

## Researchers working on process development for high-volume manufacturing of innovative 2D nanomaterial products

“HEA2D” consortium aims to create basis for end-to-end processing chain for two-dimensional nanomaterials

**Herzogenrath/Germany, July 19, 2016** – AIXTRON SE (FSE: AIXA; NASDAQ: AIXG), a worldwide leading provider of deposition equipment to the semiconductor industry, is working together with five partners in the “HEA2D” project to investigate the production, qualities, and applications of 2D nanomaterials.

When integrated into mass production processes, 2D materials have the potential to create integrated and systematic product and production solutions that are sustainable in social, economic, and ecological terms. Using 2D materials will help to address topics such as climate change, an environmentally-friendly and affordable energy supply or mobility, addressing the increasing scarcity of resources. These materials also enable new and innovative solutions to be explored. Even though the potential harbored by this new class of materials has been demonstrated for increasing numbers of applications and with ever greater dynamism in a laboratory environment, attempts at high-volume product manufacturing functionalized with 2D materials have so far failed due to the fragmented production chain. In view of this, material-based innovations with 2D materials have not yet led to any major product innovations in practice.

The joint project HEA2D is now researching an end-to-end processing chain consisting of various deposition processes for 2D materials, processes for transfer onto plastic foils, and mass integration into plastics components. AIXTRON’s partners for implementing systems technology and integrating materials into plastic molded parts are the Fraunhofer Institute for Production Technology (IPT), Coatema Coating Machinery GmbH (Coatema), and Kunststoff-Institut Lüdenscheid (K.I.M.W.). This work is being supported in terms of nano-analytics and the development of prototype components by the Institutes of “Electronic Materials and Nanostructures” (University of Duisburg-Essen) and “Graphene-based Nanotechnology” (University of Siegen).

Drawing on co-operations already in place at the project partners, the project results will be communicated to interested companies worldwide. The aim here is to integrate suggestions from end users into the production chain at an early stage of development already. To this end, the project will also use the platform operated by the “Graphene and 2D Materials” specialist group and the North Rhine Westphalia plastics cluster “Kunststoffland NRW”.

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One focus of AIXTRON's subproject involves researching (MO)-CVD processes and systems technology for the deposition of optically active 2D semiconductor materials such as molybdenum tungsten (Mo, W), selenium sulfur (Se, S), and graphene. Furthermore, together with its project partners the company will be working out a roll-to-roll concept for use in the synthesis and transfer of graphene. To ensure the efficient realization of a demonstration tool which is a core aspect of the HEA2D innovations, preliminary investigations will be performed, particularly to identify suitable source chemicals, on an existing system at AIXTRON's applications laboratory. Based on the findings, the existing system technology will be enhanced. Together with its project partners, demonstrators on the basis of 2D semiconductor materials will be manufactured.

"HEA2D" is being promoted with funds from the European Fund for Regional Development (EFRE) 2014-2020.

#### **About AIXTRON**

AIXTRON SE is a leading provider of deposition equipment to the semiconductor industry. The Company was founded in 1983 and is headquartered in Herzogenrath (near Aachen), Germany, with subsidiaries and sales offices in Asia, Europe and in the United States. AIXTRON's technology solutions are used by a diverse range of customers worldwide to build advanced components for electronic and opto-electronic applications based on compound, silicon, or organic semiconductor materials. Such components are used in a broad range of innovative applications, technologies and industries. These include LED applications, display technologies, data storage, data transmission, energy management and conversion, communication, signaling and lighting as well as a range of other leading-edge technologies.

Our registered trademarks: AIXACT<sup>®</sup>, AIXTRON<sup>®</sup>, Atomic Level SolutionS<sup>®</sup>, Close Coupled Showerhead<sup>®</sup>, CRIUS<sup>®</sup>, Gas Foil Rotation<sup>®</sup>, Optacap<sup>™</sup>, OVPD<sup>®</sup>, Planetary Reactor<sup>®</sup>, PVPD<sup>®</sup>, TriJet<sup>®</sup>

For further information on AIXTRON (FSE: AIXA, ISIN DE000A0WMPJ6; NASDAQ: AIXG, ISIN US0096061041) please visit our website at: [www.aixtron.com](http://www.aixtron.com).

#### **About the University of Siegen**

With more than 19,000 students and around 1,900 employees, of which around 1,200 academic staff, the University of Siegen is an innovative university with an interdisciplinary focus. With a broad spectrum of subjects ranging from humanities and social sciences via economics to natural sciences and engineering, it offers an outstanding climate for teaching and research, as well as numerous interdisciplinary and transdisciplinary research projects – all consistent with its motto: "Creating a Humane Future".

The "Graphene-based Nanotechnology" workgroup at the Science and Technology Faculty of the University of Siegen investigates innovative components based on graphene and other two-dimensional materials. The faculty has a dedicated "2D" cleanroom laboratory at which this new class of materials is manufactured on laboratory scale and integrated into components. Integrated components form the key focus of investigations, which are mostly experimental, but the workgroup also addresses aspects of process technology and integration. Alongside proof-of-concept evaluations for new components, the workgroup also deals with interfaces to industrial manufacturability and system integration, as well as circuit design with new materials and components.

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## **About the University of Duisburg-Essen**

Creative inspiration between Rhine and Ruhr: the University of Duisburg-Essen is located in the European region with the highest density of institutions of higher learning and research. Created in 2003 by the merger of the universities of Duisburg and Essen, it is the youngest university in North Rhine-Westphalia and one of the ten largest universities in Germany with about 42,000 students.

The "Electronic Materials and Nanostructures" workgroup at the Engineering Faculty of the University of Duisburg-Essen (Uni-DuE) investigates nanostructures for electro-technical applications, and here especially opto-electronics. One key focus is on 2D materials (graphene, transition metal-dichalcogenides) for transparent electrodes, light emitters, photovoltaic elements, and electrographic inks. A 4" graphene CVD system for thermal and plasma CVD is available for developing processes and components, as are various lithography and coating processes, chemical process technologies and electrical contacting and characterization. We perform extensive microscopic analytics using laser spectroscopy, electrical scanning force microscopy, and electron microscopy. This enables fundamental connections to be made between material properties on the nanometer scale and component functionality.

## **About Coatema Coating Machinery GmbH**

COATEMA is a family-owned mechanical engineering company that has been offering unique competence in its core activities of coating, laminating, and printing for 40 years now. The company develops and markets system solutions for use in laboratory and development applications and designs customized solutions for pilot systems and production on substrate widths of up to 5 meters. COATEMA is a reliable partner for coating systems that offer substantial added value and flexible process management (click & coat module). Furthermore, COATEMA maintains its own technical laboratory in order to optimize system development for special customer requirements. It also offers its partners and customers the opportunity to perform experimental coating. COATEMA's success here is documented by proprietary patents and awards. The company's global presence at specialist fairs and conferences enables the latest solution concepts to be analyzed and translated into proprietary system specifications. With project partners, COATEMA then works to achieve these target specifications in processes and components and thus to qualify system technology on component level.

## **About Fraunhofer IPT**

Fraunhofer IPT combines longstanding expertise and experience in all areas of production technology. In the fields of process technology, production machinery, production quality, measurement technology, and technology management we provide customers and project partners at our location in Aachen with specialist solutions and results that are directly implementable in networked, adaptive production. We view production not only in terms of its individual steps, but also account for processes in their entirety. We see the connections between individual aspects of the process chain – from preliminary and product development work via preparation for production through to manufacturing and assembly.

The services we offer focus on individual tasks and challenges within specific sectors, technologies, and product areas: tool and mold construction, optics, turbomachines, life sciences engineering, and lightweight production technology.

Fraunhofer IPT currently has around 460 employees and operates on 9,000 m<sup>2</sup>. Of these premises, around 5,000 m<sup>2</sup> are used as laboratories and machine halls. Via the Fraunhofer Center for Manufacturing Innovation CMI in Boston, USA, we also offer our customers sustainable technology transfer between European and American industry.

## **About Kunststoff-Institut für die mittelständische Wirtschaft NRW GmbH (K.I.M.W.)**

Kunststoff-Institut für die mittelständische Wirtschaft NRW GmbH (K.I.M.W.), Lüdenscheid, is a research institute associated with South Westphalia University of Applied Sciences which focuses on enhancing the quality and economic viability of injection-molded components made of thermoplastics as well as their coating. The Institute sees itself as a point of transfer and interconnection between university research and industrial companies. The Institute has been running the "Competence Center for Surface Technology and Plastics" network since 1988 already. This has around 350 members and was included in the "go-cluster" (formerly "Competence Networks Germany") in 2005 already. This cluster meets the excellence criteria of the European Cluster Excellence Initiative (ECEI) and was awarded the GOLD Label in 2013. The Institute is also characterized by longstanding expertise in the field of surface technology for plastic components. As well as providing specialist advice, the Institute focuses on industry-specific and company-specific process development for industrial applications. Building on interdisciplinary cooperation between its specialist departments, the Institute offers the clear advantage of covering all aspects of product development. The key focus here is on evaluating, developing, and validating functional materials for industry solutions. In the past, the Institute successfully performed extensive R&D activities, particularly in the field of back injection. This includes the specific design and construction of injection molds and process management, as well as prefabrication of foils using deep drawing and laser processing.

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## **Forward-Looking Statements**

This document may contain forward-looking statements regarding the business, results of operations, financial condition and earnings outlook of AIXTRON within the meaning of the safe harbor provisions of the US Private Securities Litigation Reform Act of 1995. These statements may be identified by words such as "may", "will", "expect", "anticipate", "contemplate", "intend", "plan", "believe", "continue" and "estimate" and variations of such words or similar expressions. These forward-looking statements are based on our current views and assumptions and are subject to risks and uncertainties. You should not place undue reliance on these forward-looking statements. Actual results and trends may differ materially from those reflected in our forward-looking statements. This could result from a variety of factors, such as actual customer orders received by AIXTRON, the level of demand for deposition technology in the market, the timing of final acceptance of products by customers, the condition of financial markets and access to financing for AIXTRON, general conditions in the market for deposition plants and macroeconomic conditions, cancellations, rescheduling or delays in product shipments, production capacity constraints, extended sales and qualification cycles, difficulties in the production process, the general development in the semi-conductor industry, increased competition, fluctuations in exchange rates, availability of public funding, fluctuations and/or changes in interest rates, delays in developing and marketing new products, a deterioration of the general economic situation and any other factors discussed in any reports or other announcements filed by AIXTRON with the U.S. Securities and Exchange Commission. Any forward-looking statements contained in this document are based on current expectations and projections of the executive board and on information currently available to it and are made as at the date hereof. AIXTRON undertakes no obligation to revise or update any forward-looking statements as a result of new information, future events or otherwise, unless expressly required to do so by law.

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