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News Release

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BMBF Project PrintOLED: Development of Printed Light-Emitting Diodes Successfully Concluded

Darmstadt, Germany, April 17, 2014 – After five years of intensive research in the field of printed organic electronics, the "PrintOLED - Printed Organic Light-Emitting Diodes" project has been successfully concluded. The project received around € 5 million in funding from the German Federal Ministry of Education and Research (BMBF). The aim of the project, which was conducted as part of the leading edge cluster “Forum Organic Electronics” at the InnovationLab in Heidelberg, was the development of a concept for large-area, homogenous coating of organic functional materials from solution. The consortium was led by Merck KGaA, Darmstadt, Germany, a leading company for innovative and top-quality high-tech products in the chemical and pharmaceutical sectors, and also comprised BASF SE, the Karlsruhe Institute for Technology, OSRAM, Philips Technologie GmbH, the Technical University of Braunschweig, the Technical University of Darmstadt as well as Heidelberger Druckmaschinen AG as an associated partner.

Due to the high material utilization rates in comparison with conventional vacuum evaporation processes, the printing processes investigated in this project (gravure, inkjet and slot die coating, among others) enable a more economical production of OLEDs (organic light-emitting diodes) and (organic) solar cells. As part of the project, it was demonstrated that the fabrication of very thin (< 100 nm) homogeneous layers from OLED materials is also possible from solutions with very low viscosity. Printable buffer layers based on metal oxides, which were applied using sol gel processes at moderate

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temperatures, permit not only the production of fully printable OLEDs, but also the realization of highly specialized applications such as transparent OLEDs.

Together with its partners, Merck KGaA, Darmstadt, Germany, developed and tested in this project OLED materials and their formulation for contact printing methods and inkjet printing. The focus was on the development of a material set for a completely solution-based fabrication of a high-performance OLED device. By varying the formulation and the process parameters, light-emitting layers applied from solution were optimized and integrated into working OLED devices. At the end of the project it was possible for the consortium to demonstrate OLEDs with homogeneously coated active areas of 10 cm^2 and 27 cm^2 by classic gravure printing and slot die coating. At least two of the layers were processed from solution.

When depositing a second organic layer from solution onto an already existing layer, the greatest challenge is preventing the destruction of the first layer. Significant improvements with specific material sequences were achieved and the realizations form a valuable basis for further elaboration towards the application.

The scope of the project extended from light-emitting materials processed from solution, electron transporting materials and printable electrodes based on conductive polymers and silver nanowires, up to the formulation development and evaluation of printing processes on rigid and flexible substrates. For the first time it was possible to print with speeds of up to 3 m/s semiconducting OLED layers with a homogeneity meeting the quality standards of industrial-scale OLED production. In the second phase of the project, this knowledge was also successfully applied to other technologies such as polymer OPV (organic photovoltaics) and sDSC (solid state dye-sensitized solar cell).

Additional physical and structural investigations were performed on the materials and on the different devices in order to gain more in-depth knowledge for future material developments.

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