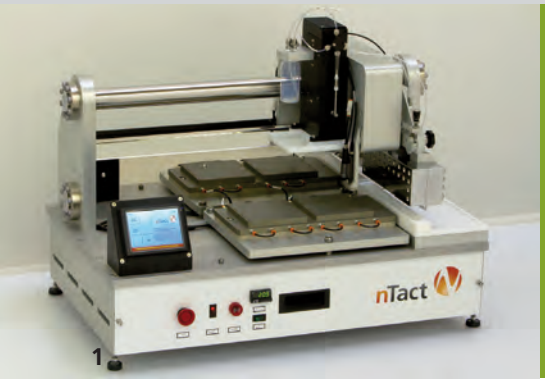
Fraunhofer
FEP

FRAUNHOFER INSTITUTE FOR ORGANIC ELECTRONICS, ELECTRON BEAM AND PLASMA TECHNOLOGY FEP



1


2


3

1 *Slot Die Coater (© nTact)*
2 *Brewer Science® Cee® 200X Spin-Coater (© Brewer Science Inc.)*
3 *8" Spin-Coater (© Laurell Technologies Corp.)*

LIQUID PHASE DEPOSITION TO CREATE ORGANIC LAYERS

Fraunhofer Institute for Organic Electronics, Electron Beam and Plasma Technology FEP

Winterbergstr. 28
01277 Dresden, Germany

Contact persons

Ines Schedwill
Phone +49 351 8823-238
ines.schedwill@fep.fraunhofer.de

Dr. Matthias Schober
Phone +49 351 8823-368
matthias.schober@fep.fraunhofer.de

Emmy Holst
Phone +49 351 8823-479
emmy.holst@fep.fraunhofer.de

www.fep.fraunhofer.de

Introduction

For organic semiconducting materials, solution deposition procedures are of increasing interest. In comparison to vacuum processes, deposition from liquid phase is especially beneficial in terms of process cost. Moreover, liquid phase processing enables the use of materials with high thermal stability that can be processed in ambient clean-room atmosphere, and even be structured by photolithography.

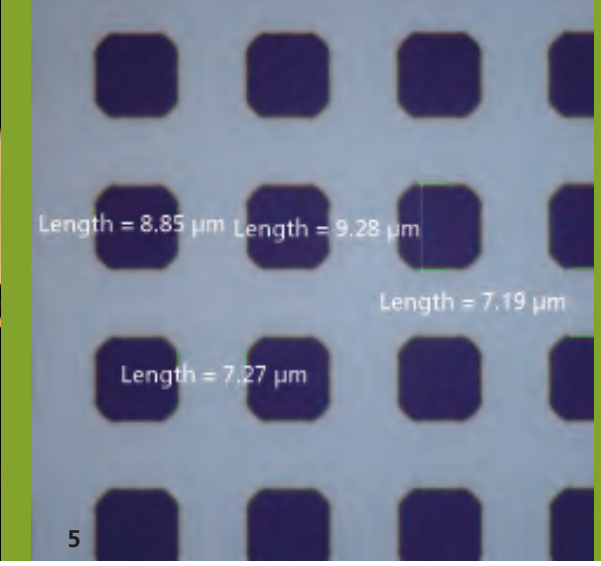
Today, liquid phase deposition already serves to fabricate many different products such as e-book readers and electronic sensors. Further applications are technologies of OLED, OPV, OPD, RFID and others.

Liquid Phase Deposition

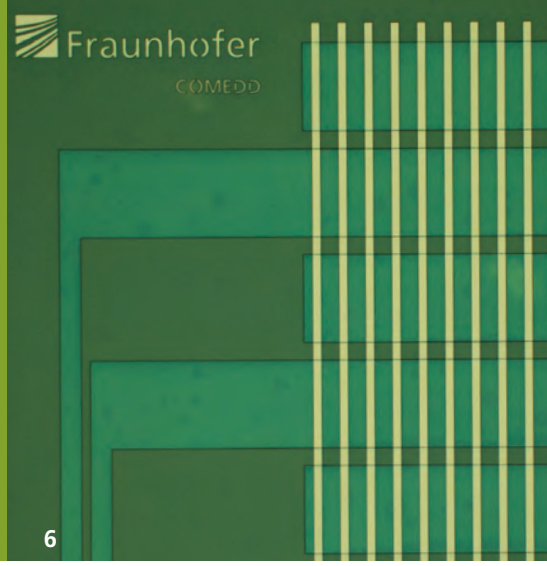
At the Fraunhofer FEP, various liquid-phase deposition processes are used and further developed. For this, versatile process equipment is available in two clean rooms (ISO 4): a screen printing tool, a slot-die coater as well as various spin coaters in ambient air and inert Nitrogen atmosphere. Among standard processes are the production of grid anode structures, passivation layers, as well as of hole-injection and hole-transport layers for use in organic semiconductor devices.

Further applications addressed at the Fraunhofer FEP are micro-structured or printed circuits, e.g. OFET backplanes for display and sensor devices, moreover spectroscopy and thin-film batteries.

4



5



6

Orthogonal Photolithography

Orthogonal photolithography has matured into a reliable and versatile micro-structuring technique for organic semiconductors. The technology makes use of special photo chemicals which are eco-friendly and compatible with most organic semiconductors. These photo chemicals are used similarly to conventional photo resists, developers and strippers in standard photo-lithography equipment. Typically, the Orthogonal photo resist is deposited onto underlying organic layers by spin coating. Afterwards, it is exposed to UV light in a contact aligner and developed with Orthogonal developer in a spray-coater system. The main benefit of the specialized photo chemicals is their "orthogonality" towards organic materials, which means that the chemicals do neither react with nor dissolve the underlying organic layers. Pattern transfer is realized by plasma etching methods. This also means that Orthogonal photo lithography is not limited to organic materials but can be applied to other materials such as ITO, Si, SiO_2, metals and others as well. At the Fraunhofer FEP, these methods are used to fabricate micro structured OLED and OPD devices for display and sensor applications, on substrates up to 200 mm.

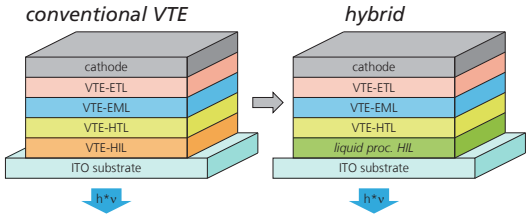
Slot-Die Coating in use for hybrid OLEDs

Organic Light-Emitting Diodes that combine organic layers deposited from liquid phase and organic layers deposited via vacuum processes are called "hybrid OLEDs". The benefits of hybrid processing are manifold. One major advantage is the reduction in vacuum process time and thus in process cost. Another benefit of solution deposited layers is the planarization of rough bottom electrodes featuring peaks or particles that can lead to shorts and therefore be crucial to the device performance. Further advantages lie in inherent features of the solution processed materials such as high thermal stability and superior energy-level alignment at metal electrodes. Especially for hole injection and transport materials, these features are widely spread under solution processable materials.

Equipment for Liquid Phase Deposition at the Fraunhofer FEP

- **Slot-Die Coater (nTact)**: partially-automated slot-die coater with 200 mm die width; operation under ambient conditions; processing of polar and non-polar solvents on various substrates.
- **Screen Printer**: automated screen printer for substrates up to 370 × 470 mm²; operation under ambient or inert Nitrogen conditions.
- **Spin Coater (EVG)**: fully automated spin coater for 200 mm wafers; processing of polar and non-polar solvents.
- **Spin and Spray Coater (Brewer)**: semi-automated spin and spray coating unit for different substrates up to 200 mm; processing of Orthogonal photo chemicals.
- **Spin Coater (Laurell)**: semi-automated spin coater in inert Nitrogen atmosphere; flexible use of substrates up to 200 mm; processing of aqua-free solvents only.
- **Dispenser**: semi-automated dispenser in inert Nitrogen atmosphere; flexible use of substrates up to 200 × 200 mm²; processing of aqua-free solvents only.

7 *Diagram of a simple exemplary preparation of a hybrid with one solution-deposited layer*



VTE:
vacuum thermal evaporation

ETL, EML, HTL:
functional layers in OLEDs

4 *Hybrid OLED (~ 65 cm²)*

5 *8 µm polymer pixel*

6 *Passive matrix display structured by photolithography*

TÜVRheinland ZERTIFIZIERT
Management System
ISO 9001:2015
ISO 50001:2011
www.tuv.com
ID 9105050079

We focus on quality and the ISO 9001.