



1 Flexible OLED manufactured in roll-to-roll process within the PI-SCALE project (funded by the Horizon 2020 research and innovation programme of the European Union; Funding reference 688093)

2 Roll-to-roll vacuum deposition system

ROLL-TO-ROLL PROCESSING IN ORGANIC ELECTRONICS

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Organic light-emitting diodes (OLED) and other devices of Organic Electronics have already found a variety of applications. Because Organic Electronics allow to build devices on flexible substrates, such as polymer film, metal foil or even ultra-thin flexible glass new applications arise. Such devices on flexible substrates are currently produced in sheet-to-sheet processes on individual sheets. Cost-cutting potential, as well as the ability to present unique designs, such as long strips, are made possible by novel roll-to-roll techniques. Here, all

processing takes place on rolls which are only cut into the individual modules at the end of the entire process chain.

At Fraunhofer FEP, the world's first process line for organic light-emitting diodes for lighting and signage applications has been set up and continuously improved in recent years. Thus, in the roll-to-roll manufacturing of organic-based components on flexible substrates, we offer R&D services ranging from concept studies to the production of prototypes on different substrate types.

General specification

- 50 – 300 mm web width
- Metal strips up to 500 µm thickness
- Polymer webs from 50 – 500 µm thickness
- Ultra-thin flexible glass between 50 – 100 µm
- Process speed between 0.01 – 1 m/min
- Liner film protection of substrates
- Inert transfer between systems



Vacuum deposition system

The vacuum deposition system is available for evaporation of organic materials (small molecules) and metals. The 14 linear evaporators (4 double, 3 single, 1 triple) are able to realize a white OLED with high efficiency and other organic devices like solar cells. The winding concept of the roll-to-roll coater avoids front side contact of the substrate to the transport rollers. After the coating process the web can be protected during the re-winding by a liner film. The deposition drum can be heated up to 80°C for substrate pre-treatments and can be actively cooled down to -10°C during the deposition process.

- 14 linear evaporators (1 triple, 4 double, 3 single)
- 2 metal thermal evaporation sources
- Magnetron for metal- and reactive metal oxide sputter processes
- Temperature controlled deposition drum for substrate pre-treatment by heating or substrate cooling during deposition

Lamination and coating unit

The coating and lamination unit (fig. 3) is suited for functionalizing the substrate surface by coating processes and encapsulation of organic devices with e.g. a barrier film. The coating and lamination unit is encased in an inertbox to process under protective atmosphere. Therefore printing and coating with moisture and oxygen sensitive materials is possible.

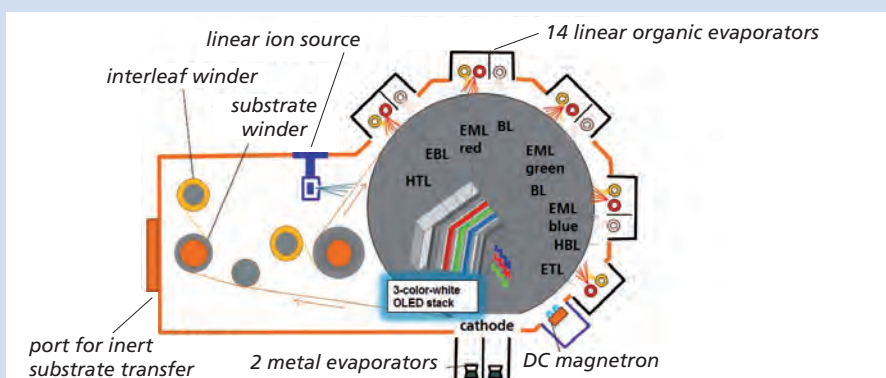
- Protective nitrogen atmosphere
- Flexographic printing and slot die coating
- Web inspection system
- Thermal (IR) and UV light curing possibility
- Flash lamp annealing for sintering of printed metal busbars
- Substrate lamination with edge (cartridge) and area (hot-meld) encapsulation

Inspection system

The inspection system (fig. 4) consists of a winding unit with a CCD camera bank for pixel resolution down to 14 µm (100% web inspection) and a modular, moveable optical microscope with a point resolution down to 1 µm.

- Contactless winding of the substrate under clean room class ISO6
- 100% inspection by means of line scan cameras (pixel resolution 14 µm)
- Attached moveable optical microscope (point resolution 1 µm)
- Rewind mode for defect analysis detected by the line scan cameras
- Automatic statistical analysis of recorded optical images by spot counting
- Integrated confocal microscopy for substrate and device topography analysis

5 Schematic layout



3 Roll-to-roll printing and lamination system

4 Roll-to-roll inspection line encased in an inertbox (clean room class ISO6)



We focus on quality and the ISO 9001.