Fraunhofer Institut Lasertechnik

Press release

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Among chips and ships

International Laser Technology Congress AKL'08: Widening interest in luminous ideas

Over 30 years ago, the pioneers of laser technology would hardly have believed it possible that 500 laser specialists from all over the world would one day attend an International Laser Technology Congress in the historic city of Aachen. For three days in 2008, the subjects of discussion ranged from chips to ships as the experts built up their professional networks.

The once esoteric discipline of laser technology spreads to new areas of application every day. Hence the title of the presentation by Professor Dr. Reinhart Poprawe M.A., director of the Fraunhofer Institute for Laser Technology ILT in Aachen: "From chips to ships". An engineering technique developed in the 1970s primarily as a means of drilling holes in hard materials has since evolved into a source of extreme ultraviolet (EUV) light for lithographic processes in the semiconductor industry, remote laser applications in the car industry and a regenerative technique for repairing the blades of aero-engine turbines.

But Professor Poprawe, whose institute organizes the biennial congress, was not there just to talk about stunning technological achievements: "Unfortunately, we still don't often enough put our heads together with the production planners, who are capable of achieving double-digit percentage improvements in productivity by means of clever organization."

The technological feedstock to bring technologists and planners closer together can be found, for example, at Jenoptik in Jena, whose laser and material processing experts develop and manufacture solid-state and diode lasers and integrate them in complex laser systems and plant. "We cover the entire value chain," says the company's CEO Dr. Michael Mertin.

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One of the highlights from Jena is the pulsed ASAMA disk laser (wavelength 515 nanometers, output up to 100 watts, 1-8 millijoules, 10-100 kHz, 300 to 600 nanoseconds) that can be used to manufacture polycrystalline silicon films. This homogenous material serves as a basis for producing high-performance LCD (liquid crystal) and tomorrow's OLED (organic light-emitting diode) flat screens for mobile devices and even full-size computer monitors and TVs. A further advantage is emphasized by Dr. Mertin: "The variable pulse length and high pulse repetition rate guarantee an optimized manufacturing process and high productivity."

Jenoptik has meanwhile teamed up with Trumpf to establish a strong European manufacturer of fiber lasers. In the summer of 2007, the two companies set up the joint venture JT Optical Engine GmbH + Co. KG in Jena. "As the name implies, we develop optical engines there – the key component of fiber lasers," explains the head of Jenoptik. The joint venture aims to start marketing the first pulsed laser systems (operating in the nanosecond range) in 2009, to be followed by extremely high-power cw lasers and high-performance ultra-short pulsed lasers in 2010. Dr. Michael Mertin adds: "One of the objectives of this joint venture is to defy overseas competition, particularly from the United States."

Philips Lighting B.V. in Eindhoven aims to simplify the lithographic processes used to manufacture microchips by employing light sources that operate with extreme UV light (EUV) at a wavelength of 13.5 nanometers. The new alternative to existing laser techniques was developed by the Philips research laboratories in Aachen in collaboration with the Fraunhofer ILT. The process known as DPP (Discharge Produced Plasma) produces a laser-triggered plasma spark with an output of up to 500 watts in a vacuum. Dr. Joseph Pankert, CTO Business Unit Special Lighting Applications: "It is the only process that has been able to maintain a constant output for over 120 hours in industrial trials."

Another of the new laser applications is polishing. A smooth surface is produced by melting a thin top layer of the material, less than 100 micrometers deep. Dr. Edgar Willenborg, senior scientist in the surface engineering department of the Fraunhofer ILT, won the 2006 science prize awarded by the industry club in

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Düsseldorf for his work in this field. In Aachen, Dr. Willenborg demonstrated the enormous potential of laser polishing on a medical device made of titanium: The several hours needed to polish each workpiece manually can be reduced to just a few minutes. What's next on the program? The team in Aachen is now working on methods of laser-polishing complex 3-D geometries, and on CAM systems based on CATIA V5.

A remarkable number of this year's papers dealt with solutions for the aerospace industry. In the EU project FANTASIA (running from 2006 to 2010), partners from eight countries are working on the development of laser metal deposition and direct laser forming techniques that can be used to repair or manufacture components to near net-shape accuracy. Dr. Konrad Wissenbach, head of the surface engineering department at the Fraunhofer ILT: "Used in combination with conventional manufacturing processes, these techniques have the potential to create a real breakthrough in the production of parts for aero engines." One of the more interesting findings is that they are capable of processing new materials such as titanium-aluminum in addition to more conventional nickel- and titanium-based alloys.

Dr. Mark Geisel is a production manager at MTU Aero Engines GmbH in Munich, and hence something of an expert in laser drilling. But his paper focused less on the process as such and more on problems that arise and how to solve them. For instance, for one particular customer, the engine-maker wanted to machine drill holes by laser to tighter specifications than before. But attempts to optimize the drilling operation didn't succeed, even though the dimensions were only modified by a fraction of a micrometer. Suddenly, the holes were no longer cleanly drilled. The cause of this initially inexplicable behavior was an algorithm that used an iterative numerical method to convert the parameters into separate Cartesian movements. It only took the slightest change in the parameters to reveal the shortcomings of the hitherto reliable calculation program. MTU had to introduce a very complex, more accurate calculation routine before the holes could be drilled as required.

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One of the main challenges for automobile manufacturers is to achieve both light weight and strength. Daimler AG in Stuttgart has been using lasers since 1983. A meanwhile established technique allows turned or cast parts of the gear assembly to be replaced with thin, laser-welded sheet-metal parts. While such techniques are now standard practice, the engineers in Stuttgart find the lack of genuine online control a handicap. Dr. Michael Zürn, Senior Manager Materials and Process Engineering: "I would like to see an online quality assurance system based on a method that provides absolute measurements of quality criteria instead of making comparisons with reference variables." What production engineers need to know is whether a particular hole has been drilled through, what the surface looks like, and how strong the laser weld seam is.

Solar energy systems represent one of the booming areas of industry today. But as Dr. Martin H. Sommer, Director of Manufacturing for Schott Solar Inc. in Billerica, USA, points out, this means that production plant has to provide 98 percent availability. And this in turn calls for very reliable manufacturing processes: "We need processes with a sufficiently wide process window, capable of coping with the variety of shapes and thicknesses of the silicon wafers." Dr. Sommer cites the example of a water-guided laser beam used to cut silicon, which is capable of tolerating undulations on the surface of the wafer by its focal length.

Laser market: Taking off financially too

Laser technology is not only productive in the technical sense but also as a financial investment. According to an estimate by Optech Consulting in Tägerwilen, Switzerland, the world market for laser processing systems grew by five percent in 2007 to 6.3 billion euros – despite the European currency's unfavorable exchange rate with respect to the weak U.S. dollar (down nine percent) and the Japanese yen (down ten percent). It is a trend that has been developing consistently over the last ten years. The average market growth rate over this period was over ten percent.

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Fig. 1

A wider range of applications: Lasers emit shorter pulses, generate higher output, work with greater precision, and can thus move into completely new fields of application. Source: Fraunhofer ILT, Aachen, Germany

Fig. 2

Professor Dr. Reinhart Poprawe M.A., director of the Fraunhofer Institute for Laser Technology ILT in Aachen: "Unfortunately, we still don't often enough put our heads together with the production planners, who are capable of achieving double-digit percentage improvements in productivity by means of clever organization ." Source: Fraunhofer ILT, Aachen, Germany

Fig. 3

Dr. Michael Mertin, CEO of Jenoptik AG, Jena: "In our joint venture with Trumpf, we develop optical engines – the key component of fiber lasers." Source: Fraunhofer ILT, Aachen, Germany

Fig. 4

Dr. Konrad Wissenbach, head of the surface engineering department at the Fraunhofer ILT: "Used in combination with conventional manufacturing processes, the techniques of laser metal deposition and direct laser forming have the potential to create a real breakthrough in the production and maintenance of parts for aero engines." Source: Fraunhofer ILT, Aachen, Germany

Fig. 5

Dr. Martin H. Sommer, Director of Manufacturing Schott Solar Inc.: "We need laser processes with a sufficiently wide process window, capable of coping with the variety of shapes and thicknesses of the silicon wafers." Source: Fraunhofer ILT, Aachen, Germany

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Fig. 6

The International Laser Technology Congress AKL´08 attracted more than 500 visitors, an increase in attendance of around 20 percent. Source: Fraunhofer ILT, Aachen, Germany

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