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Press Release

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North Rhine-Westphalia's 2011 Innovation Award for additive manufacturing by Fraunhofer ILT

North Rhine-Westphalia's 2011 Innovation Award in the »Innovation« category has been awarded to Professor Reinhart Poprawe M.A. (57), Director of the Fraunhofer Institute for Laser Technology ILT, and his team of laser experts comprising Dr. Andres Gasser (52), Dr. Ingomar Kelbassa (38), Dr. Wilhelm Meiners (47) and Dr. Konrad Wissenbach (56). The award, which carries a cash prize of 100,000 euros, will be presented to the winners by Svenja Schulze, North Rhine-Westphalia's Minister for Innovation, Science and Research, at a ceremony to be held on November 14, 2011, at the K21 museum of contemporary art in Düsseldorf. The Fraunhofer ILT research team has been driving forward progress in the field of additive manufacturing for over 20 years, developing techniques that help to save energy and resources in the production environment. The institute's specialists have systematically evolved laser processes for use with different materials and in different applications, paving the way to their implementation on an industrial scale. Dr. Poprawe and his team are the world's leading experts in the technique of selective laser melting (SLM), a field in which Fraunhofer ILT has led the way since its inception. SLM enables customized components such as medical implants or functional parts for machine tools to be manufactured cost-effectively and extremely rapidly in small batches on the basis of 3-D CAD data, following the just-in-time principle. This has opened the door to entirely new business models in the manufacturing industry, including mass customization, open innovation and co-creation, which allow end users to participate in the design process or even take over a large part of the design work themselves.

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Over the past 20 years, the team of experts at the Fraunhofer Institute for Laser Technology ILT and the associated Chair for Laser Technology LLT at RWTH Aachen University has expanded additive manufacturing from a niche role as a rapid-prototyping application to an enabling technology with a major impact on future industrial manufacturing processes. This view is illustrated by the words of Professor Reinhart Poprawe: »In a few years' time, the way spare parts are manufactured for an established supplier of hydraulic components will be radically different. Instead of keeping hundreds of variants of spare parts in stock, the manufacturer will simply store the 3-D CAD data of all components that have been produced in the past. Then, when an order is received, the appropriate part can be produced on demand using the selective laser melting process and shipped promptly to the customer.«

The scope offered to designers of customized parts is significantly wider in terms of geometrical freedom and function integration when components can be constructed layer by layer. The selective laser melting process enables 3-D CAD data to be directly transformed into the real component. Dr. Ingomar Kelbassa, vice and academic director of the Chair for Laser Technology LLT at RWTH Aachen University and department head at Fraunhofer ILT, emphasizes the unique opportunity this offers to product designers: »Designers are liberated of almost all restrictions related to the production process, and can freely express all of their creative ideas in the product. Everything else is taken care of by our 3-D printing process.« Things were very different 20 years ago; at that time, while prototypes could be built using plastic or paper, manufacturing metallic versions of these components was simply not possible.

Rapid prototyping took on an entirely new dimension when Fraunhofer ILT in Aachen developed the technique of selective laser melting. »For the first time, designers and product managers were able to present a demonstration model or even a functional prototype in metal based purely on CAD data with no more than a day's notice. In the past, that used to take days or even weeks, for example when

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designing new tool inserts,« relates Dr. Wilhelm Meiners, group manager Rapid Manufacturing at Fraunhofer ILT. He and his team invented the selective laser melting process for metallic materials, which they patented in 1996. It was to be the first in a whole family of patents. »We have since moved on to the next important stage,« says Dr. Wilhelm Meiners confidently, »which is to take the rapid prototyping approach further and develop it into rapid manufacturing, enabling customized products to be manufactured rapidly in batches of any size, and at reasonable cost.« More and more companies are integrating additive manufacturing techniques in their production strategies. Dr. Konrad Wissenbach, competence area manager Additive Manufacturing and Functional Layers at Fraunhofer ILT, offers a convincing argument: »The 3-D construction technique used in additive manufacturing processes reduces production costs across the board, regardless of the complexity of the component. In contrast to conventional ablation processes, additive manufacturing techniques have no need of additional resources such as costly tool modifications to produce undercuts, internal cooling channels or complex support structures, for example.«

In addition to SLM, a technique developed from the outset by the laser experts in Aachen, the Fraunhofer ILT research team is also promoting the use of Laser Material Deposition LMD in manufacturing MRO, repair and modification activities. The main applications at present are the repair of aircraft engine components and tools for a wide range of industrial sectors. Dr. Andres Gasser, group manager Laser Material Deposition at Fraunhofer ILT, explains the difference between SLM and laser material deposition: »In SLM, the component is built up by melting particular areas of successive layers of powder using a laser source that fuses the material in a pattern corresponding to the final product. By contrast, in LMD, the components are produced by laser melting powder material projected by a nozzle onto specific areas of the component. SLM is capable of generating the finely detailed structures of complex components. LMD is more suited to the manufacture of large-area components and to repairs.«

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The members of the Fraunhofer innovation cluster »Integrative Production Technology for Energy -Efficient Turbomachinery – TurPro«, which benefits from over ten million euros in overall budget, include leading aircraft manufacturers and energy providers in addition to the Aachen-based Fraunhofer Institutes for Laser Technology ILT and for Production Technology IPT. It is here that concepts for manufacturing cost-intensive nickel-alloy components such as BLISKs, or blade-integrated disks, for aircraft engines are developed. »Laser material deposition beats all other processes for repairing and manufacturing BLISKs in terms of precision and flexibility,« claims Dr. Andres Gasser. The core competencies of Fraunhofer ILT are by no means restricted to manufacturing processes: they also extend to systems engineering. The services provided by the institute to its industrial partners also include the development of powder nozzles and optical heads for optimized component processing, process control units for quality-optimized process control, and manufacturing concepts based on optimized machining processes. In the framework of Aachen's Cluster of Excellence »Integrative Production Technology for High-Wage Countries« in close collaboration with an interdisciplinary team of engineers, material scientists, physicists and economists, Prof. Poprawe develops industrial production systems for future mass customization.

Additive manufacturing processes, based on Selective Laser Melting (SLM) and/or Laser Material Deposition (LMD), open the door to entirely new business models in the manufacturing industry, including mass customization, open innovation and co-creation, which allow end users to participate in the design process or even take over a large part of the design work themselves. The ability of the new technology to process a wide variety of materials is one of the most important factors in its growing popularity across a variety of business sectors. Professor Poprawe and his team first demonstrated an additive process for the manufacture of metallic components in their laboratory in 1996. The revolutionary aspects at the time were that it allowed the use of commercial powder materials and that the laser beam

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fully melted the powder particles. Hence the name given to the process by the Aachen-based scientists: »Selective Laser Melting« or SLM. The technique enables a component density of nearly 100 percent to be achieved. This feature enables the mechanical characteristics of SLM components to approach those specified for the processed material. SLM is meanwhile being marketed under many proprietary brand names. The range of materials that can be processed in this way has grown over the years, and now includes stainless steel, tool steel, aluminum, copper, ceramics and bioresorbable materials used in medicine. The milestones generated by this diversity of Fraunhofer ILT services are eloquent:

• The industrial use of additive manufacturing processes for die and tool making, with the implementation of near-net-shape cooling channels. The improved temperature-control of the tools significantly reduces injection-molding cycle times for plastics and improves their quality. (2001)

• The additive manufacturing of metal dental restorations. The first implementation of a mass customization concept based on metallic components produced by means of additive manufacturing. (2002)

• The qualification of volume-produced aluminum components for road vehicles. (2006)

• Patients implanted with replacement hip joints created using additive manufacturing processes. (2008)

• Use of bio-resorbable materials for bone implants created using additive manufacturing processes. (2009)

• All-ceramic dental bridge produced using an additive manufacturing process. (2010)

The processing speed of additive manufacturing techniques has meanwhile been multiplied by 10 compared with the first variants, opening the way to entirely new fields of application. With this significant increase in efficiency, it is now possible to deploy additive manufacturing techniques in

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the implementation of functionally optimized structural components, for example in the automotive and aerospace industries. Users can expect to realize far greater efficiency in their use of resources and energy throughout the entire product lifecycle.

Captions:
Figure 1: Exposure ot the powder according to the CAD data. Picture source: Fraunhofer Institute for Laser Technology ILT, Aachen / Volker Lannert.
Figure 2: Component removal at the end of the SLM process. Picture source: Fraunhofer Institute for Laser Technology ILT, Aachen / Volker Lannert.

You can download these pictures as well as the portraits of the contact persons under: http://www.ilt.fraunhofer.de/en/publication-and-press/press-release.html

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