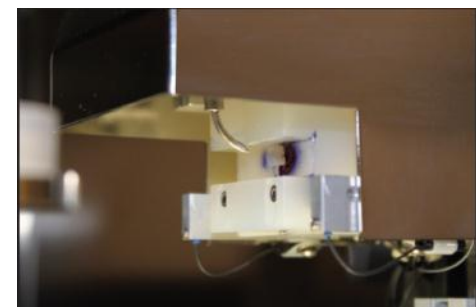


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Module B

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

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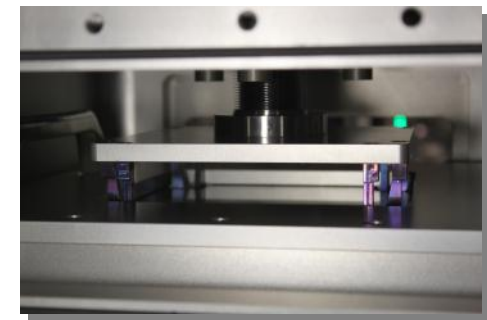


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Module D

Encapsulation



Main Features

- Inert Conditions
- Vacuum Oven for initial Drying
- UV-Cleaning
- Getter Dispense Platform
- Vacuum Lamination

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Process Tools

Slot-Die Coater...



83.26 nm	75.48 nm	74.47 nm	75.20 nm	76.14 nm	80.12 nm	79.07 nm
82.90 nm	76.38 nm	74.69 nm	72.89 nm	73.81 nm	79.06 nm	77.91 nm
81.79 nm	75.88 nm	74.42 nm	74.88 nm	75.32 nm	78.96 nm	78.23 nm
84.11 nm	77.17 nm	75.42 nm	75.21 nm	75.21 nm	80.35 nm	79.01 nm
80.61 nm	74.84 nm	72.04 nm	73.19 nm	74.67 nm	79.52 nm	76.50 nm
81.16 nm	75.95 nm	73.78 nm	74.33 nm	75.84 nm	80.70 nm	76.42 nm
83.85 nm	74.65 nm	73.40 nm	74.95 nm	76.09 nm	80.14 nm	78.04 nm

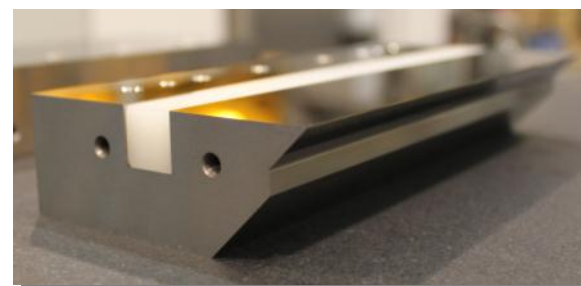
8" glass substrate; plasma treated

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



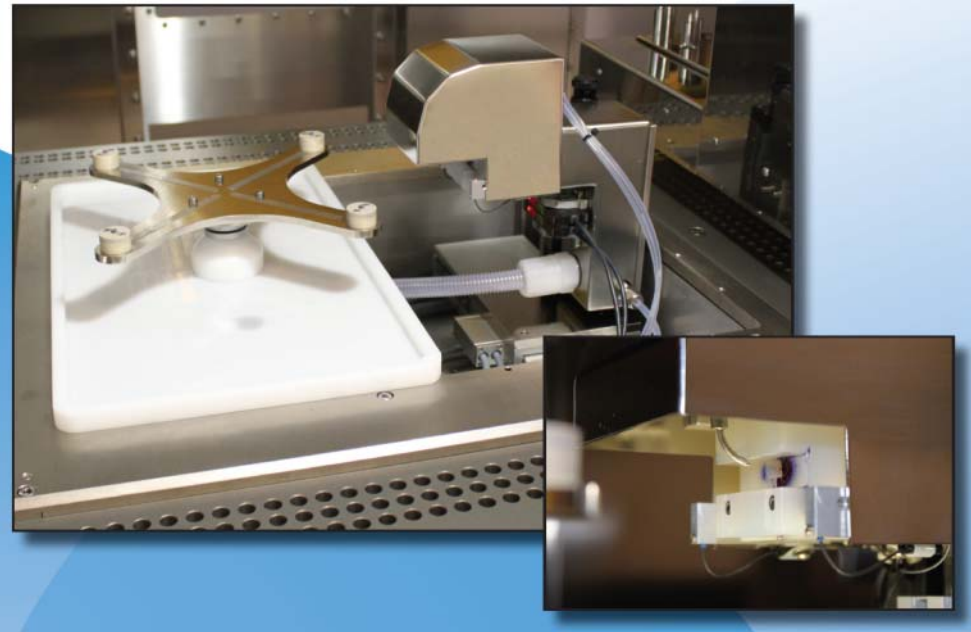


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Process Tools

Edge bead removal...



test results with X-Y driven EBR nozzle

- ➡ 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

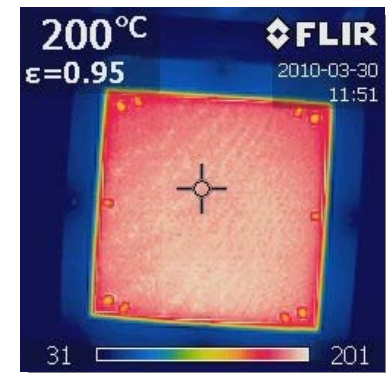
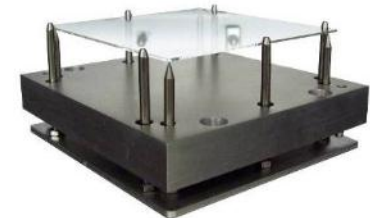


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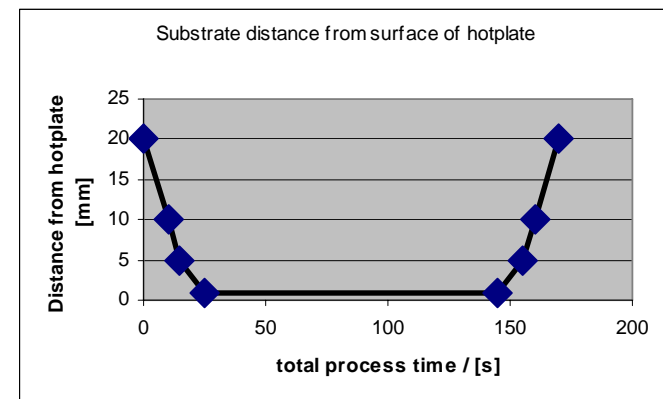
Process Tools

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








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Process Tools

Getter Dispense Platform...



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

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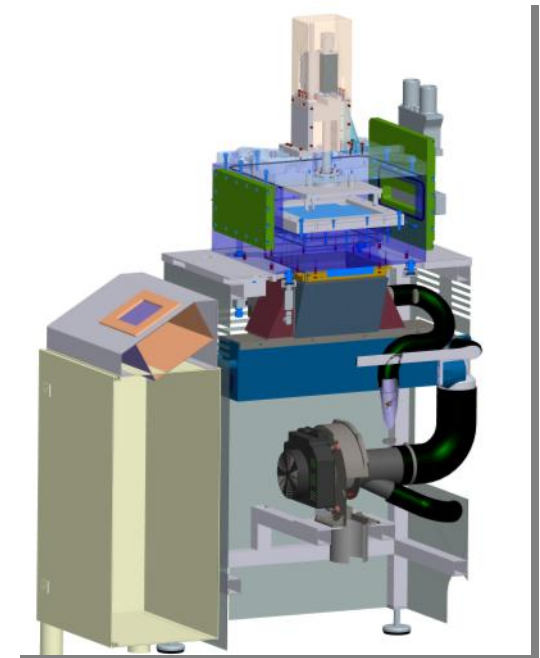
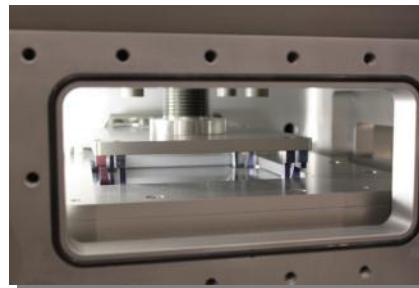
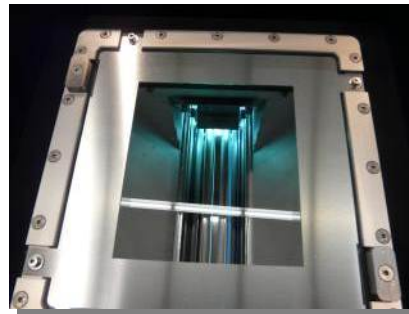


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Process Tools

Vacuum Lamination...



process modes	non-contact gas pressurised with decompress function 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/cm^2); URS reflector



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Summary

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- 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



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Thank you for your attention

