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Functional Layers and Device Manufacturing based on Printing Technologies

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After half a millennium of technological development printing has achieved the quality level to meet the requirements of its mission: to convince the human eye to recognize a well defined ensemble of discrete coloured screen dots as a perfect halftone image. And this quality level applies to printing on endless paper web or paper sheets and on a broad variety of substrates additionally. Nowadays developments of industrial printing are more or less solely addressing improvements of the production efficiency.

During the last decade, several approaches have been published, which employ printing technologies for the solution based layer-by-layer manufacture of electronic components and devices. The printed layers are made from new functional inks which targeted functionalities are not the regular process colours CMYK but functionalities beyond colour, e.g. electrical conductivity or semi conductivity. These applications, contradictory to lithography, utilize the advantages of printing as an additive material deposition technology: the functional materials are only deposited in areas of the substrate, where their functionality is essential for the final electronic devices. Particularly the digital printing technology inkjet allows the geometrically exact deposition of smallest amounts of rare and therefore expensive functional materials.

In this paper our strategy of functional printing will be introduced, that exploits the potential of cutting-edge printing technologies for the digital fabrication of items with advanced – i.e. not-only-graphical – functionalities. The examples presented comprise concepts for printed energy storage devices, packages with RFID functionality, printed membranes and micro sieves, electrically conducting tracks and further approaches to manufacture devices and components of organic and large-area electronics (OLAE). The implementation of functional printing requires well-directed interdisciplinary efforts to manufacture stacks of functional layers and to understand their structure-property relationships. In many cases the envisaged functionality is rather directly related to the nanoscopic structures than to bulk materials properties.

The paper presents the integrated research approach of Printed Electronics in Chemnitz comprising Chemnitz University of Technology for science, the Fraunhofer Institution for Electronic Nanosystems (FhG-ENAS) for applied science and industrialization for the exploitation of future large area and organic electronics products.