



© Centre for Process Innovation Ltd (CPI) ([www.uk-cpi.com](http://www.uk-cpi.com))  
All Rights reserved

## THE LACE-LINE

HIGH-END OLED PROTOTYPING FOR SOLUTION BASED MATERIALS



## **BACKGROUND**

Many of commercialized OLED display and lighting products are manufactured by depositing numerous thin layers of materials onto glass substrates or flexible plastic foils. Today's highest-efficiency OLEDs are usually made using evaporative processes under vacuum conditions. However most manufacturers face challenging tasks to reduce overall manufacturing costs with the current equipment concepts and material systems. Switching to atmospheric-pressure conditions, solution-based processing shows great potential to reduce the overall cost of OLED manufacturing, removing the need for expensive vacuum equipment and reducing the wastage of costly OLED materials.

## **GOAL**

Development and optimization of solution-based processes by adapting existing key-technologies such as slot-die-coating is the main goal of LACE-Line. In order to introduce solution based processing into the current production lines of end manufacturers, MBraun Inertgas-Systeme GmbH brought together key players across the value-chain to create a unique system concept which allows for cleaning, coating and encapsulation of organic light emitting diodes and organic photovoltaic technologies.

## **CONCEPT AND MAIN FEATURES**

The LACE prototyping line has been designed as an open platform to enable the development and pilot-scale production of organic light emitting diode and organic photovoltaic technologies. It is suitable for processing both air sensitive and non-air sensitive material sets for the manufacturing of devices on a range of substrate sizes up to 200mm square.

Four core modules with maximum process flexibility have been conceptualized to accommodate manufacturing of both small molecule and solution based (polymer) materials in a high quality class 10 clean room environment and H<sub>2</sub>O and O<sub>2</sub> concentrations below 1 ppm . Capabilities include slot-die-coating technology and spin coating which are run under ambient pressure conditions as well as physical vapor deposition in a high-vacuum cluster tool. The latter provides both inorganic cathode capability and organic small molecule capability.

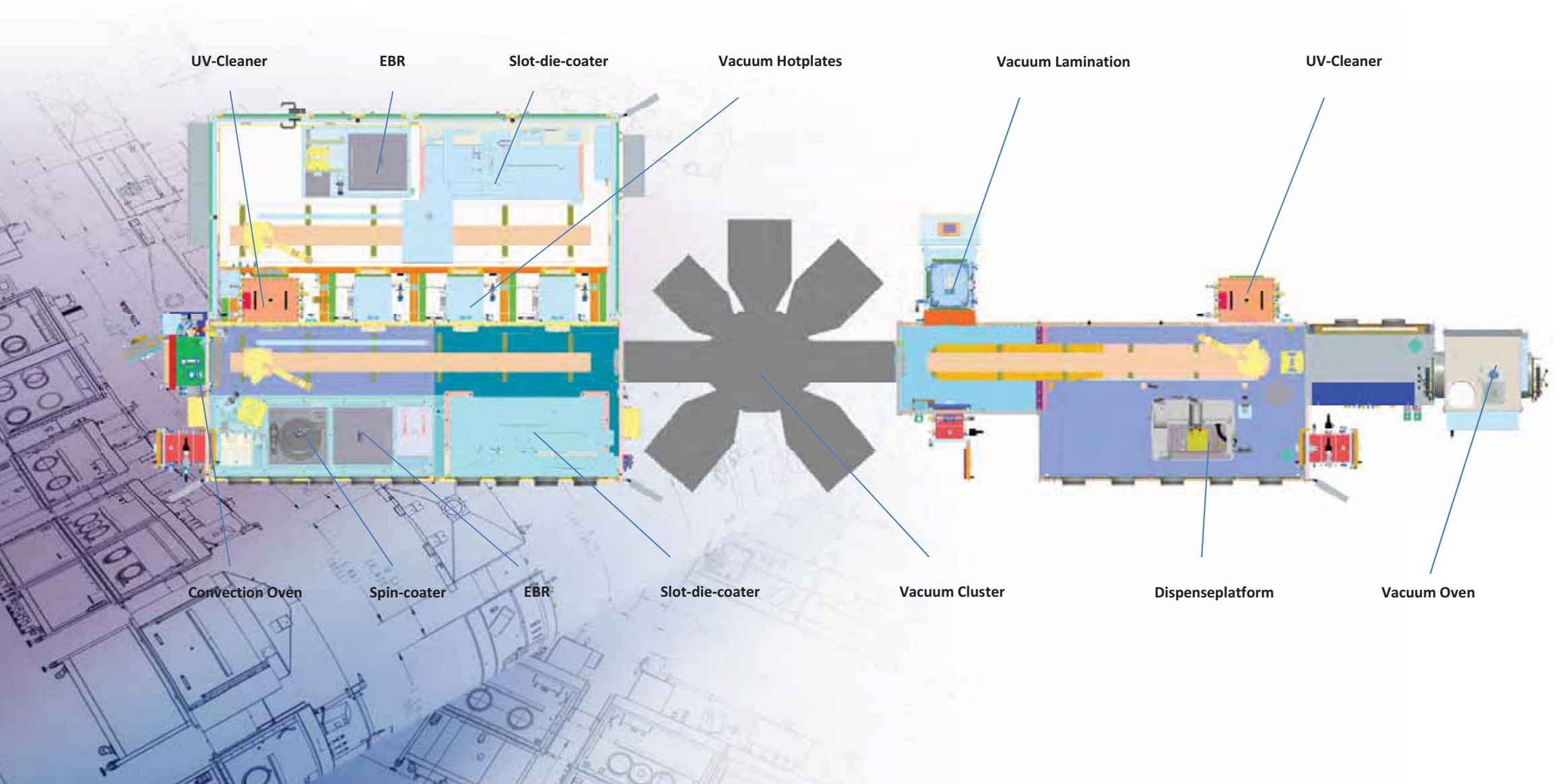
Device performance and lifetime is enhanced by the use of a dedicated encapsulation module to apply desiccant sheets and glue adhesives to a cover glass before the organic devices are laminated under vacuum conditions. Fully automated robotic control, cassette to cassette handling and ULPA filtered laminar flow modules provide a unique environment to support high yield, low defect device quality.

Designed and built by MBraun Inertgas-Systeme GmbH, the line provides material companies, device designers and end-users the unique opportunity to optimize their processes and material formulas within a fully automated, controlled environment.



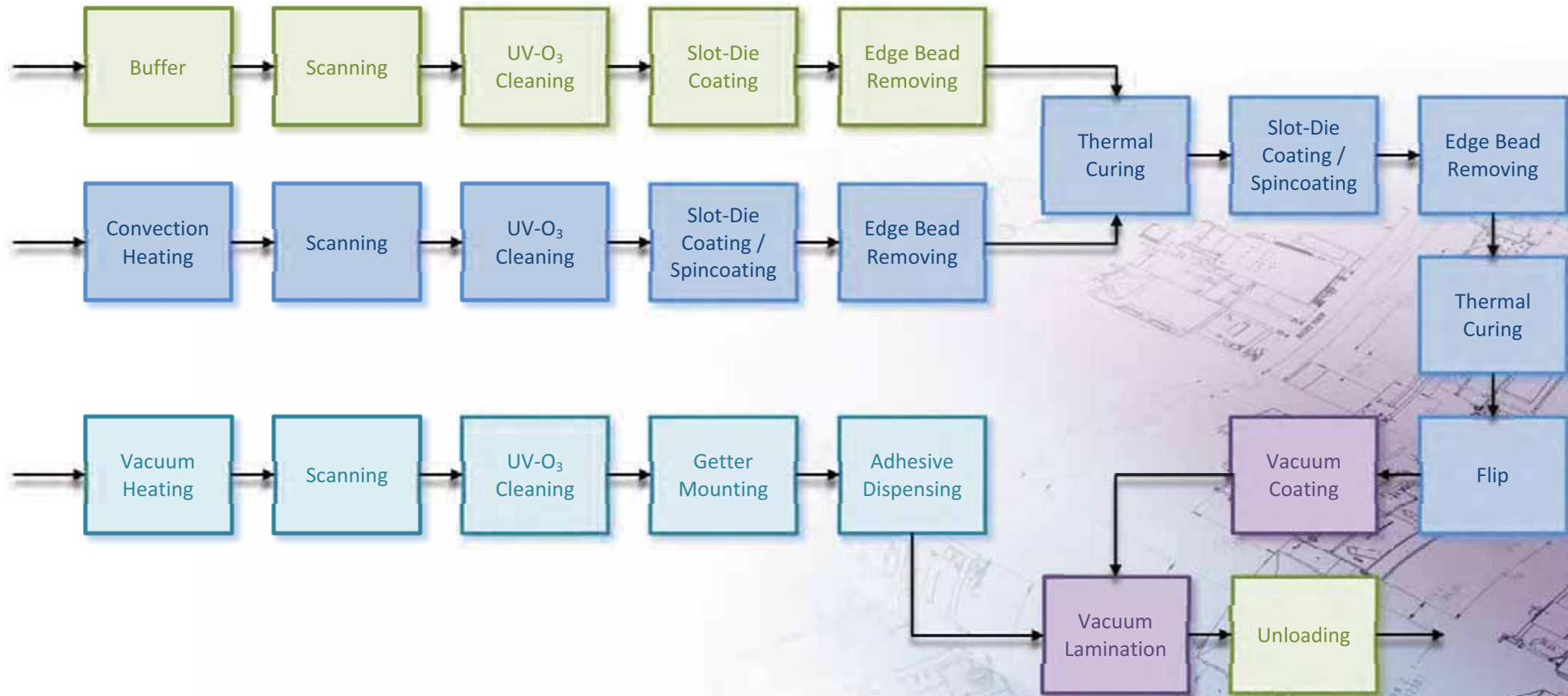
## SYSTEM SETUP

The LACE-line consists of four core modules – the ambient coating module, the inertgas-coating module, the vacuum cluster and the encapsulation module. Each module is fully robot aided which prevents the necessity for manual interaction thus eliminating any kind of human error. Various process stations for cleaning, coating, curing and encapsulation are integrated into the different modules. A supervisory control system with recipe and process data management retrieves all parameters of each substrate during the manufacturing process creating an individual process history log file for each device.



## PROCESS FLOW

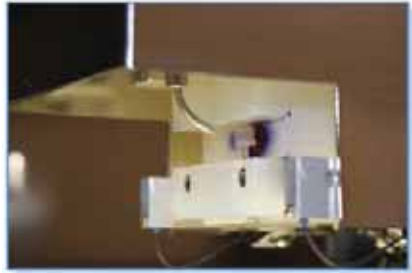
Having the main focus next to reliability and process repeatability on flexibility the system offers several process variants which can be performed on this system. This includes an ambient coating process for non-air sensitive materials, an inertgas based coating process for air sensitive materials and a vacuum coating process.







### EBR-Tool – Selective Layer Removal



Cleaning the edges from organic layers is the prerequisite for an optimized subsequent encapsulation of the organic device. The removal process itself utilizes a high velocity solvent jet. By directing the solvent jet towards the organic layer and moving the nozzle parallel to the substrate edge, a precise and accurate removal is achieved.

Technical Characteristics:     Boundary area adjustable between 1-15 mm  
  Defect-free selective removal of organic layers  
  Proprietary debris removal system  
  Up to 6 feed lines for different solvents

### Spin-Coater – Material Quick Tests



High-end spincoater with a range of extra features enables quick-testing of new material formulations and optimization work of existing processes. Main features are an external cartridge dispensing system for small material amounts, diaphragm dispense pumps for larger material quantities, covered chuck technology for enhanced layer uniformities and various feed lines for up to 6 materials.

Technical Characteristics:     Rotation speed up to 6.000 rpm  $\pm$  1 rpm  
  Acceleration 160rpm/s<sup>2</sup>  
  For viscosities up to 800 cps  
  Low contact vacuum chucks

### Cluster Tool – Vacuum Coating



This module is a traditional vacuum cluster tool. With automatic mask-handling, one chamber for organic material evaporation, one chamber for metal coatings and spare positions for future extension a wide range of materials and processes can be run under vacuum conditions in the 10<sup>-7</sup> mbar range.

Technical Characteristics:     Base pressure  $\leq$  5 x 10<sup>-7</sup> mbar  
  Multi-source process chambers with shutter systems  
  Automatic mask-storage and mask-changing system  
  Layer uniformities: organics  $\leq$   $\pm$ 3%; metals  $\leq$   $\pm$ 5%











© Centre for Process Innovation Ltd (CPI) ([www.uk-cpi.com](http://www.uk-cpi.com))  
All Rights reserved



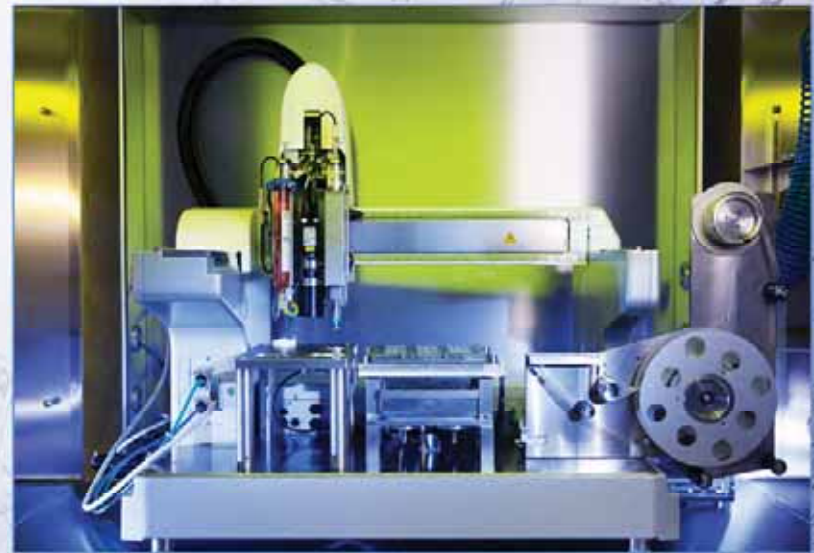
© Centre for Process Innovation Ltd (CPI) ([www.uk-cpi.com](http://www.uk-cpi.com))  
All Rights reserved



© Centre for Process Innovation Ltd (CPI) ([www.uk-cpi.com](http://www.uk-cpi.com))  
All Rights reserved











 *turning ideas into solutions*

**M. Braun Incorporated**

14 Marin Way • Stratham, NH • 03885  
Phone: +1 603-773-9333 • Fax: +1 603-773-0008  
[www.mbraunusa.com](http://www.mbraunusa.com) • [info@mbraunusa.com](mailto:info@mbraunusa.com)

**M. Braun Inertgas-Systeme GmbH (Headquarters)**

Dieselstr. 31 • 85748 Garching • Germany  
Phone: +49 89 32669-0 • Fax: +49 89 32669-105  
[www.mbraun.de](http://www.mbraun.de) • [info@mbraun.de](mailto:info@mbraun.de)

**M. Braun Inertgas Systems (Shanghai) Co. Ltd.**

No. 145 Jintang Road • Tangzhen, Pudong • Shanghai • 201201  
Phone: +86 21 5032 02 57 • Fax: +86 21 5032 02 29  
[www.mbraunchina.com](http://www.mbraunchina.com) • [info@mbraunchina.com](mailto:info@mbraunchina.com)