Karlsruhe Institute of Technology

Electronics from the Printing Press

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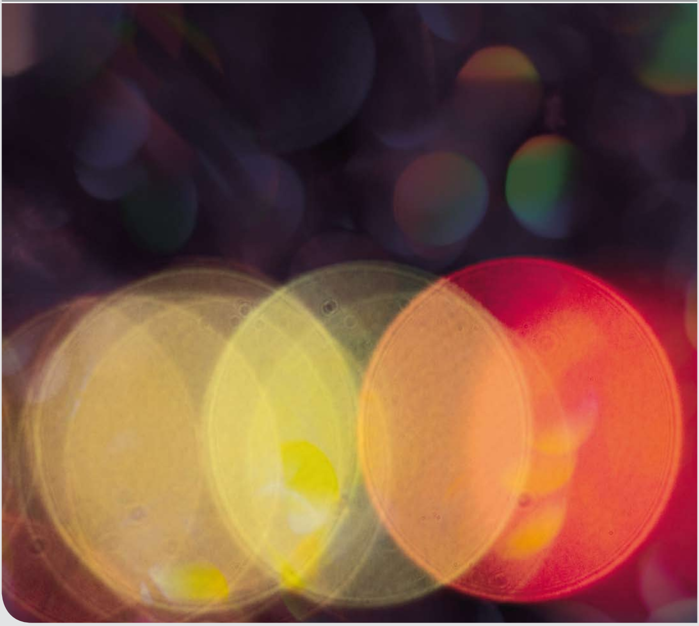
Research & Technology – Leading Trade Fair for R & D and Technology Transfer

Hall 2, Booth C18

RESEARCH – TEACHING – INNOVATION



KIT – University of the State of Baden-Wuerttemberg and
National Research Center of the Helmholtz Association

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Optimizing Processes and Materials

Finding printable materials of electronic functionality, which are stable in air, is chemical detective work. Various working groups of Karlsruhe Institute of Technology (KIT) focus on the synthesis of these novel materials. Others concentrate on the production and formulation of printing inks.

For the mass production of printing inks, new processes have to be developed. It is important to cooperate with companies that are already producing inks for ultra-high-resolution printing systems on a large technical scale and possess the necessary process know-how. The KIT Institute of Nanotechnology has first electronically modifiable printing inks. With the help of commercial ink jet printers, prototypes of electronic switches can be printed for experimental purposes.

In the fields of organic solar cells and light-emitting diodes, the KIT Light Technology Institute has advanced even further. Active organic materials can be provided with a very thin electronic coating on the laboratory scale to produce organic solar cells and light-emitting diodes.

In parallel, process engineers of the Thin Film Technology Division of the Institute of Thermal Process Engineering focus on industrial coating and drying processes and the transfer of laboratory findings to mass production. Tool and dryer concepts are developed for the large-area and homogeneous coating of plastic foils with electronic functional materials.

Printed electronics, no matter whether in the form of printed logics elements, solar or light-emitting foils, is an example of how nanotechnology will modify existing products and open up future markets.

A Way to Inorganic-based Printed Electronics

The concept of Printed Electronics (PE) encompasses manufacturing of electronics with any standard printing processes such as ink-jet printing, screen printing, offset or gravure. The primary benefit of this union between printing technologies and electronics is its ability to produce lightweight and robust electronics at low cost on large area, cheap flexible substrates. In case of inorganic based PE the progress has been hampered notably due to processing limitations such as low temperature and solution processibility. The novel approach developed by the researchers at Institute of Nanotechnology (INT), KIT has shown that ink-jet printed and room temperature processed high quality inorganic transistors can be produced when electrochemical gating is utilized. Consequently an interdisciplinary and comprehensive research at INT has been launched to develop fully printed, electrically and mechanically proven, functional devices and circuits based on inorganic materials.

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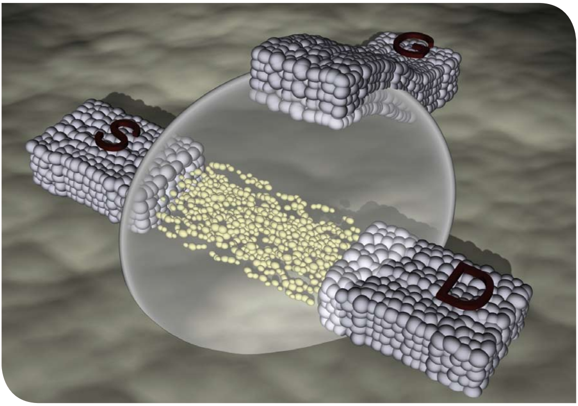
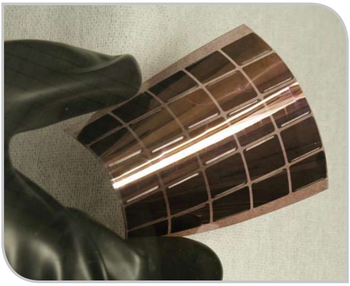


Organic Electrionics – Research, Development, Innovation

The Light Technology Institute has great expertise in the development and investigation of novel organic devices such as solar cells and light emitting diodes (OLEDs), focussing mainly on the development of solution processable materials and related coating techniques for the fabrication of efficient organic devices. These solution-based systems allow for the utilization of large scale and potentially low-cost coating and printing techniques which open pathway for an energy and cost efficient fabrication of organic solar cells and OLEDs.



For related research and development purposes the Light Technology Institute is equipped with a 150 sqm clean room laboratory, to allow for the in-house fabrication and characterization of organic devices. For a detailed understanding of the underlying physical and optoelectronic processes high resolution microscopy and spectroscopy setups are available. Moreover, optical and electrical properties of organic devices are modelled using in house developed simulation tools in order to generate a deeper physical understanding of the device working principles.

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High Precision Slot Die Coater for Printed Electronics

For the mass production of organic electronic devices, apart from structured printing techniques such as Inkjet and gravure printing, highly precise laminar coating methods are needed. The high requirements at the quality and reproducibility of the monolayers reduce the options to pre-metered coating techniques, as e. g. slot die coating. The wet film thicknesses being small compared to conventional coating tasks represent a special difficulty for the production of thin layers for organic electronics. Desired dry film thicknesses of approx. 20 to 100 nm require wet film thicknesses of 5 µm and smaller, depending upon solid content of the coated solution. Besides, a slot nozzle for organic electronics must be designed to match the very low solution viscosities.

For the special requirements at coatings for organic electronics, a new slot die coater was developed in the research group Thin Film Technology (TFT) at the Karlsruhe Institute of Technology in cooperation with the company TSE Troller. Using the new coating tool, homogeneous layers for hybrid solar cells were manufactured

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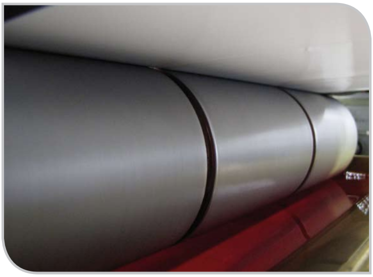
Gravure Coating

Gravure coating is a very promising coating method by which a large area of homogeneous and defect-free layers with a wet film thickness of 1 to 50 microns can be achieved. The material is carried in the liquid phase by regular structures applied on the surface of a roller and transferred to the substrate. The surface characteristics of the engraved roller, which basically can be divided into „open“ (grooves) and „closed“ (cells) structures and vary in their density distribution have a decisive effect on this transfer behavior.



The detection of the coating process limitations can be investigated by manufacturing of structures with the greatest fineness, which is determined by the machining process. The structuring is carried out at wbk on a 5-axis machining center with integrated ps-laser. By a downstream frequency converter with the possibility of laser wavelength variation it is possible to focus the laser beam more strongly than with the output wavelength (1064 nm), making the smallest structures in the range of a few microns producible. By varying the wavelength and having a low pulse duration with less than 10 ps it is also possible to select tailored process parameters for different materials and thus achieve optimal results without post-processing.

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Optoelectronic Materials for OLED and OSC

Organic semiconductors are considered to exhibit a great potential in the product development of novel low power consumption display und lighting technologies. The basic advantages of the OLED technology such as its high energy efficiency, rich colouring, and pleasant light generation, have only been used so far for high-pricing displays and light sources by means of capital intensive and time-consuming production techniques.

The use of novel cynora materials allows for an easy and cost efficient production of economical and flexible general diffused lighting which is not accessible using today's technologies. Novel applications such as printable light foils, luminescent labels, transparent window and cornice lighting, printable displays, flexible solar cells will therefore be commercially available. The possibility of integrating large-area light sources and thin solar cells into flexible and transparent plastic foils will open up new and unimagined fields of applications and, by combination of both technologies will result in novel energy efficient and self-sufficient products.

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