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PRESSEINFORMATION

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PRESS RELEASE
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Flexible OLED applications arrive

R2D2, a joint project to analyze and development high-TRL processes and technologies for manufacture of flexible organic light-emitting diodes (OLEDs) funded by the German Federal Ministry of Education and Research (BMBF) has been successfully completed.

In contrast to point light sources like LEDs made of inorganic semiconductor crystals, organic light-emitting diodes (OLEDs) are light-emitting surfaces. Their light attains a new level of homogeneity and can be dimmed smoothly. The light does not throw harsh shadows and requires no reflectors, light pipes, or similar optics. This makes OLED light sources efficient and light-weight, and they require no supplemental cooling. OLEDs can be applied to flexible and bendable substrates and arbitrarily shaped, so they establish an entirely new world of design.

The previous high fabrication costs for OLED lighting modules needed to be reduced for the technology to be reasonably priced and easily employed for manufacturing marketable products. In the project, that is now concluded the processes and market sectors were thoroughly analyzed, the potential for improvement was identified and realized. A series of OLED lighting applications were developed that combine special design features of delicacy and flexibility with efficient fabrication techniques.

The tail light displayed at CES 2016 in January was developed as part of the project in cooperation with AUDI AG, OSRAM OLED and HELLA. It was fabricated as a complete 3D OLED module from just a single flexible OLED formed by bending it around various axes into a three-dimensional unit. AUDI AG took over specification and control of the segmented OLED and developed the interface technology, which was realized by OSRAM OLED and assembled by HELLA to fit a mounting socket design in the tail-light assembly. Two of these modules were integrated into each tail light; the emission color and brightness correspond to the ECE standard. The light emitting 3D unit requires no additional optics or reflectors whatsoever to be seen easily from all viewing angles. The OLED in 3D-design increases safety and offers new potential for automotive design, and for development of lighting designs with particular homogeneity of the luminous surfaces and precision construction.

Fraunhofer FEP was able to demonstrate through this project for the first time that ultra-thin flexible glass is able to be coated and processed roll-to-roll. Specific OLED components were developed using this technique for design studies such as "Glow-food" in cooperation with OSRAM OLED and the Finnish lighting manufacturer Tunto Design, for example. This design, as well as an additional one, was created by taliaYstudio in Vienna under contract from OSRAM.

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Dr. Christian May, Project Coordinator and Division Director "Flexible Organic Electronics" at Fraunhofer FEP, summarizes: "The R2D2 project funded by BMBF has brought OLED technology in Germany a good deal further. Flexible OLEDs in innovative lighting solutions will be coming onto the market in the near future. Other sectors will follow suit. There are already prospective designs for household appliances and even for aircraft over the long term."

AUDI AG is offering the glass-based OLED technology in a high-volume production model for the first time as the tail lights for the new AUDI TT RS . This was already presented at CES 2016 in Las Vegas next to the Audi "e-tron quattro" concept with tail lights developed from flexible OLEDs under the R2D2 development project. Progress in OLED technology is happening rapidly. The transition to a production-ready product could only be achieved with the advances of this project.

Novaled, a leading global expert in OLED materials and technologies for high-efficiency, long-life OLEDs, was a member in the consortium. Novaled was able to optimize the OLED layers and charge-carrier transport materials to meet the high demands of the automobile industry. Cost-effective solutions were devised. This included providing materials having stable fabrication processes that can be efficiently employed in mass production, as well as methods that can ascertain the compatibility of new organic materials with manufacturing processes, thereby saving development time.

The consortium also included the VON ARDENNE GmbH which ensures the industrial feasibility of the developed technologies as one of the market leaders for equipment of highly productive roll-to-roll coating of flexible substrates. VON ARDENNE contributes additional expertise to the project with its linear evaporation sources of high yield. The innovative evaporation sources have been developed and brought to market maturity especially for this project. They enable the control of the coating process within a small temperature range. These tight specification limits are necessary for the evaporation of temperature-sensitive materials and thus achieving optimal coating results.

About R2D2

The project consortium covers the entire value-added chain, from material research to equipment construction, component technology, and application studies for future products. The work planned was based on the globally recognized results of the R2Flex, So-Light, and TOPAS2012 projects for organic electronics (in particular organic light-emitting diodes and organic photovoltaics) funded by the German Federal Ministry of Education and Research (BMBF). The direct participation of noted OLED light manufacturer OSRAM OLED GmbH and light-source end users AUDI AG, HELLA KGaA Hueck & Co, and the Diehl Stiftung & Co. KG promoted rapid and comprehensive commercialization of the research results that has an impact on the entire value-added chain through new opportunities for market penetration. R2D2 has helped organic

LEDs for illumination applications attain higher awareness among the public and led to technological progress that represents an important competitive economic advantage for German companies.

The consortium partners are: Fraunhofer FEP (head of the consortium), AUDI AG, Diehl Aerospace GmbH, HELLA KGaA Hueck & Co, Novaled GmbH, OSRAM OLED GmbH, and VON ARDENNE GmbH.

The consortium would like to thank the German Federal Ministry of Education and Research (BMBF) for funding the project "R2D2" with a grant of 5.9 mill. Euros over a 30-month period.

About Fraunhofer FEP

The Fraunhofer Institute for Organic Electronics, Electron Beam and Plasma Technology FEP works innovatively on problems in the areas of vacuum coating, processing and treatment of surfaces using electrons and plasmas, and organic semiconductors. The foundation of this work is core expertise in electron beam technology, high-rate coating using sputtering, plasma-activated as well as PECVD techniques, and technologies for organic electronics as well as for IC & systems design. Fraunhofer FEP offers a broad spectrum of research and development together with pilot fabrication, in particular for treatment, sterilization, etching, and plating of surfaces as well as for OLED micro displays, organic and inorganic sensors, optical filters, and flexible OLED illumination. Our goal is to develop potential innovations in electron-beam & plasma engineering and organic electronics to create novel and practical production processes and components for our customers.
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About HELLA

HELLA is a global, family-owned company, listed on the stock exchange, with around 32,000 employees at over 100 locations in more than 35 countries. The HELLA Group develops and manufactures lighting and electronic components and systems for the automotive industry and also has one of the largest retail organizations for automotive parts, accessories, diagnostics, and services within Europe. Complete vehicle modules, air-conditioning systems, and vehicle electrical systems are also produced in joint venture companies. With more than 6,000 people working in research and development, HELLA is one of the most important innovation drivers on the market. In addition, with sales of approx. 5.8 billion euros in the fiscal year 2014/2015, the HELLA Group is one of the top 40 automotive parts suppliers in the world and one of the 100 largest German industrial companies.
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About OSRAM

OSRAM, with headquarters in Munich, Germany, is a leading lighting manufacturer worldwide, with a history of more than 100 years. Its portfolio extends from high-tech applications based on semiconductor technologies like infrared and lasers, to intelligent networked illumination solutions in buildings and cities. OSRAM employed 33,000 worldwide at the end of the 2015 fiscal year (September 30) and achieved total sales of just under 5.6 billion Euros. The company is listed on the Frankfurt and Munich stock exchanges under commercial paper identifier LED 400, and stock market symbol OSR. You can find further information in the Internet under www.osram.de.
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About AUDI AG

The Audi Group, with its Audi, Ducati, and Lamborghini brands, is one of the most successful manufacturers of automobiles and motorcycles in the premium segment. It is present in more than 100 markets worldwide and produces at 16 locations in twelve countries. In the second half of 2016, the production of the Audi Q5 will startin San José Chiapa(Mexico). 100-percent subsidiaries of AUDI AG include quattro GmbH (Neckarsulm, Germany), Automobili Lamborghini S.p.A. (Sant'Agata Bolognese, Italy), and Ducati Motor Holding S.p.A. (Bologna, Italy).
In 2015, the Audi Group delivered to customers approximately 1.8 million automobiles of the Audi brand, 3,245 sports cars of the Lamborghini brand and about 54,800 motorcycles of the Ducati brand. The Audi Group achieved in the 2015 financial year total revenue of 58.4 billion euros and an operating profit of 4.8 billion euros. At present, approximately 85,000 people work for the company worldwide, about 60,000 of them in Germany. Audi focuses on new products and sustainable technologies for the future of mobility.

About Novaled GmbH

Novaled GmbH is a leader in the research, development and commercialization of technologies and materials that enhance the performance of OLEDs (organic light-emitting diodes) and other organic electronics. Novaled offers OLED product manufacturers a unique combination of proprietary technology, materials and expertise, and is currently the only company in the OLED industry licensing and selling organic conductivity doping technology and materials for use in the commercial mass production of display products. Novaled has developed strategic partnerships with key OLED innovators and producers throughout the world and, with a broad portfolio of more than 500 patents granted or pending, has a strong IP position in OLED technologies, structures and materials. Novaled is headquartered in Dresden with some 140 staff and with offices in Asia. Since end 2013 Novaled belongs to Samsung. For more information, please visit www.novaled.com.

About VON ARDENNE GmbH

VON ARDENNE develops and manufactures equipment for industrial coatings on materials such as glass, wafers, metal strip and polymer films. These coatings give the surfaces new functional properties and can be between one nanometer and a few micrometers thin, depending on the application. The coated materials are the basis for products such as architectural glass, solar modules or touch screens.
The Company works continuously to improve and develop innovative technologies and applications in which extremely thin functional layers promise benefits. Currently VON ARDENNE is pursuing future topics such as coating technologies for organic electronics, flexible glass in the R2R process and for future generations of batteries and fuel cells.
VON ARDENNE is a leading provider of architectural glass coating equipment and coating systems for thin-film photovoltaics. The family-owned company with subsidiaries in China, Japan, Malaysia, Taiwan and the USA relies on customer proximity in order to offer ideal on-site service. VON ARDENNE equipment is in operation in more than 50 countries around the world.
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About Diehl Aerospace GmbH

Diehl Aerospace is one of five Business Units within the Corporate Division Diehl Aerosystems. With an annual turnover of approximately 1.2 billion euros and around 4,800 employees, the Corporate Division is the umbrella organization for all aviation expertise within the Diehl Group. The company is the leading German supplier for avionics systems, cabin electronics and lighting systems, for both passenger as well as military aircraft. With its core competencies in cockpits and cabins, Diehl Aerospace sets global standards in state-of-the-art technology and consistent customer service. Especially, in the field of cabin lighting systems the company belongs to the leading manufacturers worldwide. For example, the All-LED lighting systems on board the Boeing 787 Dreamliner and on board the Airbus A350 XWB are coming from Diehl Aerospace.
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A 3D OLED tail light module with three independently controllable segments made from a single flexible OLED was developed under the R2D2 project based on designs of AUDI AG in cooperation with OSRAM and HELLA. Two such modules are mounted in a complete tail light assembly.
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The future on view: tail lights of flexible OLEDs – presented by Audi at CES 2016 in Las Vegas with two of the OLED modules developed under the R2D2 project.
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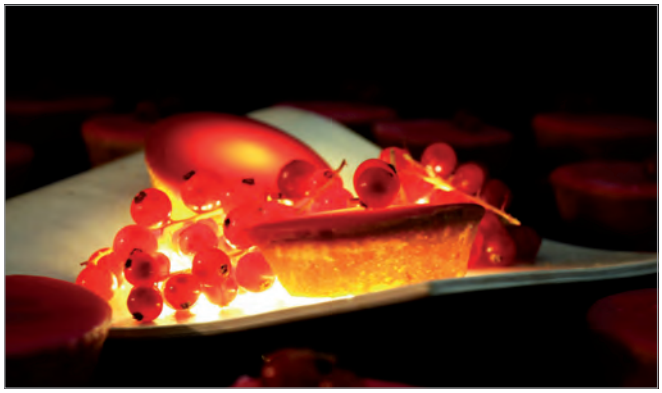

"Glowfood" demonstrator – flexible OLED tile from Fraunhofer FEP embedded in laminated wood. Coordinated by OSRAM OLED, designed by taliaYstudio, and realized by Tunto Design.
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"Glowfood" demonstrator – flexible OLED tile from Fraunhofer FEP embedded in laminated wood. Coordinated by OSRAM OLED, designed by taliaYstudio, and realized by Tunto Design.
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"Coolfood" OLED demonstrator from DIEHL using an OLED module fabricated by Fraunhofer FEP on flexible ultra-thin glass.
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OLED demonstrator by Diehl Aerospace showing potential applications in the aircraft cabin.
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