

# Production Technologies for Large Area Flexible Electronics

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## Abstract

*There is a wide variety of printed large area flexible electronic devices and at the same time a number of different visions and estimates for this new emerging industry and market. But as every new industry or technology, printed electronics has to overcome technology red brick walls, survive the valley of death for the start ups and spin offs and be competitive enough against existing technologies, like silicon technologies.*

*The talk wants to give a broad picture on these new products and describes the potential market outlook. Then the talk tries to give a definition of common characteristics for printed electronics and the potential of not only single printed devices, but for integrated products which can consist of only printed devices or a mix of printed and silicone devices.*

*Out of the broad picture the talk focuses then on how to scale up processes from lab to fab, from the view of an equipment maker being in high tech developing markets like fuel cells, lithium ion batteries and solar for more than fifteen years.*

*From this overview the talk then gets more detailed into needed processes, parameters, printing systems, laser scribing, nano-imprint and coating systems. The next chapter describes the equipment solutions of today and tomorrow, which is the effort to give the existing state of the art of technology resulting of being in this market since ten years and the outlook into large scale factory solutions.*

## Processes

From the broad picture the talk focuses on specific topic, to show the topics of upscaling into production. The message the author wants to give is that there is not only one process, like printing, to produce a printed electronic process, but rather it is a bundle of processes for different type of products. The aim for a producer of printed electronic products should be to get an optimum fit in the processes he is using from the perspective of technical performance as well as from the perspective of cost of ownership and return on invest he is looking for.

## Application methods

The mayor topic is the application of several submicron layers in the process. Here the several printing systems for roll to roll (R2R) systems are explained. The Inkjet system, often described in discrete applications, is not seen as reliable for higher speed applications today. The systems described are engraved roller printing and screen printing. Engraved roller printing is often used for the application of PEDOT:PSS and screen printing is being used for the silver grid application. New topics are also related to

printing, they pattern a surface of a substrate which can be a PET film or a glass sheet. Laser is one of these techniques being used already to scribe ITO layers. Nano-imprint is the other one. There is a short overview on a new research project Coatema is involved and it shows an approach to use one or several laser sources in patterning OPV devices. In the nano-imprint part the focus is to show existing R2R technologies and to give the audience some ideas where these technologies can be used.

The main theory of the talk is that new technologies not always need new production technologies. Sometimes it is easier to get into production to fine tune existing production technologies. But the big mistake in understanding of the methods being used for printed electronics is to think that only printing is used. There is a detailed description of one system which is most used for stripe coating today: the slot die. The slot die is described in theory and different designs of the slot die flow field will be shown. Specifically the topic of creating stripes for OPV is described in detail.

## Equipment

After the basics of layer application options the focus goes to the process and equipment layout itself. To make the process easier to understand, smaller and more integrated systems, like the Smartcoater, are described.

In this unit all needed processes, like plasma treatment, web cleaning, coating, printing, curing and laminating are integrated and easy to overlook. From this basic development tool the transfer for the audience is being done to a semi production line, the Coatema Basecoater 3<sup>rd</sup> Generation. This layout is more complex and different layout steps are being described.

The final layout of a complete OPV Fab gives the idea how these big scale operations could look like in the mid term future. Here of course the cost of ownership is the winning game and the yield of the new scale factory are the only key factors for success.

## Conclusion

In summary the talk intends to give some ideas how the today operation of R2R production technologies looks like and how the mid term future could look like. One of the ideas is to avoid technologies which are not scalable into big scale industrial production like spin coating or other non R2R methods. There will be and there have to be tremendous economies of scale for large area printed electronics to be competitive against other technologies. One step to it is to use R2R technologies on a large scale.