

Volume 20 April / May 2023

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PhotonicsViews

OPTICS • PHOTONICS • LASER TECHNOLOGY



In the Art of Making Lasers

COVER STORY

Holographic recordings without compromise

HÜBNER Photonics

hubner-photonics.com



20th volume anniversary issue

WILEY

published in media
partnership with



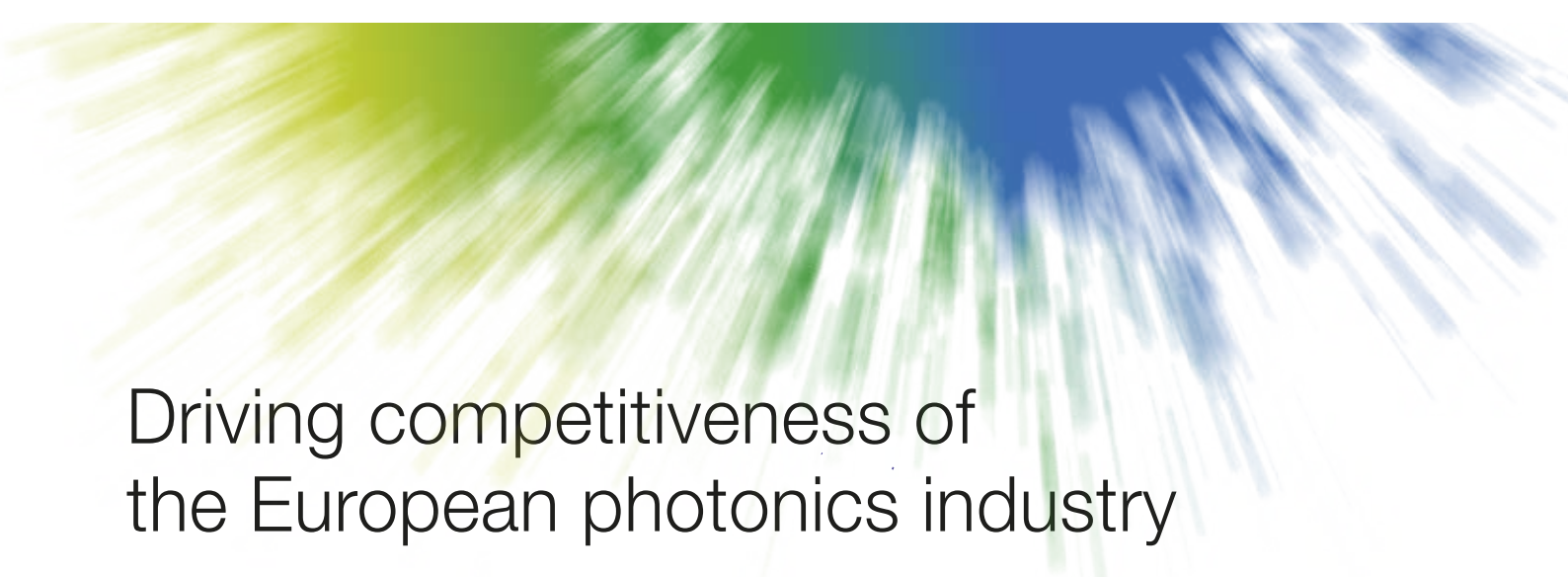
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New Logo
Same Mission



Driving competitiveness of the European photonics industry

EPIC is the world-leading industry association that promotes the sustainable development of organizations working in the field of photonics in Europe. We foster a vibrant photonics ecosystem by maintaining a strong network and acting as a catalyst and facilitator for technological and commercial advancement.

Happy 20th volume anniversary!

Lasers in materials processing – a market overview, funding opportunities in optical technologies, an interview with Dirk Basting the co-founder of Lambda Physik, precision drilling with short and ultra-short laser pulses, UV lasers in flat panel display manufacturing, efficiency and reliability of disk lasers; these were the topics in the very first issue of Laser Technik Journal's first volume. And the industry responded with great interest, so a second issue followed in the same year, four in the following year, and then the first international issue at Laser World of Photonics 2005.

Laser technology – like optical technology in general – was finding its way into more and more industrial sectors because it made numerous applications more cost-effective or environmentally friendly – or enabled them in the first place.

Wiley responded to the success of "LTJ" and the diversification of markets by creating a sister magazine, Optik & Photonik, also with initially two, then four issues per year.

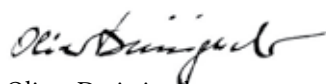
Both magazines were equally well received by decision-makers, as well as researchers and developers in industry and at research institutes, and so the two magazines soon became not only essential reading, but also partner publications such as for the AKL Laser Congress in Aachen, or as society media partners such as for the European Photonics Industry Consortium, EPIC.

The 2010s then saw many company mergers, often aimed at vertical integration, for example between beam source manufacturers, component and system suppliers, and integrators. This is also evident at EPIC who, 10 years ago, chose "O&P" as their publishing partner, since their members were primarily optics and photonics companies at that time. But in the following years, EPIC was gaining numerous entrants from the laser technology area – classically readers of Laser Technik journal – who were getting used to the term 'photonics' as an umbrella designation. So Wiley did the obvious: combine the two journals into a new, bi-monthly title, PhotonicsViews – the brand already familiar from the Web portal photonicsviews.com, the international website of both LTJ and O&P, now part of WileyIndustryNews.com.

To celebrate the 20 volumes in total and the 5th current volume of PhotonicsViews, we asked our long-term partners for a few greetings; you can find them on pages 29 to 31.

'We' includes Stephanie Nickl from the Wiley technology team who was assigned to the PhotonicsViews editorial team in November 2022.

But not only do we have a reason to celebrate: numerous companies, associations, or trade fairs have outstanding anniversaries this year. Enjoy exploring our focus section!



Oliver Dreissigacker



Oliver Dreissigacker
editor-in-chief



Stephanie Nickl
co-editor



www.twitter.com/photonicsviews



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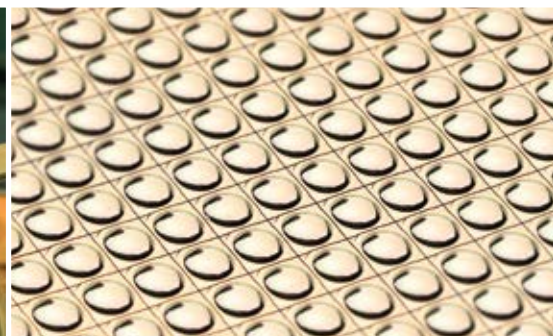


contributing partners



PhotonicsViews

OPTICS • PHOTONICS • LASER TECHNOLOGY



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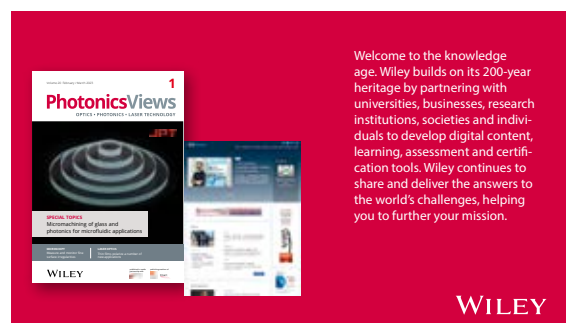
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WILEY



Cover:

Tunable single-frequency cw lasers from HÜBNER Photonics are helping simplify production of holographic optical elements (HOEs) that will be used in future VR/AR/MR applications.

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VDMA: Machine exports at their peak

The export-strong machine and plant manufacturers from Germany have been able to assert themselves well in a difficult global environment. According to preliminary results from the Federal Statistical Office, machine exports for 2022 recorded a nominal increase of 6.1 % compared to the previous year. The export value of the industry thus reached a record value of € 192.4 B, an increase of € 11.1 B. In price-adjusted terms, companies posted a decline of 1.3 % in real terms last year. “Although the annual balance sheet has nice price effects,

the result is also impressive in real terms. The sharp decline feared by many did not materialize in 2022,” says VDMA chief economist Dr Ralph Wiechers.

On an annual basis, the fourth quarter in particular showed a strong nominal increase of 9.3 %. “In addition to numerous indicators such as lower freight rates, the most recent export data show that disruptions in global supply chains have continued to resolve,” analyzes Wiechers.

The USA continues to be the most important export market for machine deliveries from Germany. Last year, the

lead over China was expanded even further. Exports to the United States increased by 20 % to € 24.8 B. Exports to China, on the other hand, fell by a nominal 2.3 % to € 18.9 B. This means that 12.9 % of all machine deliveries from Germany went to the USA; China's share of 9.8 % is now below 10 % for the first time since 2016.

Italy, Switzerland, Turkey, and UK with strong growth in Europe

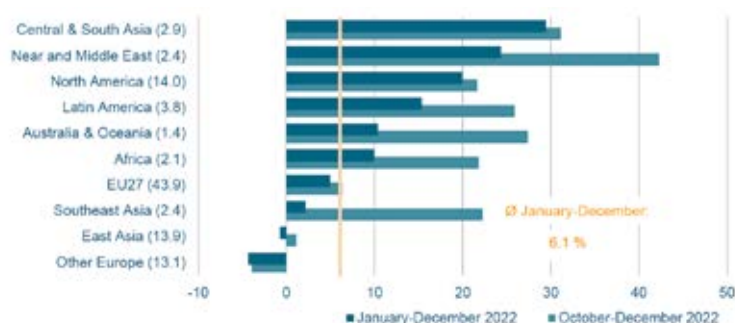
Machine exports from Germany to the EU-27 increased by a nominal 5.0 % to € 84.4 B last year. The EU partner countries thus account for 43.9 % of German exports. Machine exports to the three most important customer countries in the EU-27 – France (up 5.2 % to € 12.9 B), Italy (up 9.0 % to € 9.6 B) and the Netherlands (up 6.1 % to € 8.5 B) – were above the EU average. In the European countries outside the European Union, German exporters saw strong growth, partic-

ularly in Turkey (up 20.8 % to € 4.8 B), in the United Kingdom (up 9.7 % to € 8.3 B) and in Switzerland (plus 11.8 % to € 6.1 B).

Exports to Russia almost halved, India gaining importance

Machine exports to Russia fell sharply last year by 49.4 % to € 2.8 B. For December 2022 alone, there is a downturn of more than 65 % in the books. The share of German machine exports to Russia in the total German machine exports is only 1.4 %, which corresponds to 19th place in the export ranking. Before the Ukraine war, Russia was still among the top-10 buyer countries. India, on the other hand, recorded a significant increase in its share. With an increase in exports of 28.2 % to € 3.9 B, India now ranks 14th among the buyer countries for machinery and equipment from Germany.

www.vdma.org



German machinery exports by region – changes to previous year in percent (Source: Fed. Stat. Office Germany / VDMA)

New report shows quantum technology thriving in Europe

A new study published recently by the European Commission called “Taking the lead in the quantum revolution” shows Europe's quantum technology ecosystem is thriving with a suite of

Quantum Flagship – Europe's €1B, ten-year research and innovation program, the report reveals.

Since the initial four-year ‘ramp-up’ phase (2018-2021) began, Europe's 1,500 quantum scientists across 236 organizations filed 105 patents (with 64 already granted) and published 1,313 scientific papers with a further 223 under review.

Investment in quantum technology has been vital in establishing strong growth within the sector. According to the report, during the ‘ramp-up’ phase, the European Commission invested € 150 M to support 24 consortia involving leading research institutions and companies.

This growth phase was complemented by the Quant-

ERA project – a network of 39 public research funding organizations (RFOs) supporting research and innovation in quantum technology – which leveraged a combined € 89 M. These combined activities helped establish 25 start-ups and spin-offs that are working to commercialize communication, computation, simulation, sensing, and metrology solutions.

The report finds that the initial ramp-up phase has established strong foundations upon which Europe can build its globally-competitive quantum ecosystem of SMEs, corporations, investors, and leading researchers.

The success of the Flagship's ramp-up phase has enabled significant investment from major national

quantum initiatives, creating funding comparable to that already committed by the Flagship (€ 2 B in Germany, € 1.8 B in France, and € 670 M in the Netherlands). The authors note that coordinating research at national and European levels is more critical than ever, given that no single country can carry out the complex endeavors required to develop quantum technology by itself.

A new Strategic Research and Industry Agenda will be published in 2023, reflecting the Flagship's progress so far and setting goals for its future. The Commission will continue to support the Flagship until 2027 with at least € 500 M in funding from Horizon Europe.

<https://digital-strategy.ec.europa.eu>



solutions being developed by projects, start-ups, and spin-offs for a number of applications, including sensing, communication, and computation.

The driving force behind many of the continent's quantum technology breakthroughs since 2018 is the

Topptica takes over Azurlight Systems to form French branch



l-r: Drs Wilhelm Kaenders, Nicholas Traynor, and Juergen Stuhler, VP quantum technologies at Topptica Photonics AG who will become general manager of Topptica Photonics SAS.

German laser manufacturer Topptica Photonics has entered into a definitive purchase agreement to acquire the majority of the shares of French fiber laser technology company Azurlight Systems

as per 22nd December 2022. Azurlight will continue and further foster its fiber laser business under the new name Topptica Photonics SAS. The parties did not disclose the purchase price.

Dr Nicholas Traynor founder and president of Azurlight Systems who will become president of Topptica Photonics SAS: "We are proud to join the Topptica group and excited about the

opportunities this offers for the next stage in our development. Putting together the proven technologies of narrow band and tunable diode lasers with our lowest noise fiber amplifiers will be mutually beneficial for the product families of both companies."

Dr Wilhelm Kaenders, founder and member of the executive board of Topptica Photonics AG, adds: "We envisage further strengthening of fiber laser development in France and strong common product development. This will grow our offering for industry and scientific research, especially in the growing markets of quantum computing and biophotonics and industrial metrology."

www.topptica.com

Amplitude acquires instrumentation provider Fastlite

French manufacturer of ultrafast lasers Amplitude is taking over Fastlite, a French high-technology company specializing in ultrafast pulse shaping, characterization, and optical parametric amplifiers.

Amplitude and Fastlite have long-established ties and have worked together to bring advanced ultrafast technology to the market.

"We have worked with the Fastlite team for many years,

and it is an honor to have them join the Amplitude family. The complementary expertise of the two companies will enable Amplitude to design and manufacture the next generation of ultrafast lasers," says Eric Mottay, president and CEO of Amplitude.

"Fastlite shares the same passion for ultrafast laser technology as Amplitude, and I am looking forward to our teams working together.

Amplitude's world largest ultrafast laser portfolio constitutes an invaluable asset towards the offering of Ytterbium pumped OPA and OPCPA products and solutions," explains Pascal Tourniois, CEO of Fastlite.

Fastlite is recognized for its ultrafast scientific instrumentation and has offered customized ultrafast laser sources based on ytterbium-pumped optical parametric chirped pulse ampli-



Fastlite headquarters in Antibes, France

fiers to the ultrafast scientific community since 2016.

<https://amplitude-laser.com>

<https://fastlite.com>

Chromacity enters strategic agreement with Edmund Optics



Chromacity CEO Shahida Imani with business development manager Bertrand Frossard (r) at their Photonics West booth

At Photonics West, Chromacity announced a strategic partnership agreement

with Edmund Optics for the global supply and distribution of its ultrafast lasers.

The announcement coincides with the launch of Chromacity's latest ultrafast laser emitting light at 920 nm. Their range of fixed-wavelength femtosecond lasers will be actively promoted and distributed through EO's global channels and optical imaging network. The agreement strengthens the development of OEM opportunities for both parties within biomedical imaging. The remote installation capability of Chromacity's ultrafast

lasers helps life scientists to build and operate their own microscopy set-ups, while the ease-of-integration and system stability are crucial for microscope manufacturers.

Promoting Chromacity's newly developed 920 nm system forms part of the agreement. The Chromacity 920 is an important laser source for two-photon microscopy and the excitation of key fluorophores and calcium markers.

<https://chromacitylasers.com>

www.edmundoptics.com

Becoming market leader in optical ground stations



Source: Cailabs

Cailabs has completed a 26 million euros funding round to rapidly expand the company's laser communications and optical ground station business. The funding round was led by Luxembourg-based growth stage investor NewSpace Capital with the support of existing investors: Definvest – a specialized equity fund managed by Bpifrance

in consultation with the French Defense Procurement Agency – Starquest, Innova-com, Safran Corporate Venture and Crédit Agricole Ile et Vilaine Expansion. Cailabs has also been selected to receive support from the European Innovation Council (EIC) fund for innovative deep tech companies.

Founded in 2013, Cailabs' original field of expertise

was long distance telecommunication, leading to the 2017 world record for transmission capacity through a single optical fiber with the Japanese operator KDDI. The company has turned this record-breaking technology into a product for local networks, upgrading more than five thousand links around the world in hospitals, universities and factories, and

has expanded its product mix further with innovative laser-based material processing solutions.

"With the support of NewSpace Capital we will be able to extend our offer to naval, aeronautical (aircraft, UAV) and land links," said Jean-François Morizur, co-founder and CEO of Cailabs.

www.cailabs.com

Physik Instrumente takes over activities of engineering company IBS

Karlsruhe-based "PI" has taken over 53 employees and the existing business of the engineering company IBS in a new company as of January 1, 2023.

The 53 employees taken over from Physik Instrumente (PI) are engineers, software specialists and other

skilled workers. "PI's engineering capacity will immediately increase by approx. 55,000 hours per year," calculates Markus Spanner, CEO of the PI Group. "The employees will support PI with their expertise in the construction of products and systems, in software development, and in

simulation. The further automation of our own manufacturing will also benefit from the IBS engineers' know-how." The new company will also continue existing business with current customers, PI explains.

IBS Ingenieurbüro Dr. Klaus Schnürer GmbH, also

in Karlsruhe, Southwest Germany, is specialized in the development and implementation of automation projects, mainly for the automotive industry, and was forced to file for insolvency during 2022.

www.physikinstrumente.com

MicroVision acquires Ibeo Automotive Systems



Source: MicroVision

MicroVision's mavin lidar hardware and Ibeo's mature software will position MicroVision as a leading partner to OEMs.

MicroVision has signed an agreement to acquire certain assets from German company Ibeo Automotive Systems for up to 15 million euros. The acquisition combines Mavin Lidar with Ibeo perception software features into the MicroVision ASIC for automotive OEMs. In addition, this acquisition expands MicroVision's multimarket strategy focusing on industrial, smart infrastructure, robotics, and commercial vehicle segments with Ibeo's flash-based sensor. The combined company is expected to have revenue streams

from existing and new product lines ranging from software, Ibeo's flash-based lidar and MicroVision's scanning lidar sensor, as well as other combinations of hardware with perception software solutions. The closing of the acquisition, expected to occur during the first half of 2023, is subject to regulatory clearance from the German ministry of economics and climate protection.

MicroVision expects to expand on Ibeo's relationship with ZF Friedrichshafen for lidar manufacturing.

www.microvision.com

Trumpf invests in Quside, joins Qutac consortium

The German high-tech company is lining up with the Quantum Technology & Application Consortium's twelve existing members and tapping the market for random number generators of around €10 B expected by 2026.

"With Trumpf, we are welcoming yet another highly innovative German company to Qutac. We stand to be enriched by their experience in applying quantum computing to essential areas such as machine tools, net-

nomically successful quantum computing ecosystem, as well as to digital sovereignty for Germany and Europe."

Trumpf will initially be active in Qutac's production and logistics and quantum systems working groups. The applications the Ditzingen-based company will develop will focus on optimizing machine occupancy on the production floor, image processing via machine learning, and how quantum computing can be harnessed to accelerate

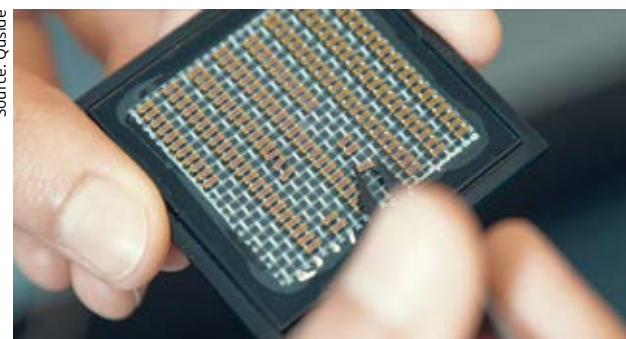
At the same time, Trumpf Venture is making a multi-million euro investment in the Spanish startup Quside. The company's core product is a high-performance random number generator located in a photonic chip. Using the quantum mechanical properties of light, it produces completely random number combinations very quickly – in the Gb/s range. This makes it possible to improve the encryption of messages enormously. It can also be used to perform simulations such as risk analyses in the financial sector or weather forecasts much faster and with far greater energy-efficiency.

The chip is compatible with common semiconductor manufacturing (CMOS), which enables easy mass production. Quside is based in Castelldefels near Barcelona and currently employs around thirty people. Founded in 2018, the startup's first customers are from sectors with high security requirements, such as aerospace.

www.trumpf.com

www.qutac.de

<https://quside.com>



Photonic chip

worked manufacturing, and laser technology," says Jörn Messner, chairman of the Qutac executive committee and CEO of Lufthansa Industry Solutions. "This will bring us one step closer to an eco-

machine learning. Trumpf is also researching how to use quantum computing to simulate heat input during laser cutting and how it can improve production equipment automation.

Zeiss buys Polish manufacturer of optical 3D metrology

The Lenso company will be part of Zeiss' industrial quality solutions division in the future. Lenso, headquartered in Poznan, Poland, is a manufacturer of optical 3D metrology.

"We are pleased to be pooling our strengths and know-how in the important Polish market," says Dr Marc Wawerla, head of Zeiss' industrial quality solutions division. "Our goal is to be the num-

ber one for metrology and quality control in Poland and to shape the market," adds Michael Hubensack, CEO of SSC Carl Zeiss Poland. "We look forward to being part of Zeiss and to combining our efforts to offer our customers the best solutions," says Marek Radke, CEO of Lenso.

Once the transaction is completed, Lenso will be part of the Zeiss sales company in Poland. Zeiss and Lenso will continue to be responsible for the services they offer their customers. Both sides have agreed not to disclose the financial details of this transaction.

www.zeiss.de/messtechnik



Marek Radke (left) and Michael Hubensack

ALSO OF INTEREST

Schott and 3D-Micromac join forces regarding AR waveguides

Partnership to focus on dedicated laser cutting process and mass production system for Schott RealView high refractive index glass

Igus exceeds one billion in sales

Ten-digit turnover achieved for the first time

Blood glucose monitoring with laser light instead of needles

People with diabetes will simply be wearing a wrist-worn device that reads their glucose with a minilaser

Quadric and AMS Osram collaborate on intelligent image sensors

Solution enables new capabilities of low power and small form factor smart sensing for various applications

Turnkey fingerprint sensor solution for the smartphone industry

Isorg collaborates with Precise Biometrics on a new fingerprint on display (FoD) solution for mobile devices.

Modulight laser gets FDA approval for photodynamic AMD treatment

Company launches product in the US – EU authorization is expected this year

Nuburu now publicly listed

Common stock and warrants will commence trading on February 1, 2023 on the NYSE

TKH Vision opens Solution Center in Constance, Germany

Center serves as a demo and experience center for TKH Vision's integrated vision solutions

Pepperl+Fuchs breaks the billion mark

Company was able to record a total sales increase of more than 40 %

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Wasatch Photonics turned 20 in December 2022

The company from Utah and North Carolina celebrated its 20th anniversary in December. Founded in 2002, the company designs and manufactures high efficiency transmission gratings for spec-

troscopy, optical coherence tomography (OCT), astronomy, and pulse compression, as well as spectrometers for OCT, Raman, and other spectroscopic techniques.

In these twenty years, Wasatch Photonics has grown from a small shop started by a group of entrepreneur-innovators in Logan, Utah, to commercialize disruptive volume phase holographic (VPH) grating technology, establishing three sites

across the US and a global distributor network. Along the way, they patented several unique VPH grating technologies and developed a line of highly configurable modular spectrometers for OCT and Raman with industry-leading sensitivity and speed. Both the Logan, UT, and Morrisville, NC, manufacturing facilities are ISO 9001:2015 certified and are under upgrade or expansion. Board chairman Lind-

say Burton said, "It is amazing to be involved in cutting edge technology that couldn't have been done ten to twenty years ago."

Doug Miller, one of the founders, said "Now we are a company that can design to a high spec, build it, and deploy it reliably. No longer a start-up, we have become big enough to have an impact in the industry, but still care about each customer."

<https://wasatchphotonics.com>

Wasatch Photonics



A quarter of a century of CTX

Wilfried Schmitz founded a sales company with the Swiss sensor manufacturer Contrinex and a silent partner in December 1997 with the two independent business

which renamed itself CTX Thermal Solutions.

CTX grew with the increasing digitalisation of industry and everyday life and the accompanying rise in demand for thermal management. At the same time, new markets emerged, such as the cooling of LEDs, which successively replaced conventional incandescent, neon and halogen lights.

At the end of 2021, Jens Mirau joined the company as managing director for operations. In 2022, CTX founded a subsidiary in China and Wilfried Schmitz began concentrating on projects such as the planning and realization of strategic investments and succession planning.

www.ctx.eu

Source: CTX Thermal Solutions



Wilfried Schmitz

divisions of sensor technology and cooling bodies. In 2013, the sensor division was spun off into the newly founded company Contrinex Sensor. The heat sink division remained with Contrinex,

Endress+Hauser celebrates 70th anniversary

The specialist for measurement and automation technology celebrates seven decades in business this year. Georg H. Endress and Ludwig Hauser entered their company in the commercial register on 1 February 1953. In the meantime, the group operates in 125 countries and produces in all major economic regions. As in the previous year, the company plans to continue creating new jobs and investing in buildings and facilities in 2023.

E+H was able to record sales and unit growth in 2022 despite strained supply and logistics chains. "We can be proud of what we have achieved and look to the future with confidence," says CEO Matthias Altendorf.

The employees of the company group will celebrate the 70th birthday at both large and small events. From 26 to 28 June 2023, Endress+Hauser invites



Matthias Altendorf

partners to join the Global Forum in Basel to discuss the sustainable transformation of the process engineering industry together with customers, partners and experts.

www.de.endress.com

Source: Endress+Hauser

Polytec celebrated the 100th birthday of the company founder

Heinz G. Lossau founded the Polytec company in 1967 together with his wife

Liselotte Lossau. He would recently have reached 100 years old. Throughout his

life, Lossau not only made a name for himself as an agile and courageous entrepreneur and company founder, but also as a pioneer of laser measurement technology. As a young physicist he got to know the new laser technology in the US. He recognized its potential for research and industry and set himself a major goal: to bring laser technology to Germany, to make it known there and to develop it further. In the decades that followed, Los-

sau built up the areas of length and speed measurement in production plants with Polytec, NIR spectroscopy for process analysis, industrial image processing and optical systems.

Heinz G. Lossau died in 2005 at the age of 82. Today the company looks back on more than 50 years, employs almost 500 people worldwide and has branches in the USA, England, France, Japan, Singapore and China.

www.polytec.de

Source: Polytec



Heinz G. and Liselotte Lossau

Nuremberg Exhibition Center inaugurated 50 years ago



Source: Bischofbroel Manfred Gillert

When the new events year began for 2023, international exhibition hub Nuremberg could celebrate a landmark anniversary: it was on 10 January 1973 that the city inaugurated its new exhibition center. “Messezentrum Nürnberg” has been hosting trade fairs, conferences and corporate events for five decades now. The group of multifunctional halls in Langwasser, a new part of town at the time, represented an innovative counterpoint to a city whose urban landscape up to then had been defined most of all by its Old Town. “Today, the courageous step taken by the City Council in those days can be considered one of the most important moments in opening up Nuremberg as an international business location,” said Mayor Marcus König. “By building this exhibition venue, as a city we laid the cornerstone then for

the subsequent success story of our NürnbergMesse.” But the exhibition company itself, today’s NürnbergMesse GmbH, will not be celebrating its own 50th anniversary until 5 April 2024 – commemorating the day when it was entered as a legal entity in the commercial register.

The exhibition venue’s location, in the immediate vicinity of the Congress Hall, the Zeppelinfeld and the entire complex of the former Nazi party rally grounds, highlights the sense of obligation that the Franconian exhibition company still feels today. “The choice of this site back in the day, with the historical dimensions it implied, still charges us with the mission of dealing appropriately with the history of the place,” emphasises NürnbergMesse Group CEO Prof Roland Fleck. And his joint CEO, Peter Ottmann, adds, “In light of the many inter-

national meetings that have taken place at this location, we could hardly have found a better place to underscore the cosmopolitan, economically vigorous, and internationally harmonizing side of the City of Nuremberg.”

Spielwarenmesse sets the tone

In February 1969, the city council voted by a large majority to give serious consideration to building a new exhibition center that would keep the successful toy trade fair in Nuremberg and offer potential for new trade fairs to come and join it. The area of today’s center was chosen after a variety of other locations had also been considered. One advantage here was the site’s good transport connections with both the Autobahn and the city center. The underground rail system in the direction of the new Langwasser district

had already been under construction since 1967. The City Council voted unanimously in February 1970 to invite detailed plans for a new exhibition center and approved the first segment of construction on 16 June 1971. Ground was broken on 20 September of that same year.

Only 16 months later, after an investment of 100 million Deutschmark, the new center was festively opened by Mayor Dr Andreas Urschlechter at a New Year’s reception in January 1973.

Today, Nürnberg Messe is one of the 15 largest exhibition companies in the world with 16 exhibition halls and a total of 180,000 square meters of exhibition area and 50,000 square meters of open space. It also includes the Nürnberg Convention Center (NCC), offering space for up to 12,800 visitors at conferences and corporate events.

www.nuernbergmesse.de

Luxinar celebrates 25 years at MEC SPE 2023

Laser manufacturer Luxinar has been making a mark during its 25th year by showcasing its CO₂ and ultrashort pulse laser sources at MEC-SPE, Bologna, Italy.

Regional general manager of Luxinar Italy Walter Gensabella and his team showcased the SR e 9.3 µm series, the latest in Luxinar’s well-established SR series of sealed CO₂ laser sources, targeting the electronics industry, where high peak power and low heat-affected zones are required. The SR e series

is ideal for processing polarizing film, removing excess bonding agent, and laser texturing; applications that need perfect edge quality and minimum disruption of the surrounding area. The SR 10e, with up to 115 W average output power and 330 W peak output power and the SR 15e, with up to 160 W average output power and 460 W peak output power, offer fast processing capabilities and high-quality results.

As with the rest of the SR series, the SR e series have

a rating of IP66; this means they are ideal for the harshest industrial environments to ensure high protection against water and dust ingress. The output beam is in the same place on all the SR series, allowing power upgrades with minimal design changes. An integrated RF power supply that is replaceable in the field reduces production downtime. The simple control interface and compact mechanical design of the units allow easy integration into laser-based processing



machines used for cutting and drilling, among others.

The Luxinar Italy team will be on hand throughout the exhibition to share their knowledge and provide expert advice on laser technology.

www.luxinar.com

Precitec acquires majority stake in startup Enovasense



The team at Enovasense (Source: Precitec)

Precitec has acquired a majority stake in start-up Enovasense, which has developed sensors for measuring the thickness of all types of coatings on any substrate.

The remaining shares of Enovasense are held by the two founders Jean Inard-Charvin and Geoffrey Bruno, who will continue to lead the company on its growth path. The closing took place on November 30, 2022. The parties agreed not to disclose the purchase price.

Enovasense has developed a laser gauge to measure the thickness of all types of coating. It enables fast, non-contact and non-destructive measurement on any type of coating – whether metal, ceramic, paint, polymers or adhesives. Enovasense's customers include a number of major industrial companies. So far, the patented laser-based technology has been sold mainly in France,

but also to other countries through distributors.

Enovasense's sensors will expand application possibilities for Precitec customers, as they are able to accurately measure the thickness of opaque layers or coatings as well as nanometer-thin films. The expanded portfolio could be used in particular in the semiconductor industry, consumer electronics or electromobility. Precitec sees enormous growth opportunities for Enovasense here.

Dr Thilo Wersborg, CEO of Precitec, comments, "With the majority stake in Enovasense, we have acquired a young, dynamic team with a promising technology and a proven track record in the French market. Enovasense's products perfectly complement our high-quality portfolio in the field of monitoring and 3D measurement technology."

www.precitec.com

Cognex acquires Sirius Advanced Cybernetics, AIT the spun-off solution division

With the acquisition of the solutions division of SAC Sirius Advanced Cybernetics, AIT Goehner strengthens its vision domain. After Cognex had acquired SAC, the solution division was spun off. AIT Goehner – system integrator for image processing and AutoID – has now taken over this business area.

"This creates a huge opportunity for us and our customers," says Michael Gauch, managing director at AIT. "SAC's core competence lies in surface inspection, which we are now integrating at AIT and thus further expanding our solution portfolio."

The two companies have already been working closely together for several years and were able to develop a joint image processing concept with SCI Smart Cell Inspection, for example.

In order to enable seamless project continuation, AIT Goehner will retain the Karlsruhe location. A large

part of the staff will be taken over. Sebastian Grimm will be the new site manager.

The acquisition of SAC Sirius Advanced Cybernetics by Cognex expands the Massachusetts company's footprint across industries that manufacture at high speed with minimal tolerance for safety-critical failures, such as automotive and consumer electronics. Cognex plans to feature SAC's Trevista products with its Vision Pro software offering.

Founded in 1996 in Karlsruhe, Germany, SAC's strong customer base includes leading European automotive suppliers and manufacturers.

"SAC's technology will improve our defect detection capabilities, and position us particularly well with EV battery manufacturers," said Joerg Kuechen, Cognex' senior vice president and CTO.

www.cognex.com
www.ait-goehner.de



Michael Gauch, (left), CEO AIT Goehner, and Sebastian Grimm, site manager, AIT Goehner. (Source: AIT Goehner)

AMS Technologies signs distribution agreement with GH Optics

The range of high-precision aspherical lenses, fiber collimators and thermal imaging lenses from GH Optics is now available in Europe via AMS Technologies. Thanks to its expertise in developing products and solutions that are precisely tailored to the specific requirements of customer projects, AMS can also

define and develop bespoke optical solutions.

GH Optics has a sophisticated manufacturing process for blanks made of various optical glasses and the compression molding of aspherical optics enables the series production of lenses with very good optical properties, reproducible high quality

and at the same time a competitive price/performance ratio. The portfolio of compression-molded aspherical lenses is suitable for visible and infrared applications – as a single component or pre-assembled in stainless steel holders.

In addition, GH Optics has the know-how and equip-

ment for coating the components with a wide range of materials for wavelengths from 350 nm to 14 µm. The ISO 9001-certified company ensures consistently high quality with extensive measuring and testing technology. All materials used meet the RoHS directive.

www.amstechnologies.com

Laser 2000 to partner with Modulight



Source: Laser 2000

l-r: Tommi Hakulinen (Modulight product manager), Kalle Palomäki (Modulight board member), Eerika Suokas (Modulight R&D engineer), Simon Kempf (Laser 2000 sales engineer), Karl Cichon (Laser 2000 sales engineer) und Ulla Haapanen (Modulight marketing manager)

With its new partner, Laser 2000 strengthens its solution approach to address the increasing demand for tailored solutions and sub-systems.

Modulight focuses on the development and production of lasers and laser systems for biomedical, quantum and other high value-added applications. Modulight's product portfolio includes supporting laser solutions such as system integration services and laser design and manufacturing by leveraging the full vertical integration capabilities. The company's own semiconductor laser chip manufacturing

facility in Tampere, Finland, enables Modulight to ensure delivery, change control and customized solutions.

Modulight is expanding sales in Europe through this exclusive distribution partnership that makes its products available to customers in Germany, Austria, Switzerland and France. Laser 2000 customers include several of the biggest technology companies in Europe. The expectation is that this collaboration will open significant sales opportunities for Modulight's laser technology, as the local market representation provides better expo-

sure in the biophotonics and life science, quantum, sensing, and other markets.

From the diode to the electronics, software and the finished device, everything is developed and produced in-house at Modulight. Through this approach the company not only has complete control over the entire process, but is also very flexible in offering different levels of integration supporting products over lifecycle and providing supply chain security besides constant development.

www.laser2000.com
<https://modulight.com>

Fisba acquires Gray Optics

With the takeover of Gray Optics, Fisba intends to deepen and expand the engineering and development capacities of the North American subsidiary.

The combined team will enable Fisba's customers to accelerate development and new solutions in the areas of life science, manufacturing engineering, and security and defense. The acquisition of Gray Optics is intended to further support Fisba's strategy of providing optical solutions to improve health, productivity and safety and to strengthen its

technical and development expertise in North America. "We expect this acquisition to have an immediate impact on our customers as we offer vertically integrated product development and manufacturing capabilities," says Wallace Latimer, president of Fisba North America.

"This acquisition complements the product development and manufacturing capabilities we have built in the United States over the past five years," said Dan Gray, founder and president of Gray Optics.

www.fisba.com
www.grayoptics.com



Sources: Gray Optics / Fisba

Dan Gray of Gray Optics (l), Wallace Latimer, president of Fisba North America

ALSO OF INTEREST

Management change at Schaeffler

Since January, Christian Zeidlhack has been in charge of the industrial business in Europe

Jenoptik achieved strong sales growth in 2022

Company sales rose by 30 % in the 2022 fiscal year. For 2023, the executive board aims to exceed the 1 billion euro mark in sales

EVK secures rights on chemometric software

Perception Park's hyperspectral imaging software to be partly integrated in "Sqalar"

Pulsate 2nd round projects selected

12 experimental projects were successful in the open call for experiments addressing laser-based advanced and additive manufacturing

Groundbreaking ceremony for the "Future Factory Asslar"

Pfeiffer Vacuum expands its Asslar site with new production and logistics capacities

Ultracompact components for optical amplifiers

Coherent introduces product portfolio of optical amplifiers embedded in telecom transceivers and lidar subsystems

Optica names recipients for 2023 awards and medals

Robert Boyd wins the 2023 Frederic Ives Medal / Jarus W Quinn Prize and 17 more recipients for other honors

Laser-blanking system to cut costs

The new TruLaser 8000 Coil Edition is a flexible, high-volume cutting solution "straight from the coil", saving up to 1,700 tons of steel worth some 1.6 million euros per year.

Your daily quantum of photonics news

Wiley Industry News
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Prism Awards and Startup Challenge prizes at Photonics West



Source: SPIE

The 2023 SPIE Prism Awards: the evening's winners and presenters celebrate their successes and 15 years of photonics innovations.

On the evening of February 1st, SPIE recognized the top-rated new optics and photonics products with the industry-focused Prism Awards. The gala evening, held during Photonics West, also marked the Prism Awards' 15th anniversary. For consideration this year, SPIE received 76 applications from 19 countries. The 2023 winning companies and products in the eight categories are:

- AR VR MR: TriLite Technologies, Trixel 3
- Biomedical: Philophos,

- KUOS-O100
- Cameras and Imaging: Metalenz, PolarEyes
- Lasers: Kyocera SLD Laser, LaserLight LiFi system
- Quantum Tech: QuiX Quantum, 20-mode quantum photonic processor
- Sensors: Ocean Insight, SpeedSorter
- Software: Dotphoton, Jetraw
- Test and Measurement: Precitec Optronik, Flying Spot Scanner (FSS 310)

The distinguished judges' roster included the FDA's Zane Arp, iFocus' Adi Diner, AXA-XL's Simi George, MKS Instruments' Marc D. Himmel, Coherent's Qiongying Hu, Chromacity's Shahida Imani, Teledyne Princeton Instruments' Jason McClure, Technology Scotland's Alison McLeod, Tesseract Health's Nishant Mohan, Engender Technologies' Catharine Simpson, Ceres Technology Advisors' Linda Smith, Toptica's Mark Tolbert, and Nanovation's Ferechteh Teherani.

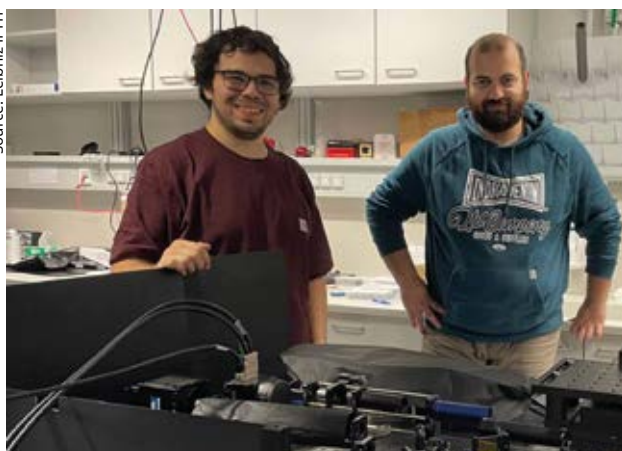
The evening before, Swave Photonics – with their Holographic extended reality chips – was announced the winner of the \$10,000 top prize at the 13th annual SPIE Startup Challenge.

Qart Medical, utilizing biophotonics and data for 3D analysis of sperm cells during IVF, came on second place and PhosPrint third, with their novel bioprinting technology that repairs in vivo human tissue during surgery.

<https://spie.org>

Chan Zuckerberg Initiative grant to improve microscopy with optimized software

Source: Leibniz IPHT



CZI grantees Dr Francesco Reina and Jacopo Abramo with a custom-built interferometric scattering microscope, iSCAT

In the search for new knowledge, scientists – from biomedicine to materials science – rely on reliable and efficient tools for microscopic

observation and detailed analysis of samples. Software solutions for image processing, such as the open-source software napari, support the

control of microscopy workstations as well as the development of scientific data.

In order to unleash the full potential of such software tools for microscopy and imaging, Leibniz IPHT researchers are working on a new plugin. This is intended to bridge the gap between microscopy setups, the used acquisition devices of these setups and the Napari multidimensional image viewer software. "Our new plugin to be developed for Napari will provide an interface to further optimize microscopy image acquisition and processing. Almost every camera can be integrated into existing setups thanks to the

plugin. The image data can then be recorded directly with the microscope acquisition device, viewed immediately in the imaging software, processed in real-time and the data analyzed while experiments are still in progress. Researchers thus gain complete control over the imaging parameters as well as their data at any time," explains Jacopo Abramo, PhD student in the biophysical imaging department at Leibniz IPHT, who together with his scientific colleague, Dr Francesco Reina, was able to secure the Chan Zuckerberg Initiative (CZI) Napari Plugin Foundations Grant.

www.leibniz-ipht.de

Lumentum announces new SVP

The manufacturer of optical and photonic products announced the appointment of Caroline Pan as the new senior vice president and chief marketing officer, reporting to Alan Lowe, president and chief executive officer. Pan will be responsible for leading strategic marketing, corporate marketing and communications, and Lumentum ventures, an initiative to drive market expansion through innovation.

"I am thrilled to welcome Caroline to Lumentum," said Lowe. "Given expanding opportunities outside of Lumentum's core customers and end markets, Caroline's portfolio of global experience, domain knowledge across industry sectors, and proven track record of delivering high impact business results make her an important addition to our executive leadership team."

Pan is a seasoned industry executive with nearly thirty years of experience across the high-tech, industrial, and automotive sectors. Before joining Lumentum, she was the chief marketing officer for Bright Machines, a venture-backed software



Caroline Pan

and robotics company that provides intelligent automation solutions for discrete manufacturing. Prior to Bright Machines, Pan was a vice president at Honeywell, where she last led strategy, innovation, and ventures for the company's safety and productivity solutions business. She also established Honeywell's first corporate marketing function and led strategy and marketing for their global high growth regions organization.

She began her career as a design engineer and product line manager at Ford Motor Company. Pan holds a bachelor of science degree in mechanical engineering from the MIT and an MBA from Harvard Business School.

www.lumentum.com

Prima Industrie announces new CEO

Following the closing operation by Femto Technologies, a new board of directors has been elected and Giovanni Negri has been appointed as the new CEO of Prima Industrie.

Negri has a degree in management engineering and a master in business administration from the Politecnico di Milano. Since November 2018 Negri has been CEO of CMS, a company specialized in the production of numerically controlled multi-axis machining centers. Previously he held, both in Germany and Italy, several positions of increasing responsibility

in SCM Group, Porsche Consulting and Siemens.

The former CEO Ezio Basso will remain on the board of directors and will actively cooperate with Negri ensuring an effective handover in the group.

www.primaadditive.com



Giovanni Negri

Change of leadership at Zebra Technologies

Bill Burns, Zebra's chief product and solutions officer, will become the company's next CEO and a member of the Zebra board of directors. Anders Gustafsson stepped down from his role effective March 1, 2023.

Burns has more than thirty years of experience in the technology sector and has served in his current role for nearly five years. During that time, he has grown Zebra's market share and profitability in its core businesses, penetrating adjacent and expanding markets, executing the company's enterprise asset intelligence vision and



Anders Gustafsson

Bill Burns

strengthening Zebra's strategic relationships with its customers and partners.

After 15 years as Zebra's CEO, Anders Gustafsson has been appointed executive chair at the top of the Zebra board of directors.

www.zebra.com

Laser manufacturer appoints new CEO

Aldas Juronis, previously Ekspla's manager of manufacturing operations, succeeded Kęstutis Jasiūnas as CEO, effective January 1, 2023.

Ekspla, Lithuania's first laser production company, turns thirty this year and now, as Kęstutis Jasiūnas affirmed,

the rapidly changing environment. That is why, as of next year, I will be focusing on the strategic development of our company and the work on the board. Aldas will be taking over the company's reigns."

Juronis started his career at the company four years



Aldas Juronis



Kęstutis Jasiūnas

the time has come to make some changes which will be quite considerable over the next few years. He stated: "Our strategic focus on femtosecond solutions has helped us develop new technologies, products, discover new buyers, and expand our manufacturing business. The growing market of original equipment manufacturers demands human resources just as it calls for additional management resources as well as the ability to adapt to

ago as supervisor of the OEM laser program, his team turned ideas into final industry-ready solutions. Last year, he became head of the laser manufacturing department.

He has acquired more than twenty years of business experience, supervising large departments in the aviation business as well as running his own company. The management of Ekspla's manufacturing unit will be taken over by Ingrida Navickienė.

<https://ekspla.com>

Coherent appoints new EVP Telecom

Dr Beck Mason has joined Coherent Corp. as executive vice president, telecommunications, leading the telecommunications business unit within the networking segment.

"We are excited to welcome Dr Mason to Coherent," said Dr Vincent Mattera Jr, chair and CEO. "In this position, Dr Mason will identify the technology vision for our telecom product offerings, play an integral role in defining our technology platforms and strategic investments, and drive the profitable growth of the telecom business in the communications markets that we serve."

Dr Mason will have oversight of Coherent's broad technology and product portfolio, one of the most complete and advanced in the industry, includes its industry-leading wavelength-tunable pluggable transceivers, high-speed coherent pluggable transceivers, wavelength selective switch (WSS) modules, pump lasers, optical amplifiers, optical monitoring, and ROADM solutions.

Beck Mason joins Coherent from Lumentum, where

he was senior vice president and general manager of the telecom transmission business and helped to guide their technology strategy for the past four years. He joined Lumentum in 2018 through the acquisition of Oclaro, where he was president of the integrated photonics business. Prior to Oclaro, Dr Mason held leadership positions at JDSU, Collinear, Finisar, Agere Systems, and Lucent Technologies Bell



Beck Mason, PhD

Labs. He holds a bachelor's degree in engineering from the University of Waterloo in Canada, a master's in aerospace engineering from the University of Toronto, and a PhD in electrical and computer engineering from the University of California at Santa Barbara.

www.coherent.com

New managing director at Analytik Jena

On February 2023, Oliver Klaeffling took over the management of the Endress+Hauser Group subsidiary specializing in laboratory analysis.

The graduate industrial engineer has worked for Merck in Germany and the US since 2004. Most recently, he was head of the Merck Innovation Center in Darmstadt. His predecessor, Ulrich Krauss, had been a member of the Analytik Jena management team since 2015 and took over as CEO in 2016.

Analytik Jena plays an important role for Endress + Hauser in its goal of accom-

panying customers from the laboratory to production. The group is currently investing 50 million euros in a company campus in Jena-Göschwitz; a new production building is to be built in Ilmenau for 27 million euros.

www.endress.com



Oliver Klaeffling

Quantel USA has a new CEO

Lumibird has appointed Cordell Maines as chief executive officer of its photonics division's US manufacturing site.

Cordell is a sales and operations leader with more than twenty years of experience. In his most recent role as business leader for Lumibird Inc, Cordell guided Lumibird's North, Central, and South American sales division, bringing expertise to the company's market strategy and enhancing client experiences. He succeeds Steve Patterson, who announced his resignation from the company in September. His appointment comes after an extensive selection process by the board.

"I am proud to take on the CEO role and eager to advance the strategy Steve and the Lumibird team have created," said Cordell. "I could not be more honored to represent such a group



Cordell Maines

of innovative, creative, and intelligent professionals who share the same passion for the photonics industry."

"On behalf of the executive committee of the Lumibird group, we are excited to welcome Cordell Maines as our next CEO," said Hervé Scoarnec, head of the photonics division. "He's a proven leader with the vision to expand on the success Lumibird has built over the past fifty years and take us into the next phase of growth and innovation."

www.lumibird.com
www.quantel-laser.com

Neil Gerrard becomes III-V Epi's director of epitaxy

Compound semiconductor industry expert Dr Neil Gerrard is a well-respected epitaxial engineer and director, with over thirty years' industrial experience. Neil's new role will help capture the molecular-beam epitaxy (MBE) and metal-organic vapor-phase epitaxy (MOCVD), III-V epitaxial manufacturing, support and R&D requirements of III-V Epi's customers. These range from universities, development departments and start-ups through to defense, smaller datacom and telecom companies.

Neil's previous experience has included technology direction, new product development, and wafer FAB and epitaxy operations. His roles have ranged from technical marketing director at Aixtron UK (Thomas Swan); UK MD



Dr Neil Gerrard

at LayTec UK; to engineering lead in start-ups, Kubos and Optical Reference Systems. Neil helped set up and run the wafer fab at Nortel Networks and helped introduce the MOCVD facility at Silvers.

He first worked with fellow III-V Epi director, Prof Richard Hogg, whilst director of operations and business development for the Engineering and Physical Sciences Research Council (EPSRC).

www.iii-vepi.com

Andrew Girardi appointed vice president of sales and business development at Efinix

Efinix has hired Andrew Girardi as vice president of sales and business development. He is responsible for the respective teams in the Americas as well as EMEA with immediate effect.

As vice president of sales and business development at Efinix, Andrew Girardi leads the corresponding activities in the Americas and Europe, Middle East and Africa (EMEA). In his more

ing unprecedented growth as our message of efficiency and rapid time to success continues to resonate with our customer base. Andrew's guidance and focus on EMEA and the Americas will be invaluable as we solidify our position in those markets and continue to gain traction with our groundbreaking technology."

Prior to joining Efinix, Girardi was vice president of sales at Flip Electronics, where he led the OEM team to record sales growth. He holds a Bachelor of Science degree from the United States Military Academy at West Point and a master of science in business administration from Boston University.

"Andrew brings a wealth of knowledge and experience to the vice president of sales position," said Mark Oliver, Efinix vice president of marketing. "As our burgeoning eco-system of customers and partners continues to explode in EMEA and the Americas, his insight and guidance in setting up a sales and business development infrastructure will be key to sustaining the rapid growth that Efinix is experiencing in those markets."

www.efinixinc.com

Management change at Volume Graphics



Since 1 January 2023, Volume Graphics in Heidelberg, Germany, has a new management team: Bernhard Fink, Christian Graf and Daniela Handl. The three founders Christof Reinhart, Thomas Günther and Christoph Poliwoda have retired from their role as managing directors at the end of 2022. 25 years ago, the founders developed a software application that could process CT slice image stacks three-dimensionally on standard PC hardware.

www.volumegraphics.com



Helios Plus

BeamWatch Integrated



Integrated Laser Beam Measurement in Automated Manufacturing

Ophir laser measurement systems for industrial applications offer a robust housing and ProfiNET, Ethernet-IP and RS-232 interfaces.

Helios Plus – Compact Power Measurement

- Measures up to 12 kW
- Simple integration
- No water cooling
- Spectral range 450-550 nm & 900-1100 nm

BeamWatch Integrated – Entire Beam Diagnostics

- Non-contact focus shift and spot size
- Focus parameters in real time
- Full measurement in less than 1 second

www.ophiropt.com

Low-noise picowatt photoreceivers with switchable gain

Manufacturer: Femto Messtechnik

Product: The low-noise Si and InGaAs photoreceiver "PWPR-2K" series enables measurements of optical signals down to the picowatt range, at a bandwidth of 2 kHz. The gain setting is switchable in two steps to enable adaption to different signal intensities. Connection of fibers to the free space input is possible using optionally available adapters.

Features: The photoreceivers cover the spectral range from 320 nm to 1060 nm (Si) and from 900 nm to 1700 nm (InGaAs), respectively. The very low noise level with NEP less than 10 fW/√Hz enables acquisition of smallest intensities in the frequency range from DC to 2 kHz. The gain can be switched between 10^9 V/A and 10^{10} V/A. The photoreceivers are equipped with UNC 8-32 and M4 threaded holes and can be mounted



easily and stably onto conventional post holders for integration into optical systems. The free space inputs are available with 1.035"-40 threaded flange or alternatively with 25 mm round flange. The optionally available "PRA-FC", "PRA-FCA" and "PRA-FSMA" fiber adapters can be screwed onto the threaded flange to connect to FC or FSMA fibers.

Applications: Spectroscopy, characterization of light sources, time-resolved pulse measurements and plenty more.

Femto Messtechnik GmbH

Klosterstr. 64
10179 Berlin, Germany
phone: +49 30 2804711-0
e-mail: info@femto.de
Web: www.femto.de

ISO 17025 compliant on-site testing at the customer's premises

Supplier: Instrument Systems

Product: Germany's national accreditation body (DAkkS) has extended Instrument Systems' accreditation. In addition to on-site testing of DMS display measurement systems, Instrument Systems is now also accredited for ISO 17025 compliant testing of illuminance with its large "AMS" and "LGS" goniophotometers at the installation site.

Customers can now receive an ISO 17025 compliant test certificate for the "DSP

200" and "DSP 10" photometers, even if they are tested and adjusted at their site of operation. This means only a minimal interruption of operation of the often continuously run quality controls and COP tests, as it is no longer necessary to dismantle the equipment and send it to the manufacturer.

Thanks to the innovative testing procedure specially developed by Instrument Systems, which was subject of thorough review by the accreditation body, Instru-

ment Systems is one of few technical service providers to hold an ISO 17025 accreditation for on-site testing of its equipment.

Instrument Systems GmbH

Kastenbauerstraße 2
81677 Munich, Germany
phone: +49 89 454943-0
e-mail: sales@instrumentsystems.de
Web: www.instrumentsystems.de

Compact controller saves space and energy for laser welding

Manufacturer: Blackbird Robotersysteme.

Product: Especially compact "Scanner-ControlBox" (SCB) scanner controller that simplifies and accelerates the integration of a welding system in automatic production systems and robot cells.

Background: Remote laser welding has become an ever more attractive joining

method for a variety of materials – also in applications beyond the automotive industry. For all applications, users face the challenge of integrating the laser scanners as easily as possible into existing or planned production systems. The dimensions play an almost as important role as the available interfaces and field bus systems.

Features: Weighing 37 kg, the new controller solution is comparatively lightweight. It can be easily wall mounted and therefore saves valuable space. The interfaces are accessible from below, which enables a plug-and-play mode installation. The controller can be connected and commissioned without additional pre-settings and driver installations. The functional scope of the new controller has been reduced to cover basic requirements and it is well suited,

for example, for welding applications in the electrical mobility environment and for on-the-fly operation. It was possible to lower the energy consumption to a minimum by the performance-relevant selection of components. The high-performance processor guarantees efficient data processing and program handling. If only limited space is available, the new scanner can be used instead of its larger sister, the "SCU 3".

Blackbird Robotersysteme GmbH

Carl-Zeiss-Str. 5
85748 Garching, Germany
phone: +49 89 307 484 700
e-mail: news@blackbird-robotics.de
Web: www.blackbird-robotics.de



Celebrating 20 years of EPIC: lessons learned and plans for the future

Thomas 'Tom' Pearsall conceived the European Photonics Industry Consortium in 2003

EPIC is celebrating its 20th anniversary. To mark the occasion, Benno Oderkerk interviewed Tom Pearsall, the founder of EPIC, to discuss his experiences leading the consortium during its first years. Pearsall recalls how, when he initially presented the idea of EPIC to the European Commission, the concept of "photonics" was not yet a part of their intellectual vocabulary. Nevertheless, the Commission was able to provide assistance by aligning EPIC with an existing program called 'Optimist'. This introduction led Pearsall to valuable long-term partners like Peter Van Daele and Paul Lagasse, the latter of whom played a key role in guiding EPIC's early direction.

In the interview, Pearsall describes how EPIC was initially divided into working groups focused on areas like optical communications, LED lighting, laser manufacturing, and biomaterials. Despite a small staff consisting of only Pearsall and Martine Keim-Paray, EPIC was able to organize workshops for each area. Overall, the interview offers valuable insights and lessons learned for anyone interested in the world of photonics. The full interview can be viewed by scanning this QR code:



Former EPIC president Benno Oderkerk (l) interviews the association's founder, Tom Pearsall.

The EPIC Agenda for this year is bringing together three key directions: OnSite and Online Meetings, as well as Delegations Trips. With the aim of helping members establish connections with global business partners, EPIC is offering eight Delegations Trips to countries such as Japan, Canada, Korea, Taiwan, China, India, and Malaysia / Singapore.

The objective is not to force companies to do business globally, but to raise awareness about global developments and trends beyond their boundaries. To facilitate these connections, EPIC

has prepared a comprehensive agenda of events.

The EPIC Technology Meetings will explore diverse topics such as Fiber Sensors, AR/VR, Defense, Space, Quantum Photonics, Battery Manufacturing, and Cancer Pathology and Surgery, among others. As travel is becoming more common again, Online Technology Meetings are now held every two weeks.

www.epic-assoc.com



Upcoming EPIC events:

- EPIC Meeting on Fiber Sensors at HBK FiberSensing
19 – 20 April 2023
Porto, Portugal
- EPIC Online Technology Meeting on Photonics for Climate Change Monitoring
24 April 2023, 15:00 – 17:00 CET
online
- EPIC Meeting on Photonics for AR/VR/MR: from Design to System Integration and Mass Production at Jabil Optics
11 – 12 May 2023
Jena, Germany
- EPIC Online Technology Meeting on Additive Manufacturing
15 May 2023, 15:00 – 17:00 CET
online
- EPIC Online Technology Meeting on Agriculture and Laser Weeding
12 June 2023, 15:00 – 17:00 CET
online
- EPIC 20th Anniversary Celebration
26 June 2023
Munich Germany
- EPIC Meeting on Micro-Optics at Laser World of Photonics
27 June 2023
Munich, Germany
- EPIC Meeting on Ultrafast Laser Processing at Laser World of Photonics, 28 June 2023
Munich, Germany
- EPIC CEO Exhibitor Breakfast at Laser World of Photonics
29 June 2023
Munich, Germany
- EPIC Technology Workshop on PIC Post-Processing & Packaging at the Laser World of Photonics
29 June 2023
Munich, Germany

For the list of all events, visit:

www.epic-assoc.com/epic-events

International Council of Quantum Industry Associations established

QIC, QED-C, Q-STAR, and QuIC form council to enable and grow the global quantum industry

The consortia have been meeting informally for over a year. In April 2022, the consortia released a joint statement for World Quantum Day with the goal of finding new ways to work together to



(l-r) Michele Mosca, Celia Merzbacher, Taro Shimada, and Thierry Botter (Source: QuIC)

advance the greater quantum ecosystem. On January 31st, Quantum Industry Canada (QIC), Quantum Economic Development Consortium (QED-C), Quantum Strategic Industry Alliance for Revolution (Q-STAR) and European Quantum Industry Consortium (QuIC) signed a memorandum of understanding in San Francisco, USA, to formally establish the International Council of Quantum

Industry Associations. The council aims to strengthen communication and collaboration among the participating consortia on goals and approaches to the development of quantum technologies.

Emerging quantum technologies leverage fundamental properties of quantum physics to surpass the capabilities of traditional 'classical' systems. "Quantum technologies are expected to revolutionize the health, mobility, logistics, finance, climate science, environmental sustainability, energy and secure communications sectors," said Taro Shimada, chair of the board of Q-STAR (Japan).

"Quantum innovation and quantum markets are emerging worldwide," said Celia Merzbacher, executive director of QED-C (USA). "The formation of this council creates lines of communication and collaboration that will help our members in countries and regions with common values and with many economic linkages to develop supply chains,

open markets, exchange talent, and support policies that benefit the emerging industry and society."

The current participating consortia are hopeful that the council will continue to grow. Michele Mosca, chair of the board of directors of QIC (Canada) said, "We look forward to working with our counterparts around the world to continue to grow and strengthen the quantum ecosystem at an international level."

Thierry Botter, executive director of QuIC Europe (Germany) added, "We are at the beginning of a global technological revolution. Forming the council and working together promotes equity and reciprocity in the advancement of the international quantum ecosystem. It allows our communities to discuss areas of common interest, such as international standards, intellectual property, and access to funding."

<https://quantumconsortium.org>
www.euroquic.org

Lex Kerssemakers joins PhotonDelta's supervisory board

The former chief commercial officer of Volvo provides expertise from the automotive industry regarding integrated photonics

"With the 1.1 billion euros National Growth Fund Program on the horizon, we are very excited about the addition of Lex Kerssemakers to our supervisory board. His strong automotive expertise fits perfectly with our goal to understand the dynamics of the automotive industry with the aim of developing world-class application technology," states René Penning de Vries, chairman of the supervisory board of PhotonDelta, the Dutch community of investors, tech companies, and end-users innovating next generation solutions in integrated photonics.

Lex's experience in the automotive industry, together with his track record in building up an ecosystem, has made him an ideal member of the supervisory board of PhotonDelta. A key piece of his strategy is to ensure a value chain behind the product so that it does not simply

become a commodity. From a European perspective, Lex sees it as vital that the region not only asserts its position as a high-tech developer – but also as a manufacturer.

A veteran of the automotive industry for over 35 years, Lex Kerssemakers joined Volvo early on – starting out in the Netherlands before moving to a variety of countries such as Germany, Belgium, Sweden, the UK, and the US where he was CEO for the Americas. In fact, this is the first time he is back in the Netherlands in more than thirty years.

During his time at Volvo the company had to reinvent itself multiple times from both engineering and commercial perspectives. With Volvo's reputation for safety in a relatively conservative industry, he quickly learned the importance of investment in emerging technologies. That is continued forward to this day,



Lex Kerssemakers

where the focus is now on autonomous driving vehicles.

"At Volvo, we started to work with lidar systems in cars, and the potential of autonomous driving vehicles. The key question was: how is that transformation going to happen? That's when I started reading about integrated photonics," Kerssemakers explains.

www.photondelta.com

Klaus Nassenstein is the new president of the AiF

At their meeting on January 18, 2023, the members of the executive board of the AiF Federation of Industrial Research Associations “Otto von Guericke” elected Dr-Ing Klaus Nassenstein (58) as the 14th president.

The new AiF president is managing director and co-owner of GTV Verschleißschutz in Luckenbach in the Westerwald. The core competence of the medium-sized company is the design and manufacture of turnkey coating systems for thermal spraying and laser buildup welding. Dr Nassenstein succeeds Prof Sebastian Bauer, whose term of office ended by rotation.

Nassenstein studied mechanical engineering and materials technology at the Technical University of Dortmund. In 1996, he received the inaugural DVS sponsorship award for outstanding achievements in the field of thermal spraying and earned his doctorate in Dortmund one year later. He has been with GTV for 27 years, first as head of research and development, later as authorized signatory and since 2005 as managing director and co-owner.

“I have been passionate about applied research and development since I started my career, and they shape my commitment as an entrepreneur and scientist.

So it is obvious that the AiF and I very soon became ‘partners’,” Nassenstein explains with a wink, alluding to the fact that he already contributed his expertise in the early 1990s as an industry representative on the Thermal Coating and Oxyfuel Technology technical committee of the AiF Research Association on Welding and Allied Processes eV of the DVS.

Through his participation in numerous project-accompanying committees of IGF projects, he also has a deep insight into the AiF network and its impact. “The structure of the AiF enables the success of this special industrial research worldwide”, I experience this daily in my entrepreneurial activities as a representative of the German SMEs,” he explains. “Therefore, I am pleased to be able to actively shape the further development and positioning of the AiF in a strongly changing environment as AiF president in the future.” And, jokingly, he adds, “A greater challenge than the new [Ger-



Source: AiF

Dr Klaus Nassenstein

man] defense minister will hopefully not await me.”

The executive committee meeting also elected Thomas Reiche, managing director at FEhS-Institut für Baustoff-Forschung eV, Duisburg, as vice president and Dr-Ing Peter Dültgen, managing director of Forschungsvereinigung Werkzeuge und Werkstoffe eV (FGW), Remscheid, as treasurer.

www.aif.de

Group 46 – together for PbX

Industry representatives met in Olching to discuss PbS and PbSe-based infrared detector technology.

At the invitation of Laser Components, industry representatives from Germany and Great Britain met in Olching near Munich for the first meeting of Group 46 on January 23 and 24, 2023. Other participants from the USA, Japan, China, Belgium, France, Sweden, and the Netherlands were included in the discussions via virtual sessions. Group 46 is an informal global stakeholder group that takes a holistic approach to advocating for the future of lead salt photonics. The name refers to the position of the elements in the periodic table: lead is found in the 4th main group, and sulfur and selenium are found in the 6th main group.

Lead salt detectors are used as PbS in the near infrared spectrum and as PbSe in the mid infrared spectrum. Although they are a niche technology, they have great economic importance for fire protection, medical technology, and analytical and process measurement technology. So far, despite consider-

able efforts, it has only been possible in isolated cases to find a technically and economically equivalent replacement. Experts assume that this will remain the case in the long term. This technology falls under the RoHS directive, even though the active material has a typical thickness of only 1 μm . A panel of experts commissioned by the EU has recommended that the current exemption be extended further. In order to achieve this goal, Laser Components allied with other companies. This then developed into Group 46.

“Group 46 is not about preserving vested interests and maintaining the status quo. We are in a time of upheaval. In medical technology, the sorting of plastic, and many other areas of application, low-cost but also precise decentralized answers are needed. These will only be available if PbX technologies are included. After all, monolithic megapixel SWIR imagers have already



Group 46 meeting, January 2023 (Source: Laser Components)

been achieved using single-chip technology,” says Johannes Kunsch, head of the IR technologies product group at Laser Components Germany.

Group 46 will organize its own session on lead salt photonics and tutorials on infrared technology as part of the 7th MSI Congress. This symposium will take place from May 8 to 11, 2023, in conjunction with the Sensor + Test trade fair in Nuremberg.

www.lasercomponents.com

OptecNet Deutschland's board expanded

Ralf Niggemann has been elected as a new member of the board

At the general meeting in December, Ralf Niggemann, manager of Wetzlar Network, was also elected as a new member of the board, in addition to the re-elected

members Andreas Ehrhardt and Horst Sickinger. "OptecNet Deutschland is continuously working on the further development of its range of services in order to be able to generate new added value for the association members," emphasizes Dr Andreas Ehrhardt, managing director of Photonics BW. "The competitiveness of the photonics industry and the importance of Germany as a business location are to be strengthened by the promotion of photonics and quantum technologies," adds Dr Horst Sickinger, managing director of Bayern Photonics. "I am very pleased to be able to play an even more active role in shaping and further expanding the

activities and projects of the umbrella organization OptecNet Deutschland in the future," says Ralf Niggemann, manager of Wetzlar Network and new board member at OptecNet Deutschland.

With the addition of Wetzlar Network eV and NanoMicroMaterials-Photonics eV (NMWP) to its membership, OptecNet Deutschland now represents around six hundred companies and research/educational institutions which cover the entire federal territory, and can further expand and complement its position as the photonics association with the largest number of members in Germany.

<https://optecnet.de>

Source: OptecNet Deutschland



Board members of OptecNet Deutschland, l-r: Andreas Ehrhardt, Horst Sickinger, Ralf Niggemann

Back in San Francisco 2023

Brilliant restart for SPIE Photonics West

"One of the best SPIE Photonics Wests ever" was the enthusiastic conclusion of SPIE's CEO Kent Rochford at the end of the trade fair in San Francisco (cf. p. 80). With more than 22,000 registered participants, over 1,400 exhibitors and 4,500 presentations, one of the most successful events in the history of North America's leading photonics trade fair

and conference came to an end on 2 February 2023.

"Incredible energy, countless technical talks, new contacts and successful accompanying events – the trade fair spirit is definitely back," confirmed Dr Horst Sickinger, board member of OptecNet Deutschland. Together with the industry association Spectaris, he represented around 700 photonics companies and research institutes of the large photonics community in Germany.

The German Pavilion, sponsored by the Federal Ministry of Economics and Climate Action, once again proved to be one of the most attractive visitor magnets at Photonics West. 64 exhibitors presented innovative optical systems and components, manufacturing technologies and the latest laser developments for applications in space or quantum communication, for example. Solving the challenges of the future with photonics was also of great interest to representatives of German politics, including the Thuringian State Secretary for Economic Affairs Dr Katja Böhler, who visited the German Pavilion.

◀ Welcome words of Thuringian State Secretary Dr Katja Böhler at the German Pavilion (upper picture), Consul General Oliver Schramm at German Evening addressing his appreciation to German photonics industry at the San Francisco Leica Store event.



Anke Siegmeier and Horst Sickinger at the German Pavilion

Source: OptecNet

Highly appreciated was also the support of Consul General Oliver Schramm, who, after visiting the trade fair, opened the German Evening by Photonics Germany in the Leica Store with more than 150 representatives of the German photonics industry. The joint evening event of the alliance of Spectaris and OptecNet Deutschland has been the most popular networking event with international customers and partners for many years.

The promotion of photonics in industry and science will be the main work of Photonics Germany in 2023: Find events, offers, and projects at www.spectaris.de and www.optecnet.de as well as on the websites of your regional German photonics network.

Anke Siegmeier, OptoNet e.V.

<https://optonet-jena.de>
<https://photonics-germany.de>

Source: OptecNet Deutschland



Source: Wayne Serrano / Leica Store



Attracting skilled workers to the photonics industry

New cooperation agreement between Spectaris and OptecNet Germany sealed

Photonics in the German Industry Association Spectaris and OptecNet Deutschland, the umbrella organization of innovation networks for optical technologies, are intensifying their cooperation as part of their joint alliance called Photonics Germany – Photonik Deutschland. Both partners have concluded a new cooperation agreement that focuses more strongly on recruiting skilled workers and securing young talent as a challenge for the industry.

In the process, it was decided that Spectaris and OptecNet Deutschland will develop joint measures and platforms to support the photonics industry in Germany in attracting skilled workers. “The shortage of skilled workers is visibly worsening despite political measures. On the one hand, we need immigration of skilled workers, but we also need to make better use of existing potential skilled workers in Germany,” emphasizes Dr Bernhard Ohnesorge, chairman of photonics at Spectaris.

Dr Andreas Ehrhardt, spokesman and board member of OptecNet Deutschland, adds: “Last year, Spectaris and OptecNet Deutschland drew up a position paper on photonics in Germany under the umbrella of Photonics Germany, combined with a call for new photonics funding, and presented it to the Federal Ministry of Research. With



l-r: Ralf Niggemann (OptecNet Deutschland / Wetzlar Network), Dr Horst Sickinger (OptecNet Deutschland / Bayern Photonics), Dr Andreas Ehrhardt (OptecNet Deutschland / Photonics BW), Dr Bernhard Ohnesorge (Spectaris / Carl Zeiss Jena), Dr Wenko Süptitz (Spectaris), Nora Kirsten (OptecNet Deutschland / OptoNet) and Jörg Mayer (Spectaris).

the new cooperation agreement, we not only want to consolidate the successful cooperation, but in particular address the continuing need for skilled workers in the high-tech sector of photonics and quantum technology and launch corresponding activities and measures.”

Close cooperation between Spectaris and OptecNet Deutschland has already existed since 2020 under the new joint umbrella brand Photonics Germany. The

goal is the common presence of the German photonics industry on a national and international level. The importance of the photonics industry will be made even more visible through joint action on economic and research policy. PhotonicsViews has been the alliance’s official publishing medium since April 2021.

www.spectaris.de

<https://optecnet.de>

<https://photonics-germany.de>

OptecNet Deutschland Annual Conference in Fürstenfeldbruck

Technology trends and networking

As numerous as the benefits of digital communication are, recent years have shown that personal exchange is indispensable. OptecNet Deutschland cordially invites you to its annual conference in Fürstenfeldbruck near Munich on April 25 – 26, 2023, to discuss technology trends and innovations of the Photonics industry.

Besides keynotes and expert presentations on the main topics of quantum communication, optical manufacturing, ultrarobust sensor technology, and laser technology, there will again be an accompanying exhibition. Additionally, an evening event offers the opportunity

to establish contacts and enables a trans-regional exchange. The annual conference will be held in German.

Sponsors and exhibitors have the opportunity to present their company or institute to around 200 experts from industry, research, education and politics.

The members of the regional innovation networks for optical technology, united in OptecNet Deutschland, benefit from a discount either as exhibitors or participants.

<https://optecnet.de/jahrestagung-2023/ueberblick>



Celebrating 20 years of European machine vision advocacy

The foundation of the EMVA in 2003 resulted from a great European initiative

Considering that the machine vision business was already very international in the early 2000s with most of the vision companies being small(er) founder-managed companies, it had become clear that a European initiative was needed. The time was ripe and the industry was ready to join forces cross-border. In 2002 the general secretary of the machine vision group at VDMA and Gabriele Jansen, then member of the board of this group, were tasked with gathering European support for a truly European vision association.

Leading players from all over Europe were then invited to send delegates to a European Vision Steering Committee. This was the start of a great pan-European collaboration. All aspects of competition were set aside and vision entrepreneurs and leaders from twelve European countries worked together for a year towards the ideation, the struc-

ture and the mission of the European Machine Vision Association. In parallel, this team planned the first ever European Vision Business Conference to take place in 2003 in Barcelona.

At this conference on May 24, 2003, the EMVA was founded by 43 European companies and the first board of directors was elected. From then on, the EMVA Business Conference has been the pivotal European event of the machine vision community and taken place in nineteen European metropolises (including Seville 2023), not to forget two virtual conferences during the Corona pandemic.

In 2012, the EMVA became an independent, non-profit and member-owned association. Since then, it has grown to over 150 members, and the association's activities to serve the interests of its members have continuously broadened. Standardization under the G3 ini-

tiative became a pillar of its work, paving the way for the breakthrough of machine vision technology. New initiatives such as the annual European Machine Vision Forum as a meeting place for research and industry were born, and during or around trade shows EMVA get-togethers always are amongst the most popular.

In 2020, Dr Chris Yates took over as EMVA president and, together with general manager Thomas Lübckemeier and the whole team, the EMVA stands by to serve the vision-tech industry in Europe for the future challenges in an ever-changing technological environment.

www.emva.org



SPIE announces its 2023 Fellows from across the globe

This year, the international society for optics and photonics welcomes 83 members as new 'Fellows of the Society'

'Fellows' are members of the association who have made significant scientific and technical contributions in the multidisciplinary fields of optics, photonics, and imaging. Since the society's inception in 1955, more than 1,700 SPIE members have become fellows.

The inductees this year hail from across the globe, representing a varied group of countries that includes Australia, Belgium, China, France, Japan, Mexico, India, Germany, the Netherlands, Switzerland, the United Kingdom, the United States, and New Zealand. In a

Society first, 35 % of the new fellows come from the industry sector including Edmund Optics' CEO Samuel Sadoulet, IBM's Martin Burkhardt, Synopsys' Lawrence S. Melvin, and Toptica Photonics Inc's president and CEO Mark A. Tolbert.

The 2023 fellows cohort also includes a strong constituency of women, including CVI Laser Optics' Julia M. Craven, the University of Auckland's Cather Simpson and Frédérique Vanholsbeeck, Ball Aerospace's Makenzie Lystrup and Jeanette Domber, and Siemens Healthineer's Rebecca Fahrig.

"As well as being recognized for their technical achievements and contributions to the society, fellows represent our international and diverse community," notes the chair of the SPIE fellows committee and TracInnovations director of business development and sales, Michelle Stock.

New fellows are acknowledged during the SPIE symposium of their choice throughout the year.

<https://spie.org>



New SPIE fellows for 2023 (Source: SPIE / Wiley)

New Chair of GenICam Working Group elected

Michael Schmidt takes over from long-term serving Dr Fritz Dierks

During the last International Vision Standards Meeting (IVSM) in Tokyo, Japan, the GenICam Working Group elected Michael Schmidt as new chair of the standard working group. Schmidt leads a camera development team at Basler. He takes over the position from Dr Fritz Dierks who has been leading the GenICam working group for

almost 18 years and chose not to stand for another reelection so as to initiate the process of rejuvenating the board of the GenICam standard working group. The GenICam standard is hosted by the European Machine Vision Association EMVA.

www.emva.org



Source: EMVA

Michael Schmidt

Robert Byer named Optica honorary member

The Spectra Physics and Stanford University emeritus, an outstanding volunteer in the laser community, is added to the most distinguished of all Optica member categories.

Optica has named laser pioneer Robert (Bob) L. Byer, Stanford University, USA, as an honorary member. Byer is recognized for his pioneering contributions to the scientific and technological foundations of lasers and nonlinear optics, his dedicated service to the optics community, and his leadership in academia and professional societies.

“Bob Byer has made extraordinary contributions to laser science and technology through his work as a researcher, educator, mentor, and leader. His exceptional contributions to our field and Society will have a lasting impact,” said Michal Lipson, Optica’s 2023 president. “It is a great pleasure to welcome Bob into this group of distinguished members.”

Honorary membership is the most distinguished of all Optica member categories and is awarded by a unanimous vote of the Optica board of directors to individuals who have made seminal contributions to the field of optics. Their number is limited to two-thousandths of the total membership of the society.

Robert L. Byer is the William R. Kenan, Jr., professor emeritus of applied physics at Stanford University. He received his MS and PhD in applied

physics from Stanford University and joined their faculty in 1969 following a role at Spectra Physics.

Byer’s work has had a major impact on laser technology. He developed the first visible, tunable red laser and helped with the development of the diode-pumped YAG laser, the most stable laser in the world, which forms the main beams of the gravitational wave-detecting instrument, LIGO. The commercialization of his work on high-energy pulsed lasers, diode-pumped solid-state lasers, and pulsed fiber lasers was key to the success of several laser technology companies. He is currently working on the Accelerator on a Chip International Program (ACHIP) with a goal of demonstrating a laser driven accelerator on a chip.

Byer is an outstanding volunteer, serving as president of Optica, the American Physical Society, and the IEEE Photonics Society. He is currently a member of the Optica presidential advisory committee and has served the society in many capacities, including Optics Letters editor, member of the strategic planning council, Frontiers in Optics program committee, CLEO steering committee, and a director at large on the board of directors.

He is a fellow of Optica, the American Association for the Advancement of Science, the American Physical Society, the California Council on Science and Technology, IEEE Photonics Society, IBM, the Laser Institute of America, and the



Source: Stanford U

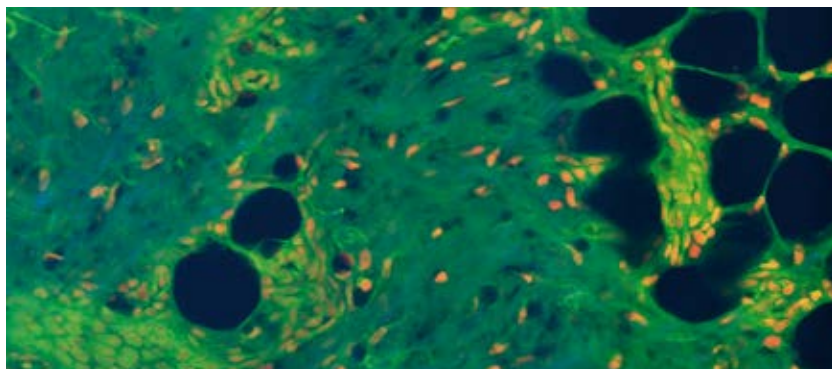
Prof. em. Robert L. Byer

National Academy of Inventors. He is the recipient of several awards and honors, including Optica’s Frederic Ives Medal / Jarvis W. Quinn Prize, R. W. Wood Prize, and Adolph Lomb Medal, the Photonics Award, the Willis E. Lamb Award for Laser Science and Quantum Optics, and the A. L. Schawlow Award.

<https://www.optica.org>

Better results for skin cancer surgery

Fluorescence imaging helps improve outcomes in head and neck skin cancer treatment at reduced cost



Green is a fluorescent protein stain, red is a DNA stain, and blue is SHG in ordered collagen tissue. (Source: Giacomelli Lab, U Rochester)

Mohs skin surgery can bring a permanent cure to skin cancers, when other methods have failed. Complete surgery and repair of the surgical site is normally a same day operation. However, Mohs is slow and extremely labor intensive because it depends on frozen sections processing to produce histological images, driving costs. University of Rochester professor Michael Giacomelli and his team want to solve this prob-

lem by using fluorescence microscopy. He recently received NIH funding to enable real-time evaluation of pathology in skin tissue with an order of magnitude reduction in processing time.

Giacomelli developed a way to image multiple depth slices without frozen section processing – by implementing two-photon imaging, widely used in the neurosciences to noninvasively image slices at different depths in living brains.

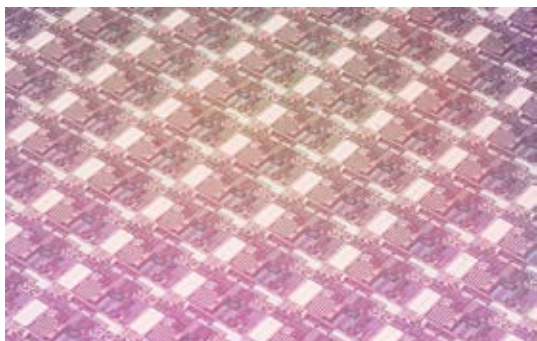
The lab team's research has adapted these fluorescence imaging technologies with rapid tissue labeling and image processing technologies. This enables real-time assessment of pathology in skin tissue. The processing time compared to frozen sections has been reduced by an order of magnitude. The data collection time is further reduced using the lower-noised silicon photomultiplier detectors developed by Giacomelli's group.

The femtosecond laser system, a FemtoFiber ultra 920, chosen for the next iteration of the Giacomelli lab's microscope is a possible solution for applications in nonlinear microscopy like two-photon excitation of fluorescent proteins and SHG based contrast mechanisms. At 920 nm it provides the highest peak power for imaging with green and yellow fluorescent protein markers (GFP, YFP) commonly used in pathology, neurosciences and other laser-related biophotonic disciplines.

www.toptica.com

Co-integration of SiN waveguide technology on silicon photonics

Imec has tackled those integration challenges within its active iSiPP platform



Detail of a 300-mm wafer processed on Imec's iSiPP platform (Source: Imec)

At an invited talk at SPIE Photonics West (San Francisco), Imec announced that it demonstrated co-integration of its high-quality silicon nitride waveguide technology with its silicon photonics platform – without performance degradation of the high-bandwidth active devices. An important upgrade for Imec's silicon photonics platform, the result enables the synthesis of high-quality wavelength-selective devices and other optical passive functions that

benefit from accurate optical phase control, meeting market demand for optical transceivers for datacom, lidar, and other applications.

Low propagation loss, accurate phase control, low-loss light coupling, lower thermal variation, and high power handling are some of the reasons why adding a high-quality silicon nitride (SiN) boosts silicon photonics integrated circuits (PIC). High-quality SiN layers achieving low optical losses and excellent control over the material properties, such as thickness and refractive index variability, are crucial for improving the energy efficiency of Si-based optical transceivers. Since such high-quality SiN layers are deposited by the low-pressure chemical vapor deposition (LPCVD) method at elevated temperatures, it is vital to avoid degrading the performance of the co-integrated baseline Si and Ge devices.

The research and innovation hub in nanoelectronics and digital technologies

Imec has tackled those integration challenges within its iSiPP silicon photonics platform, which is available for industrial partners. Thanks to various engineering updates and changes in the process flow, Imec has, for example, shown a more than four-fold reduction of the variability of the resonant wavelength of SiN-based microrings compared to the same device made with lower quality PECVD silicon nitride, currently used in the Imec platform, without degrading the co-integrated active devices.

Philippe Absil, vice president at Imec: "We are excited to have achieved this major upgrade of our silicon photonics platform. The ability to co-integrate high-quality SiN devices with our baseline technology is important to broaden our offering to our partners who can now consider system simplification with single PIC solutions to combine active and SiN passive functions."

www.imec-int.com

Detecting infestation contactless and marker-free

The PriMe joint project wants to improve multimodal microscopy for bacteria detection

Deciphering the composition of biofilms currently takes at least a day – an enormously long period for the clinical setting in which biofilms can be life-threatening. The PriMe partners now want to combine multiphoton microscopy and metabolic imaging to significantly speed up the process. To this end, they are developing a novel laser beam source with spectral properties specifically adapted to the application.

With this laser source, LZH and Becker & Hickl want to detect metabolic products such as the coenzymes NADH, FAD, and additionally the amino acid tryptophan. The latter is a central component of proteins and peptides. The combined values should then make it possible to determine which bacteria are present in the biofilm. The project goal is to develop a demonstrator with which clinical material can be examined.

The basis for the demonstrator will be an innovative, multimodal ultra-short-pulse (USP) fiber laser system, which the LZH is developing together with Valo Innovations and TEM Messtechnik. It will be optimally adapted to the needs of multiphoton microscopy



In the joint PriMe project, the LZH and its partners want to make it possible to detect bacteria fast and contactless with a microscope. (Source: LZH)

and extended fluorescence lifetime measurement. The new laser source should help scientists to gain fundamentally new insights into bacterial communities and environmental influences.

They also want to lay the foundation for a new diagnostic procedure that could significantly simplify the treatment of bacterial infections.

In the joint PriMe project, the detection and classification of bacte-

rial growth are pursued through multiphoton microscopy and molecular or metabolic imaging. The collaborative partners are TEM Messtechnik, Becker & Hickl, Valo Innovations, and Laser Zentrum Hannover. Associated partner is APE Angewandte Physik u. Elektronik. The project is funded by the German Federal Ministry of Education and Research (BMBF).

www.lzh.de

Scintil Photonics demonstrates first single-chip 100-GHz comb source

High-performance computing and AI applications gain improved computing system performance

Named SCINTIL Comb Laser Source, the device is the first fully integrated single chip that achieves 100 GHz frequency spacing, which is half to one-quarter of the spacing available today, according to the company. One of its key advantages is its very narrow controlled channel spacing, an important capability for increasing the number of optical carriers in a single fiber.

“We are thrilled to showcase our latest innovation at OFC 2023,” said Sylvie Menezo, CEO of Scintil Photonics. “Increasing computing capacity requires connecting larger networks of computing units with higher transmission rates. In order to achieve this with sustainable energy efficiency, fiber optic transmission links are used with multiple optical carriers multiplexed on one single fiber. We have succeeded in implementing a

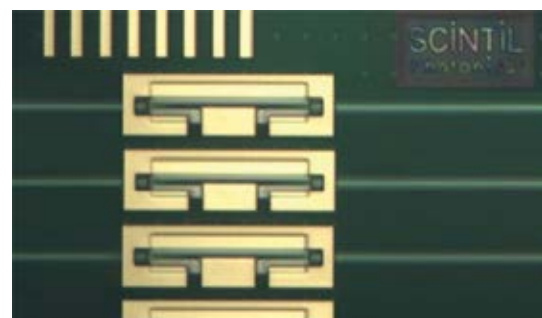
comb laser source with only 100 GHz spacing between each optical carrier. This offers at least twice the number of optical carriers compared to what appears to be available today, and therefore enables doubling the transmission speed. Leading customers are currently evaluating our solution.”

The increasing demand for high-performance computing and AI applications has led to the need for faster and more efficient optical interconnects. The chip enables the use of uncooled dense wavelength division multiplexing (DWDM) links in short-reach transmissions, with optical carriers twice as dense (100 GHz versus 200 GHz spacing).

“The Scintil integrated team did an excellent job at every step, from the design of the chip to the packaging and the electronics for a complete

solution, with additional locking functions. Thanks to our CMOS commercial foundry, we anticipate ramping up volume by Q4, 2024. We think that our technology will be a game-changer in the field of interconnects for high-performance computing and AI applications,” Menezo added.

www.scintil-photonics.com



SCINTIL Comb Laser Source (Source: Scintil Photonics)

Reducing energy consumption in electrode production

IDEEL project to manufacture laser-dried anodes and LFP cathodes first time in a roll-to-roll process

The IDEEL research project aims to introduce a laser drying process as a more climate-friendly and economical method for the volume production of lithium-ion batteries. Within this context, it has now been possible to produce laser-dried anodes and LFP cathodes in a roll-to-roll process for the first time. This new manufacturing process significantly reduces energy consumption in electrode production and at the same time enables the drying speed to be doubled.

As part of the “Implementation of Laser Drying Processes for Economical & Ecological Lithium-Ion Battery Production, IDEEL research project”, led by Laserline, the production of laser-dried anodes and LFP cathodes in a roll-to-roll process has been achieved for the first time. Based on industry-relevant electrode pastes, the PEM (Production Engineering of E-Mobility Components at the RWTH Aachen University) was able to demonstrate processability of aqueous LFP cathodes and anodes at the prototype facility at the eLab (also at the RWTH).

In cooperation with the Münster Electrochemical Energy Technology



Laser drying system with large-area irradiation of the electrode (Source: Fh. ILT)

(MEET) battery research center, the qualitative properties were evaluated, and optimized electrode pastes then developed. For proof-of-concept, a Laserline high-power diode laser with zoom optics was integrated into the existing film deposition system, resulting in the generation of a homogeneous laser spot to dry the active material. The temperature distribution across the electrode was monitored using an

Optris thermographic camera. The tests were carried out at a web speed of 1.3 m/min, and both pure laser drying and hybrid drying with both laser and a downstream convection oven were successfully demonstrated. The energy consumption in electrode production could be reduced by up to 85 percent.

www.laserline.com

www.optris.de

www.ilt.fraunhofer.de

High-throughput, low-cost surface production

LAMpAS project presents the first laser system that can achieve controlled topographic characteristics

The EU-funded LAMpAS project has successfully developed the first laser system based on interference patterning combined with a polygon scanner system, for high-throughput, low-cost surface production with controlled topographic characteristics. This new laser machine can produce well-defined surface patterns with controlled length scales and feature sizes in order to provide advanced functionality.

The new laser machine consists of several important modules, including:

- High-power ps-laser source: a 1.5 kW laser system and pulse energies up to 4 mJ has been developed by Trumpf, with 1 – 3 ps pulse durations and a reduced spectral bandwidth required for direct laser interference patterning (DLIP).
- Advanced laser surface texturing optics: a unique optical head was constructed which combines a



LAMpAS demonstrator (Source: EPIC)

polygon scanner specially designed by Scanlab with a DLIP unit from TU Dresden.

- Real-time surface characterization module: two systems were developed which are based on a near-infrared camera as well as a camera system that can monitor the structuring process in real time. Furthermore, they can detect heat-accumulation or indirectly predict

the depth of produced topographies with a resolution of about 15 nm in real time.

The LAMpAS project was set up in 2019 with a grant of 5.1 million euros under the EU's Horizon 2020 program. The aim of this project was to develop new concepts for laser structuring and to bring the technology to industrial levels at affordable costs.

www.epic-assoc.com

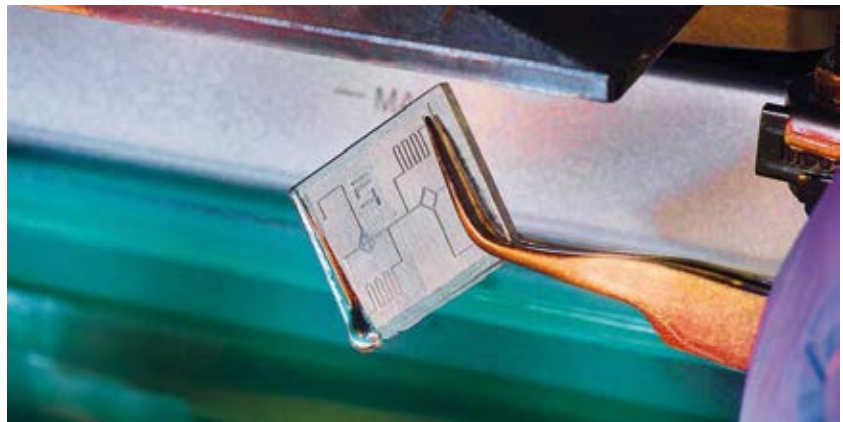
Producing high-resolution microcomponents by photo-crosslinking

LightFab, Bartels Mikrotechnik, and Miltenyi Biotec cooperated with the Fraunhofer ILT

The “High productivity and detail accuracy in additive manufacturing by combining UV polymerization and multiphoton polymerization – HoPro-3D project” aims to produce polymer microstructures economically and customized in one machine. The project partners developed a new type of 3D printer that combines fast two-dimensional exposure – scrolling digital light processing (DLP) – with multiphoton polymerization (MPP) to produce microcomponents from photopolymers.

The HoPro-3D 3D printer has two selectable exposure systems, for either high build rates (scrolling DLP) or high precision (MPP). The DLP module, which emits at a wavelength of 365 nm, exposes the basic structure of a microcomponent with a pixel resolution of 10 μm . As a complement, a femtosecond laser and the MPP module can be used to write contour lines with a resolution of about 2 μm .

The layer-by-layer approach makes it possible to build the finest MPP structures on top of already printed



Source: Fh. ILT

Sample component produced in a resin bath from the HoPro3D system.

DLP structures, thus quickly creating extended components with a complex structure and high-resolution details. The laboratory prototype allows the production of components with a footprint of up to $60 \times 100 \text{ mm}^2$.

The control software of the HoPro-3D system enables users to smoothly switch between the two exposure modules. Moreover, they can use CAD data to decide when it makes sense to switch between the printing processes. During

the layer-by-layer buildup of a component, it is possible to switch between the two processes several times.

After completion in 2022, the laboratory prototype was tested and optimized in a typical user-environment as part of the Fraunhofer SiCellNet network. The SiCellNet cluster forms a central point of contact for research into new tools and manufacturing techniques.

www.ilt.fraunhofer.de

The first high-resolution ToF sensor for all light conditions

Teledyne e2v releases a new time-of-flight CMOS image sensor for versatile 3D detection

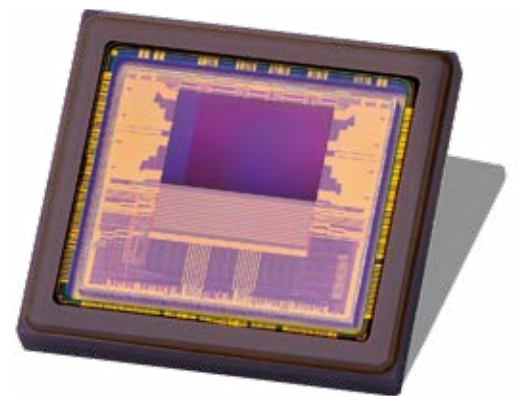
Designed with Teledyne e2v's proprietary CMOS technology, Hydra3D+ features a new 10 μm three-tap pixel which provides very fast transfer times – starting from 10 ns – and displays high sensitivity in the NIR wavelength, alongside improved demodulation contrast. This precise combination enables the sensor to operate in real-time without motion artefacts – even if there are fast moving objects in the scene – and with excellent temporal noise at short ranges, essential in applications such as pick and place, logistics, factory automation and factory safety. An innovative on-chip multisystem management feature enables the sensor to work alongside multiple active systems without interference that can lead to false measurements.

The excellent sensitivity of Hydra3D+ enables it to effectively manage lighting power and handle a wide range of reflectivity. Its high 832×600 pixel resolution,

with powerful on-chip HDR, featuring an on-the-fly flexible configuration, enables the best trade-off between application-level parameters such as distance range, object reflectivity, frame rate etc. This makes it ideal for mid, long-range distances and/or outdoor applications such as automated guided vehicles, surveillance, ITS and building construction.

The sensor has been thoughtfully designed for customers seeking real-time and flexible 3D detection with uncompromised 3D performance. It offers large field-of-view scenes captured in both 2D and 3D by a compact sensor, which makes the system very cost effective.

Ha Lan Do Thu, marketing manager for 3D imaging at Teledyne e2v said, “Today, many time-of-flight sensors suffer from motion artefacts and can not instantly adapt to changing operating conditions. With Hydra3D+, our



Hydra3D+ 832 $\times$ 600 pixel resolution time-of-flight CMOS image sensor (Source: Teledyne)

customers can easily achieve reliable 3D measurement with the highest levels of 3D performance, uncompromised image quality in both 2D and 3D modes, and in all distance ranges and conditions even where multiple systems operate or in outdoor environments.”

www.teledyne-e2v.com

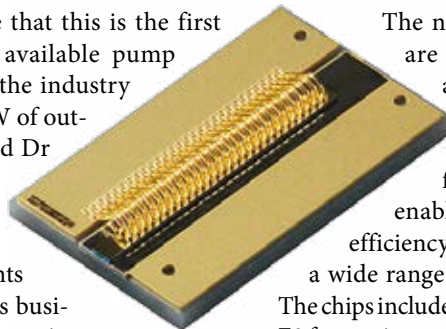
The industry's first commercially available 50 W pump laser diodes for fiber lasers

Enabling high-power industrial fiber laser designs with fewer pump laser diodes

Coherent, a leader in high-power semiconductor lasers, has introduced its next-generation pump laser diodes that achieve an industry-record high output power of 50 W from a single chip at Photonics West in San Francisco.

The deployment of fiber lasers for materials processing applications such as cutting, welding, marking, and additive manufacturing is accelerating, driving the demand for key components that lower the cost per watt of output power. The new laser diodes from Coherent achieve 50 W of output power, 40 % more than that of the existing product, enabling high-power industrial fiber laser designs with fewer pump laser diodes.

“We believe that this is the first commercially available pump laser diode in the industry to achieve 50 W of output power,” said Dr Karlheinz Gulden, senior vice president, laser components and subsystems business unit. “We continue to break new industry records in semiconductor laser diode output power, based on our gallium arsenide technology platform that has decades of field-proven reliability. These are strong differentiators that continue to accelerate our market leadership.”



The new 50 W laser diodes are available at 915 nm and 976 nm. The output facet width of the laser chips is available from 150 μm to 350 μm , enabling optimal coupling efficiency and output powers for a wide range of fiber laser designs. The chips include Coherent's proprietary E2 front mirror passivation that prevents catastrophic damage to the laser, even at extremely high output powers.

Coherent offers pump laser diodes as bare dies, chips on ceramic submounts, and in fiber-coupled multi-emitter modules.

www.coherent.com

Ultrasound makes 3D-printed parts stronger

Fraunhofer IWS and IAPT together with the Australian RMIT Centre for Additive Manufacturing start project “UltraGrain”

In the near future, ultrasound will enable industrial 3D printers to manufacture more robust, durable and cheaper components for aerospace, toolmaking and other industries than before. Researchers from Dresden, Hamburg and Melbourne have joined forces in a research alliance to bring this new technology to market within three years. Their “UltraGrain” project, launched in June 2022, aims to produce a tailored fine-grained microstructure (“grading”) in wire and

powder-based additive manufacturing technologies that promises to improve the mechanical properties and corrosion resistance of the majority of engineering alloys.

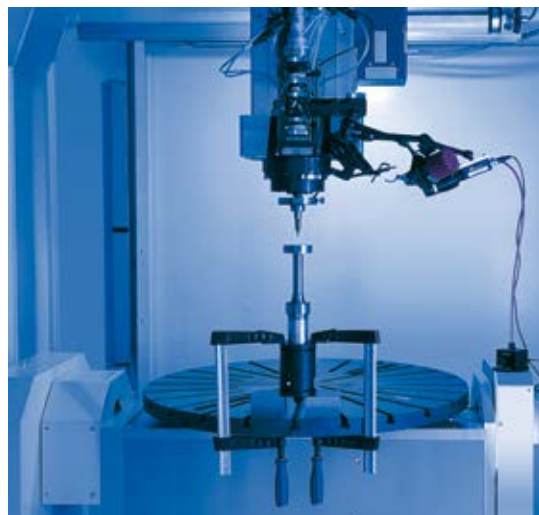
The Fraunhofer Institute for Material and Beam Technology IWS Dresden, the Fraunhofer Additive Production Technologies Facility IAPT in Hamburg, both Germany, and the RMIT Centre for Additive Manufacturing in Melbourne, Australia, are participating in the four-million-euro project. The official kick-off meeting took place in Dresden on October 11, 2022, under the heading “On-demand grading of grain structure by ultrasound-assisted AM – from demonstration to industrialization.”

In the process, the researchers are entering new technological territory. They are combining the established wire and powder-based laser deposition processes with ultrasound, which vibrates beyond the frequency audible to humans, with the aim of influencing the internal grain structure of 3D-printed components and thereby their mechanical properties. During the additive deposition process, they send fine vibrations at a precisely defined frequency globally through the resulting component or

locally following the laser and directly to the melt pool. The ultrasound prevents columnar structures from forming in it.

These microscopic columns in the material are often undesirable because their one-sided alignment results in poorer mechanical performance. However, finer and rounder micrograins are formed under ultrasonic exposure that are very evenly distributed or graded and weaken the undesired texture. This equiaxial alignment increases the mechanical and chemical load-bearing capacity of the additively produced work pieces. Component designers are able to specify exactly where the workpiece may be subjected to the greatest stress in later use because the ultrasound can be very accurately directed. There, the developers can plan for an ultrasound-treated grain structure, but also decide at which points they can do without it in favor of faster production. Such grading is essential, for instance if gas tanks for space probes have to endure outer space for many years, or if tools in car factories have to resist high point loads during mass production.

www.iws.fraunhofer.de



Experimental set-up for ultrasound-assisted laser-directed energy deposition (Source: Fraunhofer IWS)



20 volumes of optics, photonics, and laser technology

Congratulations to PhotonicsViews and 20 successful years. There are many people who started reading it during their student days, and still read it today, because laser technologies are still new for many applications. JPT is very glad to be a partner of PhotonicsViews, and to exchange ever more information through this platform. We wish PhotonicsViews all the best and look forward to our partnership getting better and better!



Jessica Xu
overseas sales director
JPT Opto-electronics Co, Ltd
www.jptoe.com

Happy anniversary PhotonicsViews!

As a US-based company, Edmund Optics started to expand into Europe about 20 years ago, and PhotonicsViews has been supporting us through better visibility and recognition in the region. We believe that the "Future Depends on Optics" and appreciate any outlet that gives a strong voice to our industry and tells stories about the exciting impact optics and photonics have addressing the great challenges of tomorrow. Thank you PhotonicsViews and good luck in your future.

Marisa Edmund
chairman of the board and
chief marketing and sales officer
Edmund Optics
www.edmundoptics.com



Congratulations to 20 years!

We thank all the editors for their great job in helping keep the laser and photonics community informed about the latest trends and technologies. We have witnessed and been proud to be a part of the evolving applications especially in the Raman spectroscopy and fluorescence microscopy areas. The development of Raman spectroscopic methods in itself is impressive. We look forward to the future and being kept up to date by reading and contributing to PhotonicsViews.



Håkan Karlsson
head
HÜBNER Photonics
<https://hubner-photonics.com>

We are aligning our laser technologies with Industry 4.0 and the potential impact of AI and machine learning and enabling tailored laser solutions for megatrends such as the e-mobility and energy storage sectors.

PhotonicsViews is important because it provides information on trends and technology reports which help to inform our strategies. As we enter our 25th year in business, we appreciate your 20 years' expertise on photonics topics.



Michael Porbadnik
managing director
Luxinar Ltd
www.luxinar.com

Photonics Germany, the alliance of Spectaris and OptecNet Deutschland, is an official partner of PhotonicsViews since 2021. The alliance regularly publishes announcements, reports on joint activities and projects in the professional journal as a renowned publishing medium with a wide international reach in the photonics community.

Photonics Germany cordially congratulates PhotonicsViews on its 20th anniversary and looks forward to the further cooperation!

Dr Andreas Ehrhardt, Dr Wenko Süptitz
board members, Photonics Germany
www.photonics-germany.de



Congratulations to PhotonicsViews

on reaching its 20th anniversary! EPIC is proud to have partnered with you over the years to help spread the word about the technology of our members. As we also celebrate our 20th anniversary this year, our mission remains the same: driving competitiveness of the European photonics industry. Here's to many more years of successful collaboration!



Carlos Lee
director general
European Photonics Industry Consortium EPIC
<https://epic-assoc.com>

Congratulations on a great journey you have made with your magazine so far, creating high-quality and valuable content and spreading the deep enthusiasm for the optical technologies! We are happy to have you as a media partner since the beginning of our conference Stuttgart Laser Technology Forum (SLT), which is organized in a biennial cycle by the Institut für Strahlwerkzeuge (IFSW) of the University of Stuttgart. We look forward to continuing this appreciated partnership; may the current 20th anniversary just be one of many more that we will celebrate together. Along the way, there will always be exciting stories to report in PhotonicsViews. For instance, the ongoing developments towards our vision of a universal laser machine which is also strongly pursued within the Innovation Campus 'Mobility of the Future' (ICM).



Prof Dr Thomas Graf
director
Institut für Strahlwerkzeuge (IFSW), University of Stuttgart
www.ifsw.uni-stuttgart.de

Congratulations to PhotonicsViews

for two decades of top-level content that has become an indispensable source of inspiration for the industry. PhotonicsViews and its predecessor magazines have been highlighting the association activities of EMVA throughout this time and it continues to be an honor to be represented in the magazine. Photonics and optoelectronics are an integral part of vision tech and as the EMVA also celebrates its 20th anniversary we look forward to many future collaborations.



Dr Chris Yates
president
European Machine Vision Association
www.emva.org

Happy 20th anniversary to the PhotonicsViews team! It is a pleasure to read quality articles on the latest developments in the optics and photonics industry. It is also a pleasure for Cailabs to contribute on a regular basis to the editorial content of the magazine with a focus on laser material processing! Thank you for the many opportunities: we will continue to support you for the next 20 years!



Dr Jean-François Morizur
CEO
Cailabs
www.cailabs.com

Trade journals make an important contribution to exchange and knowledge transfer within the industry.

PhotonicsViews stands out particularly for our industry: It has accompanied the laser from its very first hour. Sometimes critical, sometimes informative – but always factual and competent, it reported on new products, innovative technologies and future trends.



Whether purchaser, manager, user or developer –

PhotonicsViews provides food for thought for all those who are passionate about optical technologies and photonics. Of course, this passion burns especially strong among Trumpf employees. On behalf of all readers at our company, I would therefore like to congratulate you on the 20th volume! But an anniversary is not only a good time to look back at the past. It is also worth looking ahead on this occasion. After all, there is still a great future ahead of the tool that is light.

Christian Schmitz
CEO
TRUMPF Laser Technology
www.trumpf.com

The last couple of decades have been an exciting time for lasers and photonics. We have seen ultraviolet and ultrafast lasers expand into a broad range of applications, opening a whole new world of possibilities in precision manufacturing, medical, analytical instrumentation and advanced research. Spectra-Physics lasers from MKS Instruments have been one of the key drivers of this critical technology that is shaping our future today.

As one of the leading European trade magazines for optical technologies, PhotonicsViews and its preceding publications have been covering the latest developments in lasers and photonics throughout all this time. It is always a pleasure to discuss our cutting-edge innovations with this highly professional editorial team and work together to keep our global customers informed with technical articles, features, or interviews. We are looking forward to continuing our cooperation to act on the MKS vision of enabling the technologies that transform our world.



Herman Chui
vice president and general manager
Spectra-Physics Lasers, MKS Instruments
www.spectra-physics.com

We would like to thank you for 20 years of good cooperation, for the interesting technical articles and the opportunity to present our products in an appealing setting. We wish the team and the publishers continued success.



Dr Ulrich Oechsner
managing director
Schäfter+Kirchhoff
www.sukhamburg.com

As the leading European photonics trade journal, we were excited about the opportunity to publish an article in the very first issue of Photonics Views in January 2019 describing our new Corona fiber laser technology – and it promptly brought good luck as we were awarded a Prism Award at Photonics West. Since then, our article has been cited multiple times, attesting to the excellent coverage and impact of the journal.

We certainly encourage others to include Photonics Views in their strategy for communicating significant advances in photonics technologies and applications. To the entire Photonics Views team, congratulations on establishing such a prominent platform!

Dahv Kliner
vice president fiber laser technology
nLIGHT, Inc
www.nlight.net



With PhotonicsViews there is a unique magazine format which has repeatedly enabled us as Toptica to present innovative laser technology in the context of our own development efforts or through its application in the customer's research laboratory. For a company like Toptica, which is at home in many areas of physical research, this is an excellent platform – also allowing visibility for our own employees. The opportunity to generously illustrate the texts provides students with quick and emotional access, and the connection to leading research groups that we are always looking for also provides material worth reading for the specialist audience. Many thanks for this opportunity.



Dr Wilhelm Kaenders
executive director
TOPTICA Photonics AG
www.toptica.com

From the perspective of a society that is celebrating the 100th anniversary of its founding this year, 20 years seems like a very short period of time. But when you look at the enormous progress that optical technologies in particular have made over the past 20 years, it feels much longer. It is thanks to magazines like PhotonicsViews that we do not lose track of the abundance and diversity of new research results, new or exciting ways of implementing old ideas, and necessary background knowledge.

The journey of the DGaO with PhotonicsViews began just two years ago, but we felt we were in good hands right from the start and greatly appreciate the good cooperation. To be able to read bundled information from our exciting and innovative field every two months and to be kept up to date about upcoming events is a pleasure that many of our members would not want to miss. With this in mind, we congratulate on 20 years of successful journalistic work and look forward to the next 20 years of cooperation. It may also gladly become 100.



Ricarda Kafka
president
DGaO – German Society of applied Optics
<https://dgao.de>

Congratulations PhotonicsViews

on your 20th anniversary. Thank you for supporting the photonics industry over the last two decades. It has been very exciting to see how the magazine has developed over time and I am very happy to have contributed both content and advertising, but also for having been a partner to the great staff. Well done and wishing you loads of success for the future.



Agnes Hübscher
senior director global strategic marketing
Edmund Optics
www.edmundoptics.com

In my view, media reporting in general is increasingly becoming a marketplace of opinions. Social media are doing the rest and are not making the picture any better. Careful research and analysis are becoming a rarity, and there are few sources that perform their journalistic duties conscientiously and with scrutiny. PhotonicsViews is an exception here, for decades an interesting, solid source of information on industry trends and news, we all benefit greatly from it! Many thanks and congratulations on the anniversary!



Professor emeritus Reinhart Poprawe
chair for laser technology RWTH Aachen
senior advisor Fraunhofer Gesellschaft
www.ilt.fraunhofer.de



For two decades, PhotonicsViews has provided comprehensive, in-depth technical articles to its readers, making it a trusted and long-term partner for us and the whole industry. In the years to come, we wish PhotonicsViews continued success and growth in its commitment to educating readers about new developments in photonics technology. Congratulations on this incredible achievement!

Christoph Sieber
CEO
Sill Optics
www.silloptics.de

Photonics Views

Image sources: Cailabs, DGaO, EMVA, EPIC, Fraunhofer ILT, JPT Opto-electronics, Luxinar, MKS, Photonics Germany, Schäfter+Kirchhoff, SPIE, Trumpf, U Stuttgart, Wiley

A kick-start for start-ups

EPIC CEO interview with Marc Ricci, general director of Pôle Optitec



Source: Pôle Optitec

Carlos Lee, EPIC's director general, talks to Marc Ricci, general director of Pôle Optitec, a cluster based in southern France dedicated to innovative photonics technologies.

What is the background to your appointment as general director at Pôle Optitec?

Marc Ricci: After receiving a PhD in physics from Aix-Marseille University in 2000, I worked as a sales manager for ASE Group Global, a provider of semiconductor assembling and test manufacturing services, and in 2006 I was promoted to ASE's commercial director. By 2009, I had had enough of being an employee for a large corporation and, wanting a new challenge, I decided to set up my own company. I wanted to do something both creative and innovative, and after a period of brainstorming I co-founded Crosslux in 2011. The idea was to manufacture photovoltaic glazing capable of producing solar energy for glassed buildings, and thereby to reduce energy consumption and CO₂ emissions. Over the next four years, we set up a factory in Rousset, southern France, to develop a proof-of-concept, and grew to a workforce of 35. We managed to raise around thirty million euros in seed funding, but by 2018 costs had spiraled and the company became insolvent.

Shortly after setting up Crosslux, we joined the Optitec cluster, which had

been established in 2005 to promote photonics companies in the South and Occitania regions of France. My original aim had just been to give Crosslux greater visibility, but I gradually became more involved in Optitec advising start-ups, and as a member of the administrative staff becoming involved in the life of the organization and helping to plan strategy. In 2018, Optitec's general director decided to quit and I was offered his job, which I gladly accepted.

What are the aims of the Optitec cluster?

Ricci: We are a competitiveness cluster dedicated to promoting photonics technologies, primarily in the South and Occitania regions of France. Our members are made up of manufacturers, research establishments and training organizations and our mission is to support them in their research, growth and development strategy.

What is your organizational structure?

Ricci: Our administrative and management team comprises eight members of staff: general director, deputy general manager, deputy director general

affairs, head of technologies and platforms, international business manager, and communication officer. We are ultimately accountable to a 25-person board of directors. We have around 200 members, of whom 150 are SMEs, 40 research laboratories and the rest are start-ups and training organizations. Eighty percent are based in our region, and the other twenty percent are mainly in the Paris area due to the presence there of a number of defense companies.

What are the main differences between running a company and running a cluster?

Ricci: There are no real differences between the two. As with a company, the cluster needs income. In our case, fifty percent comes in the form of French and European public funds and fifty percent from member companies. When I took over as general director, I saw that there was scope to boost our activities, making them more dynamic as a way of increasing income and providing a more comprehensive range of business services for our members. In the first instance if a new company approaches us, we talk

about how we can make money together by giving added value. If it works out, we then start talking about membership.

What are your main markets and what services do you provide?

Ricci: Our two main fields of activity are in security/defense and industry, followed by health and life sciences, smart city and mobility. We spend most of our time both pushing and pulling photonics technologies to international markets in these sectors via exhibitions in places like San Francisco, Stuttgart and Munich, where we rent space to members at a discount. We also organize business meetings and trade missions. For example, last month we organized the French Pavilion at Vision, the machine vision event, to enable our members to showcase a range of their solutions over three days. We were also present at SIANE, in the Pad'Occ space which is an innovative platform to support manufacturers towards the Industry of the Future in Occitania.

Our other marketing services include helping members develop a business model and/or marketing strategy, e.g. searching for public/private funding. We also help members to gain visibility by providing communication tools to enhance and promote members' activities within the Optitec network with the aim of promoting exchanges within the network and the sector through our regular industrial, business and technological meetings. In 2019, more than a thousand people participated in our events.

At a more technical level, we help members to accelerate R&D projects and test their innovations or new products by putting them in contact with companies offering and/or using innovative technological solutions. We also help members to develop a recruitment strategy, e.g. by identifying needs, holding recruitment fairs, and organizing interviews with pre-selected candidates.

Finally, thanks to the presence of a full-time person in Brussels, we are able to guide SMEs on Horizon 2020 and Horizon Europe programs and help them position themselves at a European level in order to increase their chances of succeeding with their projects by joining a consortium. For example, we are involved in PhotonHub Europe, a new pan-European digital innovation project in photonics, and we are one of the coordinators of the 'European Key

Enabling Technologies for Dual-Use Worldwide' project that aims to facilitate access to security and defense markets for European SMEs in the US, Middle East, and Asia and Oceania.

How do you determine your strategy?

Ricci: As fifty percent of our income comes from public funds, we are obliged to comply with French national and regional economic development missions. We basically select the most relevant projects and push our members to contribute to these strategies. Similarly, we participate in various EU projects and guide SMEs on Horizon Europe programs as well as attending European cluster conferences, which are a great opportunity to meet policy makers, cluster managers, practitioners and other stakeholders. The other half of our strategy is determined by our board of directors and by soliciting the ideas of our members, which we do by sending out questionnaires and through face-to-face meetings, which are by far the most effective.

What do you enjoy most about working for a non-profit industry association?

Ricci: What I enjoy most is being part of the photonics community, talking to people and helping them develop their ideas and projects. In the last five years, we have helped to create seventy start-ups and also been very active in helping young people to find jobs in the sector by organizing recruitment fairs, which are free as they are part of our mission. For example, last month we co-organized a Job Dating Day dedicated to the defense and space professions in Toulouse. The event, which attracted 400 participants, included pitches from companies such as Airbus Défense Spatial and then an opportunity for face-to-face discussions with industrial, state and academic players in the defense and space sectors. It is interesting talking to young people about the technology, and I feel proud that we are doing something positive to help recruit the next generation of photonics engineers.

*

Author: Carlos Lee, Director General, European Photonics Industry Consortium EPIC, Rue Hamelin 17, Paris, France; e-mail: carlos.lee@epic-assoc.com, Web: www.epic-assoc.com, [in](#) carloslee

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LASER World of PHOTONICS
B2.103 & World of QUANTUM

The Laser' turns 50

The world's leading trade fair and congress has brought together the international photonics industry for five decades



Source all images: Messe München

The Laser World of Photonics is celebrating its 50th anniversary and, for the first time, it will take place alongside Automatica, the leading exhibition for smart automation and robotics. Exhibition director Anke Odouli offers a glimpse of the innovations, key topics and highlights of the laser event.

What is the scope of this year's event?

Odouli: The international photonics industry will meet at its world's leading trade fair in Munich under very special conditions at the end of June – together with Automatica! Both trade fairs will take place from June 27 to 30, 2023, while the World of Photonics Congress will be held from June 25 to 30. In one hall, the World of Quantum will once again offer the international quantum community its own platform, following its successful premiere last year (cf. p. 83).

Why is 2023 a special year for the Laser World of Photonics?

Odouli: There are several reasons: firstly, the very first edition took place in

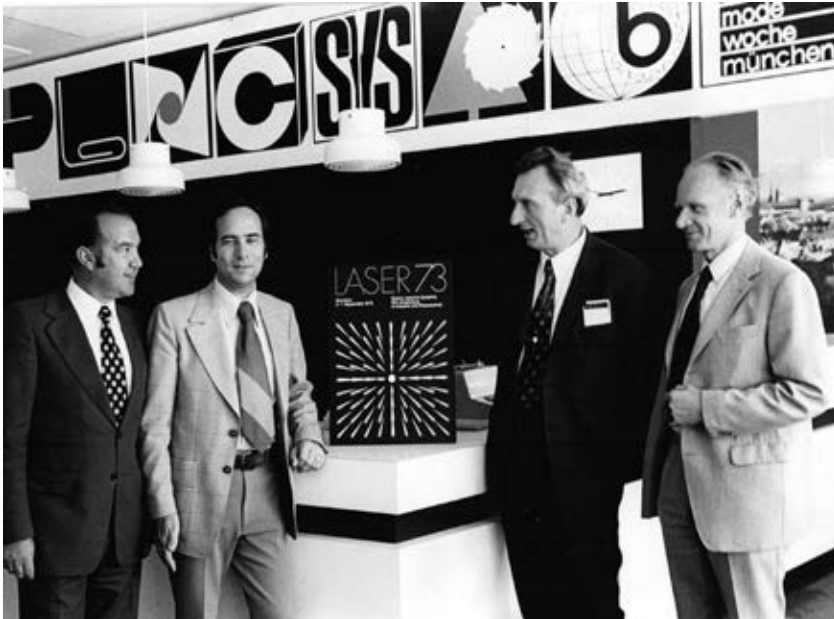
Munich fifty years ago under the name Laser 73 with around a hundred exhibitors. Gerd vom Hoevel, CEO of Messe München at the time, had the visionary idea to create the world's first trade fair for the new laser technology – the first laser was developed in 1960. Messe München also took on a pioneering role in 2022, when it initiated the World of

Quantum, a platform for the international quantum community and thus for another technology with huge potential for the future. It will once again take place alongside the Laser World of Photonics in its own hall in 2023.

And after a four-year break, the international scientific elite can finally gather in person again at the World of



Anke Odouli, exhibition director
Laser World of Photonics, Messe München GmbH



Laser congress opening 1973 with Messe München CEO Gerd vom Hövel and professors Theodore Maiman, Alexander Mikhailovich Prokhorov, and Wilhelm Waidelich (l-r).

Photonics Congress. Last but not least, we are looking forward to co-locating with Automatica for the first time, as there are many intersections between the automation and laser industries.

How are the registrations for Laser World of Photonics 2023?

Odouli: A good five months before the trade fair, we already had more exhibition space occupied in the six halls than in the whole of 2022, with exhibitors from thirty countries. We have particularly high growth rates from the United States and China. The Laser World of Photonics has always been broad and international, and we are pleased that so many international exhibitors can take part again this year was after being hindered by travel restrictions in 2022. All the market leaders from the photonics sector and important research institutes close to the industry have already confirmed their participation.

What industry topics will be in the focus of Laser World of Photonics this year?

Odouli: Photonics has become a key technology without which innovations in many areas would not be conceivable. Autonomous driving, electric mobility, life sciences, modern diagnostics and communication processes – there are hardly any industries that do not benefit from it. The exhibition areas will of course address these topics, as will the supporting program of forums, panels, the “Photonics in Production” special show and our career initiatives.

Topics that are currently affecting the industry will also play a role there, such as the issue of supply chains and the shortage of skilled workers. Despite these challenges, the photonics industry is continuing its upward trend: for Germany alone, the Spectaris industry association predicts an annual growth rate of around 6.5 percent by 2025; the industry generated 47.3 billion euros in sales in 2021.

What highlights can we expect from the World of Photonics Congress?

Odouli: We are delighted that the top scientists from all over the world can meet in person again here on our exhibition grounds after the long pause. For six days they will present and discuss their latest research results in scientific conferences and application-oriented panels. This year, the Congress comprises five individual conferences: the largest is CLEO/Europe-EQEC, which addresses all facets of optical technology and photonics in basic research. There will also be four conferences on applied science, namely LiM – Lasers in Manufacturing, Digital Optical Technologies, Optical Metrology as well as ECBO – the European Conferences on Biomedical Optics.

*

Material provided by Messe München in January 2023.

<https://world-of-photonics.com>



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- Limited stroke
- Play-free
- Frictionless
- Ball and crossed roller cages
- 5 - 450 mm stroke



PRECISE MOTION IN TIGHT SPACES

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- Ball and crossed roller cages
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The secret to success: be visionary every day!

25 years of Optisense – an interview with managing director
Dr Jens Heymans



Source all images: Optisense

Optisense turns twenty-five and is in its prime, stating that it is the market leader in non-contact coating thickness measurement.

25 years of Optisense – a long time in a technologically challenging market. What is your key to success?

Heymans: What makes us stand out, next to our multitude of innovations, is our capability to deal with new technical challenges in a flexible way. The secret to our success is: be visionary every day! Another key factor is our long-standing customer relationships. We have more than 85 percent of existing customers, who we have accompanied on their course for many years. The same goes for our team: many colleagues have been on board for a long time.

In your view, what were the milestones and most impressive moments of the last 25 years?

Heymans: Oh, there are quite a number of milestones: starting with our foundation as a spin-off of the Fraunhofer Optics Center in 1998. Just one year

later, we launched the first photothermal coating thickness sensor for an industrial robotics application. Shortly afterwards, the first major car manufacturers approached us, such as Audi. Next, the patented PaintChecker Mobile LED handheld measurement device went into series production. Then in 2016, OptiSense entered the Chinese automotive market. Two years later, our industrial controller was developed that

measures the coating thickness at up to eight points simultaneously.

In 2020, we launched our Service-Suite – a comprehensive, cost-effective and proactive support package that ensures smooth and safe operation of the coating thickness measurement systems. An important aspect of the suite is predictive maintenance. It ensures reliable measurement data as a foundation for reporting systems. This enables clients to save costs by optimizing maintenance intervals and improving planning efficiency.

How have challenges developed in recent years?

Heymans: If you work for global players and hidden champions, you cannot slack off – you have to think ahead. Accordingly, we acted early on to meet the needs of automation and miniaturization. Our sensors fit into any production environ-



ment meanwhile, no matter how tight it is. Today, quality control is largely based on fast, automated inline measurement, and this requires the development of appropriate high-performance measuring systems more than ever.

Does this also have an impact on the team and workflow?

Heymans: We have a good combination of young and experienced employees. Developments in the market call for a different way of thinking and approaching things. Developing ideas and implementing them go together more quickly than in the past, and testing for suitability can be carried out in an earlier phase. Nothing is set in stone; we want to develop ideas and try them out.

Looking back, we can say that the great commitment of our employees has made us stronger as a company than ever before. We have grown by an average of 26 percent over the last three years, and never before have we had such a broad base in terms of the markets we cover. Ultimately, the entire company has to reinvent itself over and over again. We want to stay an attractive employer where it is fun to work in a team, and to drive innovations in coating thickness measurement.

Which future trends are most relevant for OptiSense and your customers?

Heymans: From my point of view, the continuous increase in efficiency through automation will keep us very busy. Increasing speed and precision in the line needs sensors whose specifications are many times higher than today. We continue to work on topics such as analytics, platforms and IIoT: analytics, i.e. data analysis, is regarded as the foundation of modern management and is one of the most important skills for running a coating company successfully. But only a fraction of companies fully evaluate the data they collect. The result of the correlation analysis in particular can provide important insights for an optimized and really smooth coating process.

The IIoT will certainly have an increasing impact on the coating industry. Networking of sensors, products and equipment as well as the complete evaluation of collected data creates new opportunities.

How will you celebrate your anniversary?

Heymans: To celebrate our 25th anniversary,

we are launching a strictly limited product design. This limited edition will emphasize the premium concept of our brand down to the smallest detail. We will highlight the unique look of our PaintChecker Mobile 25 Years with a very special polished surface finish.

An innovation is that our customers and prospects can decide online on the final look of the mobile PaintChecker model. For this purpose we conducted a survey via LinkedIn, Instagram and on our homepage. And everyone taking part could win one of the top prizes with a total value of over 5,000 euros.

What do you wish for yourself and your team in the future?

Heymans: I would like our whole team to keep their amazing motivation! For the future, I hope that my team and I will

keep a keen interest in new things and, of course, continue to work on exciting projects for our great customers. If work is fun and everyone is excited about the job, Optisense will continue to be on the right track.

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Material provided by Optisense.

OptiSense Gesellschaft für Optische Prozessmesstechnik mbH & Co KG

Annabergstraße 120
45721 Haltern am See

Germany

phone: +49 2364 50882-0

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Motion control specialist for over 50 years

Aerotech's CEO Mark Botos and president Bob Novotnak in interview



Source all images: Aerotech

The company's history dates back to 1970, when Stephen J. Botos and two fellow engineers started prototyping a positioning system for industrial use in a garage. The first positioning system manufactured was a simple two-axis electromechanical application. A lot has happened in the past fifty years: the former 3-man start-up has grown into a high-tech company with over 500 employees. We spoke with CEO Mark Botos and Aerotech president Bob Novotnak about the company's development into a key player in the market for high-precision positioning systems and where the journey is still heading.

Mr Botos and Mr Novotnak, what were some of the key milestones in Aerotech's history that brought the company to this point?

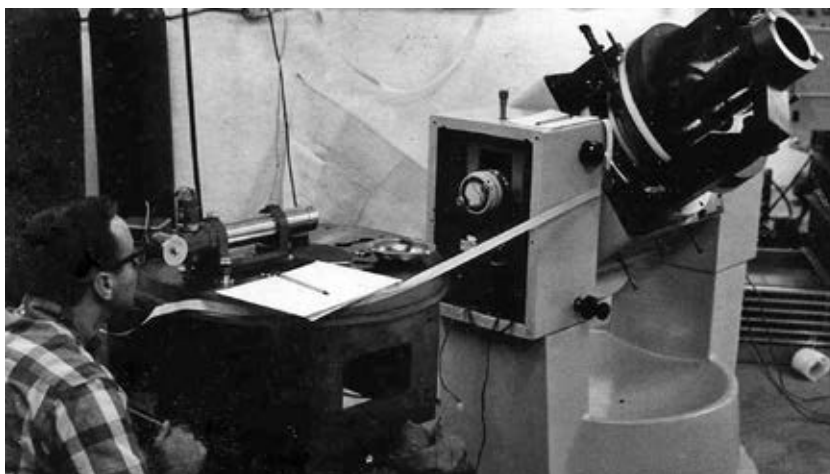
Novotnak: Decisive milestones were certainly the development of coordinated multi-axis control in the 1980s and our own servo motor production in the mid-1990s. This enabled us to ensure that our positioning solutions worked with high precision down to the nanometer range. We have also been able to open up new markets with innovative and low-maintenance air-bearing rotary axes. One example of this is our new

ABRX series for surface measurements in the nanometer range. With large air bearing surfaces, we achieve significantly better running accuracy than mechanical or other air-bearing rotary stages available on the market, which in particular benefits applications that require exceptional flatness of movement. In terms of angular accuracy, load capacity and off-axis error movements, ABRX also outperforms all other rotary stages on the market to date.

Botos: For me, an important milestone was the introduction of customized solutions into our portfolio. This enabled us

▲ Mark Botos, CEO, and Bob Novotnak, president, Aerotech Inc.

to convince numerous new customers in all industries of our positioning know-how and to win them over. We have also established and successively expanded our global presence. Today we are represented in all important markets, in some by our own subsidiaries. Another important step in 2017 was the implementation of an integrated ERP system to control our manufacturing processes. This paved the way to transform our



Company founder Stephen J. Botos before his first patent in 1973: a positioning mechanism for coarse and fine adjustment

previously predominant single-item production into effective small-series production.

What were the biggest challenges in Aerotech's history that you were able to overcome?

Novotnak: These were mainly economic crises that we had to deal with. One was the collapse of the US machine tool industry in the early 1980s, and then around the turn of the year 2000 the big telecom crash, i.e. the dotcom bubble. **Botos:** We were able to come through these crises relatively unscathed because we had made a good name for ourselves in the market for positioning systems from the very beginning and had gained a foothold in all industries, so that we were and are not dependent on just one industry.

How has the growth and increasing customer demand worldwide affected your business?

Novotnak: It continues to drive us to develop new products and business initiatives. Even though this continually brings challenges, our products and services are in demand. We help our customers solve some of their toughest automation challenges.

Botos: The biggest problems were caused more by the uneven demand. The global aspect has been less of a problem. So it is not always easy to react to the rapid ups and downs of the high-tech industry. But we continue to drive progress by using our core competencies in technology.

What have you done to build capacity to keep up with the increased demand for your products and services?

Botos: We have been working on building a diverse supply chain to expand our existing production capacity. The

focus has been on expanding our production capacity by doubling our clean room space. However, some things we do cannot be outsourced. We have therefore developed internal training and sustainable recruitment programs to build, attract and retain the talent we need.

Can you explain how technology is driving your business forward – both for your internal operations and for your products and services?

Botos: The constant change in technology creates new opportunities. As many devices such as smartphones become smaller and more ubiquitous, the demand for manufacturing these products is constantly increasing. At the same time, these developments also influence our manufacturing processes, with lasers and additive processes being the best examples. To put it in a nutshell, the smaller applications and devices become, the more precise the positioning has to be in manufacturing. **Novotnak:** I would add that our customers are increasingly automating their products because of the higher precision, smaller size and lack of available labor. This is where we see ourselves as a reliable partner for microproduction in the future as well.

What are the key features that make Aerotech unique both as an employer and as a provider of precision automation systems?

Botos: Respect for our employees and their families creates an environment where people like to stay because they know they share in the company's success through profit sharing and an employee share ownership program. And our customers can rely on us for both product performance and our global service. Our products perform

as stated, backed by data, and are supported by us for as long as possible.

Novotnak: Aerotech is unique in the industry in that we have the expertise in-house on many of the core technologies needed for our business. This gives us the opportunity to permanently adapt them to the current and future needs of our customers. A good example of this is our new Automation1 control platform, which has been developed based on customer requirements and is constantly being expanded functionally to meet customer needs.

Where do you want to take Aerotech in the future?

Botos: We naturally want to continue our growth story so that we can enable our employees and customers to achieve their own life goals. Our current starting

Company

Aerotech

Headquartered in Pittsburgh, USA, Aerotech Inc. is a mid-sized, employee-owned company. In Germany, the company is represented by its own subsidiary, Aerotech GmbH, based in Fürth, Franconia. In addition to sales and service activities, the customized assembly of positioning systems for the European market takes place in Fürth. The motion solutions are used in medical technology and life science applications, semiconductor and flat screen production, photonics, automotive, data storage, laser processing, aerospace, electronics manufacturing, as well as in inspection and testing through to assembly. Aerotech has further full-service offices in the United Kingdom (Ramsdell), China (Shanghai City) and Taiwan (Taipei City) and currently employs approximately 500 people worldwide.

<https://uk.aerotech.com>

Meet us at Control 2023, Hall 5, Booth 5425



Aerotech exhibition stand at Laser World of Photonics, 2022



Integration of a Keyence VR5000 in an Aerotech positioning systems for even larger travel distances: up to 300 mm on a stable granite gantry.

position as well as the market opportunities are ideal to sustainably drive future growth. We have hired around a hundred new employees in the last six months alone.

Novotnak: Of course we want to keep growing, but in a smart way. We see a bright future for precision automation systems, and so we will continue to do what we do best: build the best precision motion control and automation equipment for our customers. One of the latest examples is the further development of our popular ANT nanopositioning

stages. Building on the proven predecessor model, the 2nd generation ANT95 and ANT130 high-precision nanopositioners are designed to provide even better dynamics and precision. We see a wide range of possible applications for this, for example in assembly and inspection in photonics, in fiber alignment and optimization, in the manufacture, testing and inspection of optics, in sensor testing and qualification, but also in semiconductor manufacture and inspection as well as in research and laboratory applications.

Mr Botos and Mr Novotnak, we thank you for the interview and wish you continued success.

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Motion control: from component to system supplier, PhotonicsViews 19(6), pp. 86–88, December 2022

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Diode lasers in industry: a success story

A Laserline retrospective after 25 years in business



Source all images: Laserline

From the supposedly 'better flashlight' to high-performance systems for industrial materials processing: the diode laser has traced a remarkably successful path over the last two and a half decades. And there is still no end to this development in sight.

From welding, hardening and coating of steels and non-ferrous metals to plastics processing and semiconductor manufacturing: diode lasers are firmly established in numerous industrial processes. The justification for this high level of acceptance is not only due to their reliability and process stability, but also in their unrivaled high efficiency of over fifty percent. The diode laser is also compact and requires a comparatively low capital layout. Against this background, it is all the more astonishing that around 25 years ago hardly anyone believed in the industrial suitability of the diode laser. At the beginning of the 1990s, the semiconductor laser was only known from CD players, laser pointers or scanners at supermarket checkouts. Even experts did not initially believe that the technology was capable of much more, as diode laser output was consid-

ered far too low to be suitable for materials processing. With a maximum output power at the time in the single-digit watt range, they could at best only marginally heat surfaces, so they were not even remotely suitable for applications such as metal welding.

For gas and solid-state lasers the situation was entirely different as these were already widely established within industry. Solid-state lasers such as the neodymium YAG laser had long since eclipsed the multikilowatt barrier and were already used, among other things, to weld automotive chassis. Gas lasers with their significantly higher power were used, for example, to cut steel sheets as thick as a thumb. While diode lasers were still a long, long way from realizing those levels of output power, the potential to reach that goal was nonetheless available.

▲ Additive manufacturing of copper components

Dr Christoph Ullmann and Dipl.-Ing Volker Krause, founders and managing directors of Laserline, were among the very few who recognized this potential, were already convinced in the mid-1990s that the diode laser was ready for industrial applications, and believed that they could even be a future replacement for the lamp-pumped, solid-state laser. They were, however, initially met with a great deal of incomprehension and even ridicule in the industry – at the Laser World of Photonics trade fair in Munich, only five months after founding the company in 1997, they presented the world's first diode laser with an output power of one kilowatt, but were initially only met with the



Christoph Ullmann (l.) and Volker Krause (r.), founders and managing directors of Laserline, looking at the lasers of the early days

question of the purpose behind this 'better flashlight'.

About two years later at the same event, they were able to present a cutting application with a new fiber-coupled 500 watt diode laser. Metal cutting had been considered unattainable for diode lasers up until this point, and so the potential finally had to be taken seriously. Jump over twenty years forward to today and Laserline is the market-leading manufacturer of diode lasers for industrial material processing.

Diode bars, cooling and optics as development drivers

The fact that the diode laser – contrary to many expectations – did manage the leap into the high-power range was primarily due to a change in approach or,

more precisely, the development of the diode bar. So-called 'bars' form the basis of contemporary diode laser technology, containing several individual emitters mounted side by side on a semiconductor chip on a metal heat sink. Bars are then assembled on top of each other to form 'stacks', and by combining several stacks together the power of the diode laser can be increased well into the multikilowatt range. While kilowatt output powers were first realized in 1997, modern commercially available diode lasers achieve outputs of 45 kW, while prototypes with powers of 60 kW have also already been successfully tested.

Such leaps in performance became possible thanks to development work in cooling technology because the combination of hundreds of individual emitters is fundamentally limited by the high heat sensitivity of the components. Even in individual operation, the heat generation of classic laser emitters is high and can lead to the destruction or deterioration of the semiconductor, reducing their service life. This risk is exacerbated when the diodes are densely packed, with correspondingly greater heat generation.

Reliable and efficient cooling solutions therefore had to be found to prevent the overheating that would endanger the material, especially at high laser diode packing density. The best approach proved to be the integration of coolant channels directly into the individual stacks, enabling a cooling medium to be brought into the immediate vicinity of the greatest heat generation. In this

way, heat can be quickly removed while at the same time minimizing the volume of the cooling modules.

This approach together with the increase in efficiency of the semiconductor lasers has made it possible to continually reduce the device volume per kilowatt, enabling the construction of particularly compact laser systems which, in contrast to solid-state and gas lasers, can even be moved around on rollers.

Appropriate beam shaping has been a further crucial enabler to expanding the range of applications. The diode laser inherently has a narrow, rectangular beam, although for many applications such as welding, round or elliptical spots are preferred. This challenge was solved by utilizing optics consisting of lens and mirror elements that adapt the spot to the intended materials process in size, geometry and intensity distribution. Special configurations have also been developed by Laserline for more specialized applications, such as multispot optics for brazing hot-dip galvanized sheet metal. These divide the beam into a main spot and two additional spots that ablate the galvanization ahead of the main seam and thereby calm the process.

Multiple applications

Technological advances in design, cooling and beam shaping finally opened the doors to new markets for the diode laser. As a first milestone, the laser was able to enter the automotive industry at the beginning of the 2000s, this remaining one of the most important areas of application today. While initially used for soldering tailgates and roof seams, additional applications such as welding tailored blanks or hardening camshafts and crankshafts quickly followed.

But the laser also quickly gained a foothold in numerous fields of application outside the automotive sector. For semiconductor manufacturing they are successfully used for the optoelectrical quality inspection of wafers and laser-assisted soldering of highly complex electronic components such as flip chips. In additive manufacturing the laser is used for powder cladding and 3D printing, as well as for repair coating of high-wear components, amongst others. The diode laser has also been successfully used in plastics processing, for example in fiber composite tape placement as used to form three-dimensional

Company

Laserline

As an internationally leading manufacturer of diode lasers for industrial material processing, Laserline GmbH has become the embodiment of this innovative technology and can look back with pride at more than twenty years of corporate history. More than five thousand high-power diode lasers from Laserline have been delivered worldwide, and have proven their efficiency in a wide range of different processes and applications. Currently, the company employs about 360 people and has several international subsidiaries in Asia, the US, and Brazil, as well as representatives in Europe (France, UK, Italy), Australia, India and Taiwan.

www.laserline.com

Meet us at Laser World of Photonics, Hall B3, Booth 305

components such as pipes, ship hulls or aircraft wings.

More recently, the development of a blue high-power diode laser has even succeeded in conquering an area of application that has so far been largely denied to classic infrared lasers: non-ferrous metal processing. Due to the poor absorption rate of infrared light, processing of highly reflective metals such as copper, aluminum, and gold has hardly been possible in series production. Laserline introduced a first prototype blue laser in 2017, operating at the visible blue wavelength of 450 nm – and thus closed a gap in the market. As blue laser light is much more readily absorbed by non-ferrous metals, controlled heat conduction welding of such materials could also be achieved for the first time. For the diode laser, this represents a breakthrough in electronics manufacturing where copper components as used in battery and motor components of electric cars as well as hairpins and high-performance electronics could finally be reliably processed.

Electrifying manufacturing processes

Against the general discussion surrounding the sourcing and use of energy, the diode laser is making headway into manufacturing areas where highly efficient electrified solutions are sought. This is true, for example, for drying processes such as convective drying, for a long time dominated by gas-fired con-



Diode lasers in the automotive industry: joining car body components

tinuous ovens. Given the recurring cost-driven shortfalls of fossil fuels and the increasing importance of climate protection measures, operators are increasingly turning to alternative processes. Semiconductor-based direct conversion of mains electricity into laser radiation ('power to light, directly') enables a route to electrification and can make a significant contribution to improving the CO₂ balance of industrial processes.

Diode laser-based drying is of interest for numerous applications, for example for the production of laser-dried anodes and LFP cathodes in a roll-to-roll process. This is currently being investigated as part of the IDEEL research project (Implementation of Laser Drying Processes for Economical & Ecological Lithium Ion Battery Production [1], cf. p. 26) under the leadership of Laserline and is intended to launch climate-friendly and economical series production of lithium ion batteries in the future.

In addition, high-power diode lasers can also increasingly conquer new areas of application outside of industrial processes. One example of this is the generation of high-power white light with over 100,000 lumens using blue diode lasers and rotating phosphor converters. In this sense, and after about two and a half decades, the diode laser is now returning to its beginnings with applications in lighting technology – although now under entirely different conditions. It should now be clear to even the most skeptical of observers, that it is no longer possible to refer to these as merely a 'better flashlight'.

Further development potential

Even this brief portrait shows that, while initially only smiled at, the diode laser has traced a remarkably successful path as a tool in industrial production.

However, this is by no means the end of the story because from a technological point of view the diode laser still has further development potential. Research is currently underway to increase power to well over 100 kW. The optical efficiency of the systems can also be further optimized where goals of over seventy percent are realistic. There is also no doubt that the diode laser still has development potential in focusing. Due to the bundling of numerous partial beams, it is inherently poorer than for fiber or disk lasers, and this is even more so for increasing laser power. However, this problem can be effectively tackled in the future, even in high power ranges, with the help of beam converters in which the beam is directed into an active optical fiber via special lenses. One thing is certain: the envisaged system optimizations will provide access to further areas of application and additional industries. Established manufacturers are therefore convinced that the diode laser will revolutionize many processes in industrial material processing in the coming years – a buoyant prediction that seems anything but unfounded.

- [1] Reducing energy consumption in electrode production – IDEEL project to manufacture laser-dried anodes and LFP cathodes for the first time in a roll-to-roll process, [wileyindustrynews.com](https://www.wileyindustrynews.com), 2 February 2023



Early multikilowatt diode laser built in 1998 / 1999

Laserline GmbH

Dr. Alexander Arndt
Sales Director
Fraunhofer Straße 5
56218 Mülheim-Kärlich
Germany
Tel: +49 2630 964-4000
www.laserline.com

100 years of technology pioneers

How Trumpf came to the laser



Source all images: Trumpf

First laser ignition at Trumpf in the 1980s

Laser technology plays an important role in the history of Trumpf and to the present day, from the first laser cutting machines to lasers for EUV lithography. This is how Trumpf made the laser suitable for industry and how the high-tech company benefits today from courageous decisions.

It was February 1978: in a passenger jet ten thousand meters above the Atlantic, Berthold Leibinger was going through his travel documents. His plan: to visit several laser manufacturers in the US. Ten years earlier, the laser was still a nice gimmick. With its grotesquely huge resonators, it was rather impractical and mostly only stood in experimental laboratories. By then, however, lasers had become more robust, smaller and more manageable. The first companies in the US were using them to cut sheet metal and were already planning to integrate lasers into machine tools. Berthold Leibinger was sure he absolutely had to see for himself on site. These, or something similar, might have been his thoughts during his flight across the Atlantic. Due to its great success with numerically controlled nibbling machines, the Trumpf company was considered the 'nibbling king' in the 1970s. Nevertheless, in 1978 Leibinger

decided to fundamentally question what had been achieved so far and, during his trip to America, to personally test whether the CO₂ laser, which had been much discussed in the trade journals, could actually cut sheet metal on an industrial scale. Leibinger visited several laser manufacturers in the USA and, after returning to Ditzingen, he decided to order a CO₂ laser from a company in Michigan. Unlike the other American laser manufacturers, this company had a service branch in Germany from which Trumpf expected to be able to provide support comparatively quickly in the event of technical problems.

Trumpf enters laser technology

Just one year later Trumpf entered the field of laser technology, but without losing sight of or scaling back its original mechanical engineering business. The company launched a punching

machine that also processed sheet metal with a laser that delivered more than 500 watts of power: the heart of the machine was the CO₂ laser supplied from the USA. The combined punching/laser machine, as it was officially called, was offered by Trumpf under the name Trumatic 180 Laserpress and proved to be a great success. After this first application in punching machines, lasers soon found their place in cutting machines as well.

But in the early 1980s, Berthold Leibinger came to the conclusion that the lasers he was buying at the time did not quite meet his standards in terms of industrial suitability. He was also concerned about his dependence on the American laser market, and that is why the German company began developing its own laser. In October 1985, Trumpf finally filed a patent application with the European Patent Office for a "Gas



Berthold Leibinger presents the Trumatic Laserpress in the 1980s.

Laser with Transversal Coupling of High Frequency". Customers were able to buy the first Trumpf laser as early as 1986.

Even though almost all of these lasers were still intended for installation in the company's own machines, Trumpf also established itself from the beginning as an original equipment manufacturer, selling them as built-in parts to other machine builders. Due to the high demand, the company soon decided to double laser production from 60 units in 1986 to 120 units in 1987. The fact that even this target was still far too low is illustrated by the sales of around 2,500 CO₂ lasers between the years of 1986 and 1995 alone. Today, CO₂ lasers are far from being old news and are more important than ever for Trumpf.

CO₂ lasers enable the production of the most powerful microchips

Trumpf took another bold step with its decision to develop a laser for EUV lithography – and as so often in the history of this company, the impetus for this

came from the US. Robert Akins, head of Cymer LLC in San Diego, asked Trumpf whether they could imagine constructing a CO₂ laser in-house that could be used to heat tin to an extreme temperature and excite it to emit extreme ultraviolet light (EUV). Today's most advanced smartphones, computers and many other applications would not work without this light because the EUV process makes it possible to produce a new generation of even more densely packed microchips, making technical devices even smaller and more powerful in the spirit of Moore's Law.

But first things first: to produce the latest generation of microchips, highly complex lithography equipment is needed that only the Dutch company ASML manufactures. The systems work with precisely this EUV light, which can only be generated by Trumpf's giant lasers. In ASML's system, the ten-ton light source ensures that a plasma with a temperature of 220,000 degrees Celsius is generated – that is about 45 times hotter than the surface of the sun.

The giant laser is aimed at a beam of tin droplets inside the lithography facility, where it hits 50,000 tiny tin droplets every second. The giant laser even hits each tin droplet twice: once the droplet is flat – the shape somewhat resembles a pancake – a second shot converts it into a plasma which then emits the EUV light. But for the giant laser to hit 50,000 individual droplets per second at all, its light must have a special shape. Laypersons would say the laser shoots condensed light packets at the tin droplets – experts refer to this as a pulsed laser. Each light pulse consists of a compact group of light particles that whiz toward the droplet in close proximity to one another. To ensure that they hit the droplet correctly, they must arrive neither too early nor too late otherwise the tin droplet will not turn into a pancake. This complex technology is a major business success for Trumpf: lasers for EUV lithography were responsible for a good fifth of the high-tech company's total sales in the past fiscal year 2021/2022.



Commissioning of a Trumpf EUV laser system in a so-called installation bay



Welding hairpins: lasers for the manufacture of electric motors or e-car batteries are now an important business field for Trumpf.

Trumpf masters all varieties of laser technology

While Trumpf in Ditzingen concentrated on designing its own CO₂ lasers in the early 1980s, the Carl Haas company in Schramberg, barely more than eighty kilometers away as the crow flies, had been dedicated to developing solid-state lasers for industrial use since the 1970s. In 1992, Trumpf decided to acquire the Schramberg-based laser technology company. With this acquisition, Trumpf pursued the plan of supplementing its own production of CO₂ lasers with solid-state lasers of the Nd:YAG type.

Today, the heart of laser expertise in Schramberg is the so-called disk laser. Especially in automotive production this laser is the first choice due to its high power and reliability. Disk laser welding systems accelerate the production of battery cells for electric cars, for example. For this purpose, Trumpf offers a system consisting of the six (and more) kilowatt TruDisk disk laser, processing optics, process sensors – to check the weld depth for example – as well as the corresponding software and control

system. The interaction of these components and Trumpf's extensive application knowledge accelerates the production of the battery cells and reduces waste. The lasers also ensure that the production costs of batteries are kept in check, thereby further establishing electromobility. Today, Asian battery producers sometimes order lasers from Trumpf in packs of hundreds. The high-tech company has accompanied the Asian battery manufacturers from the very beginning and built up extensive application knowledge. Trumpf now works with all major battery manufacturers worldwide.

In addition to the disk laser, the developers in Schramberg played a key role in developing so-called ultrashort-pulse laser technology and bringing it to industrial maturity. This technology can be used to efficiently process hard materials such as glass or sapphire, as well as solar cells. Trumpf, together with representatives of the Bosch technology group and the University of Jena, received the prestigious German Future Prize in 2013 from the German President for the industrialization of ultrashort-pulse laser technology.

Today, the market for ultrashort-pulse lasers offers high growth potential for Trumpf. After all, short-pulse lasers have unique capabilities and industry uses them for numerous applications. As their name implies, they work with short laser pulses that deliver high pulse energies. Components can be cleaned with short-pulse lasers or paint removed from metals, i.e., secondary material ablation. With a correspondingly high energy input, short-pulse lasers can also process the component itself, for example by structuring it. These appli-

cations are possible with one and the same device.

E-mobility is one of many fields of application for short-pulse lasers: welding the copper pins of electric motors, called hairpins, is particularly challenging for example because the coating of plastic paint must first be removed. This is where short-pulse laser technology comes in: the laser pulses strike the surface of the workpiece and vaporize the coating. Since copper is a particularly sensitive material, this only works with the precise energy input of such lasers and the plastic coating can be removed from the hairpins without machining the copper itself.

In order to meet the high demand for laser technology made in Schramberg, Trumpf has invested more than 80 million euros in recent years in new development as well as a clean room and production space at its location in the Black Forest. Another groundbreaking acquisition was that of the British company SPI Laser about twenty years ago. The wholly-owned subsidiary of Trumpf quickly established itself within the group as an expert in the development and production of fiber lasers. As a result, Trumpf added fiber lasers for industrial applications to its portfolio. The high-tech company's fiber lasers are considered workhorses and are suitable for a whole range of processing solutions, from laser cutting and laser welding to additive manufacturing.

Trumpf brings its mechanical engineering expertise to laser technology

In the mid-1980s, Trumpf achieved several innovations closely linked to laser technology. First, in 1983, the company

Company

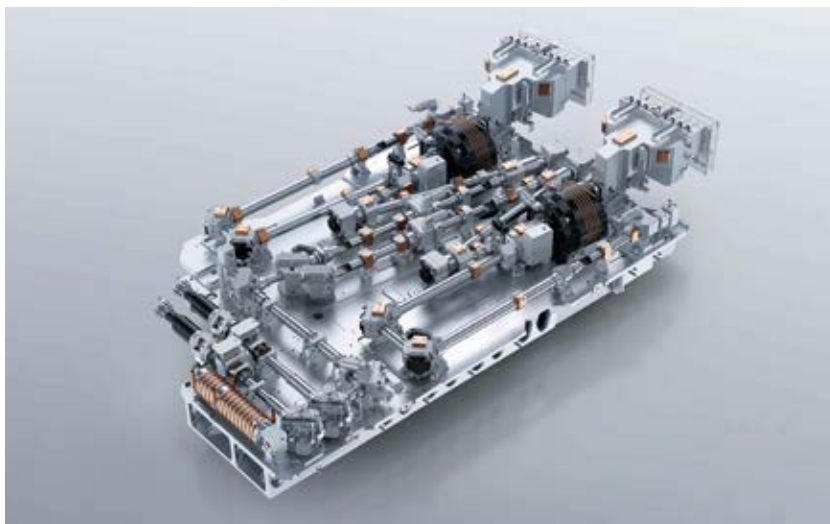
TRUMPF

The high-tech company, founded in 1923 as a mechanical workshop, offers production solutions in the machine tool and laser sectors. It is driving digital connectivity in manufacturing industry through consulting, platform and software products. TRUMPF is the world technological and market leader for machine tools used in flexible sheet metal processing, and also for industrial lasers.

www.trumpf.com

Meet us at Laser World of Photonics, Hall A3, Booth 341

Optics setup of a TruDisk laser. Multiple laser outputs make it possible to use the laser light on multiple laser systems via pluggable laser light cables without compromising power and beam quality. Disk lasers from Trumpf are used on a large scale by the automotive industry, for example.



unveiled its first laser-only sheet metal cutting machine, the Trumatic L 2000 model. This machine still closely resembled its conventional predecessors, and not only because of its classic C-shape. The cut was still made by moving the sheet under the fixed cutting edge, which was now no longer a nibbling tool but a laser head. The transition to laser cutting, however, made it possible to completely rethink the design of stationary sheet metal cutting machines. In particular, there was now the possibility, in a reversal of the previous approach, to move a mobile laser head over a stationary sheet – standard nowadays.

Trumpf management became aware that the French company Limoges Précision was already producing such a laser flatbed machine with ‘flying optics’. Trumpf therefore initially considered taking over the French company, which was in economic difficulties, but then decided to promise the company only the purchase of a certain quantity of machines – without the lasers – thereby stabilizing its economic situation for the time being. Trumpf equipped the machines imported from France with its own CO₂ lasers and added them to its product range in 1987 as the Trumatic L 3000. In the same year, Trumpf added its own design, the Trumatic L 3003.

The fact that Trumpf always thinks beyond the beam source and brings its mechanical engineering expertise to laser technology is evident today, for example in laser systems for medical technology. A major trend in the medical technology industry is the automation of production, which is particularly evident in the manufacture of high-risk products such as pacemakers. Medical technology manufacturers need standard machines that can be automated so that they can very easily combine Trumpf’s laser systems with cobots in their production. These ‘collaborative robots’, which can work together with humans without a protective enclosure, load and unload the laser systems with components. Monotonous and physically demanding movements are thus eliminated for the machine operators.

Trumpf lasers continue to open up new fields of application

Laser systems for medical technology are just one example of how laser technology from Trumpf improves new technologies today, or makes them possible in the first place. Much know-how is based on the experience the company gained many years ago with welding systems for pacemakers. Trumpf is constantly transferring this domain know-

how to new applications: in aerospace, for example, it is evident that there is no way around the laser. Laser technology is already making a decisive contribution to enabling people to use space for their own benefit in the future. For example, the welding work on a rocket’s fuel tank must be absolutely perfect and even the smallest error and the tiniest hairline crack would lead to disaster. To ensure that the tanks do not lose even the tiniest drop of fuel, space companies rely on lasers from the high-tech company. They use them to weld the rocket tanks together so precisely that they can withstand even the most extreme conditions during rocket launch. These examples show that Trumpf continues to do everything it can to stay ahead of the technological curve – as it has done so many times in its history.

TRUMPF SE + Co. KG

Gabriel Pankow
spokesperson laser technology
Johann-Maus-Straße 2
71254 Ditzingen, Germany
phone: +49 7156 303-31559
e-mail: gabriel.pankow@trumpf.com
Web: www.trumpf.com
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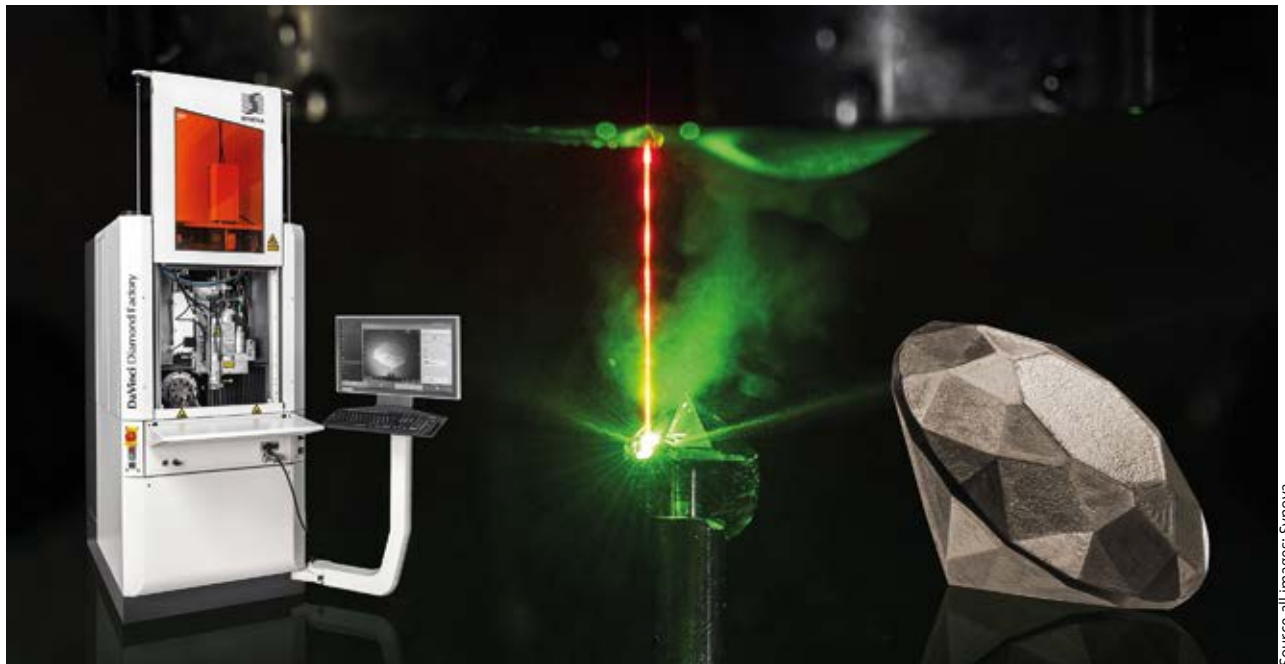


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Silver jubilee for the Laser MicroJet

Three awards for the technology kicked off the success of start-up company Synova in 1997



Source all images: Synova

Combining light and water created a hybrid method of laser machining superior to other technologies, trade-marked as Laser MicroJet. The water cools the cutting zone so that hard and brittle materials can be machined without any thermal damage.

Synova's history begins when Bernold Richerzhagen, after obtaining his master's degree in mechanical engineering from RWTH University Aachen in 1989, applied for a position in a research project at the EPFL's Applied Optics Laboratory to develop a laser-based dental tool for the removal of caries. His invention was based on the fusion of laser and water to drill tooth enamel. The laser beam was guided by total reflection within a fine water jet in the manner of an optical fiber. The laser provided the heat for ablation while the water cooled the material. This water jet-guided laser offered the advantage of a parallel cylindrical laser beam without any beam divergence that is inherent in other laser processes.

After four years of extensive trials, Richerzhagen succeeded in coupling a high-power laser beam in a hair-thin water jet. Richerzhagen obtained his doctorate in 1994. That same year and in

the following years he was awarded patents for his water jet-guided laser beam process by the German and European patent offices.

Early years

During twelve months of post-doctorate employment at the EPFL, Richerzhagen built a first functional model to find the best operating parameters as well as to convince potential industrial partners about his invention. Richerzhagen rented a facility at the EPFL's Scientific Park with the goal of commercializing his invention. He worked on developing his first prototype, named 'Machine 000' until mid-1997. By the time he established Synova in 1997, the company had already received three awards for the new technology, later trademarked as Laser MicroJet (LMJ).

The first machine served as a laboratory tool to develop new applications as well as a machine for demonstration

▲ DaVinci system for shaping diamonds

purposes to win customers. By now, the three-member team consisted primarily of engineers engaged in R&D and customer application testing. Although many customer samples were cut on the machine, there were very few orders. Looking back, it was logical because it was a new technology in a new product from a new company trying to enter an old and traditional industry – the world of machine tools. It was only in August 1999 that Synova shipped machine '001', a JPS 600, to American Dicing Inc., a job shop in Liverpool, New York, USA. This resulted in the later introduction of the Laser Dicing System (LDS) for the electronics and semiconductor industry to cut chips from wafers.

By 2001 the number of employees had grown to fifteen and a new market opened up when Synova launched

the LCS 300 Laser Cutting System. The 3-axis LCS 300 (with a working table size of 300×300 mm) was suited to a variety of precision machining applications. A milestone in the company's history took place when machine '012', the first LCS 300, was shipped in August 2001 to a job shop in Germany. The LCS 300 would become the company's workhorse. Most of the 13 LCS 300 systems shipped in 2002 were to customers in Germany, Japan, South Korea, Taiwan and USA. In 2003, the company moved from the Scientific Park's incubation center to a building located just across the EPFL campus. In psychological terms, the shift heralded a major change. In a symbolic way, the umbilical cord with the EPFL was cut and Synova was now on its own.

Laser Microjet for semiconductors

Starting in 2003, Synova supplied several Laser Edge-Grinding System ('LGS') machines to the European semiconductor manufacturer Infineon. These systems were specifically designed for the edge grinding of thin semiconductor wafers. In the same year, Synova launched the first Laser Stencil System (LSS). The first 3-axis LSS 800 systems, with a worktable size of 800×600 mm, were shipped in 2004 to two customers in South Korea. One customer operated a stencil job shop; the other customer used the LSS 800 to cut OLED masks. These two applications highlighted the important role that the LSS 800 (later LCS 800) would play in the semiconductor industry. The LMJ technology, combining a laser with a water jet, was the ideal solution

for machining silicon stencils without any heat affected zone.

In addition to the LGS system, Synova also developed the LDS system for wafer dicing and scribing applications. This dicing technology proved superior to the traditional blade dicing machines which sawed semiconductor wafers into individual chips. LMJ technology allows precise ablation of semiconductor materials ranging from silicon, gallium arsenide to silicon carbide. The water jet-guided laser guarantees a cleanly cut surface with no chipping, microcracks, burrs or depositions. There is no damage to the chips due to any heat-affected zone (HAZ). The process also has a high-throughput capability, especially for thin wafers.

The pioneering LGS and LDS systems introduced laser cutting to the semiconductor industry. In later years, Synova supplied such systems to semiconductor manufacturers in Japan and Taiwan. Samsung Electronics of South Korea even integrated the LGS system into its production line for electronic chips by introducing robots to handle wafers. One of the biggest customers is a large semiconductor equipment manufacturer who uses LMJ technology to cut silicon consumables used in etching machines. This customer has purchased 25 systems. Synova has been continually upgrading its LCS 800 systems to better serve the semiconductor industry.

Growth and crisis

Richerzhagen was a finalist in Ernst & Young's 'Entrepreneur of the Year' award in 2004 in recognition of his achievements. Frost & Sullivan awarded Syn-



Bernold Richerzhagen, founder and CEO of Synova

ova its prestigious European Award for Technology Innovation in 2005.

Although Synova was still a small enterprise with just thirty employees, Richerzhagen already had a global vision for the company. In the early years, the bulk of Synova's business came from the Far East and the US. In 2006, the company set up subsidiaries in Japan, South Korea and the US which included micromachining centers (MMCs) for customer application tests and job work. Aware of the threats from new technology disruptors, Synova entered into partnerships with various research institutes, including the Fraunhofer Institutes for Laser Technology (ILT) and Production Technology (IPT), to adapt the LMJ process for new appli-

Company

Synova

Synova SA, headquartered in Duillier, Switzerland, develops and manufactures advanced laser cutting systems that incorporate its proprietary water jet guided laser technology (Laser MicroJet) in a true industrial CNC platform. Customers benefit from significant yield and improved cutting quality as well as enhanced capabilities for precision machining a wide range of materials. The company has supplied over 400 machines designed for applications such as drilling coolant holes in turbine blades, faceting rough diamond stones and processing semiconductor materials.

www.synova.ch



Synova headquarters in Duillier, Switzerland



Synova's assembly hall

cations. The company also cooperated with industry players such as Carl Zeiss on strategic projects to further optronics technology. It also collaborated with the University of Basle in the field of bio-medical engineering and the University of Nottingham in advanced research on hybrid machining.

Meanwhile sales were booming: the company shipped a record 26 systems in 2007. Most were for new applications for the patented LMJ technology ranging from the laser doping of photovoltaic cells to the cutting of stents and drilling of fuel nozzles.

Also in 2007, Synova launched the LMJ Integration Package (LMJ-iP) for sale to system integrators. This kit, comprising the core components (optical head, laser and water pump), enables

users to integrate LMJ technology into their own production systems. The first kits were sold to Schott Solar for integration into systems to cut solar cell wafers.

The 2008 financial crisis that hit the global economy also affected Synova's operations. Shipments were halved and, despite a cash flow crunch, the company managed to retain its sixty or so employees, most employed either in R&D or application engineering. There was a slight recovery in 2009 when shipments increased.

Laser Microjet for cutting diamonds

Fortunately, a new market opened up in 2010. After years of trials, Richerzhagen's team finally found the right laser parameters to cut diamond stones. Synova supplied its first LMJ DCS (Diamond Cutting System) 300 to Laurelon Diamonds Belgium BV, which is part of the Tiffany group, in 2011. LMJ technology with its water jet reduced the risk of stones with air bubbles or inclusions being damaged. Synova's 'wet' laser also had many other advantages over the widely used dry lasers. In contrast to conventional lasers where the focused laser beam has a limited working distance of just a few millimeters, the water jet guided laser cuts with a cylindrical beam with a cutting depth that extends up to centimeters.

Synova's LMJ technology has now become the industry standard for diamond cutting with more than eighty DCS systems in operation worldwide. The DCS 50 with a smaller footprint and 5-axis capability, was launched in 2014 – a versatile machine for the precision micromachining of small components.

Laser Microjet for jet engine parts

Synova had meanwhile extended its business model to include technology licensing partnerships. In 2014 Synova partnered with Makino Milling Machine (Tokyo) to integrate LMJ technology into two metal cutting systems: the 3-axis MCS 300 and the 5-axis MCS 500. This partnership became a three-way collaboration between GE Aviation, Makino and Synova. GE had developed a ceramic matrix composite (CMC) to withstand the high temperatures in jet engines. This extremely hard material was difficult to machine: conventional machining and grinding on CMC shrouds took hours. By comparison, the LMJ-equipped MCS 500 drilled and cut the shrouds in a few minutes without cracks and with extremely few changes in the ceramic structure. GE Aviation integrated the MCS 500 into its fully robotized production line to machine CMC turbine components. LMJ technology has changed the way how engine components will be machined in future.

Laser Microjet for precision machining

On 12 December 2016, Synova moved its international headquarters from Ecublens to larger premises in a modern building in Duillier. The availability of extra space was a boon for all key functions: R&D had its own space for prototype machines; application engineering got a larger bay in the production workshop; production had space allocated for a second hall.

In September 2018, Synova launched the 5-axis LCS 305 for machining large components such as turbine blades and



Final test of the DCS 50

milling cutters. Incorporating state-of-the-art design components and technologies, the LCS 305 is the most accurate laser machine in its class. The machine is particularly suited to the machining of ceramic-matrix components used in aircraft engines or milling cutter PCD inserts.

Sensing the need for a more versatile machine for high precision machining and to integrate all the sensors that Synova had developed over the past years, the LCS 303 replaced the successful LCS 300 that was built more than 150 times. It is equipped with linear motor drives and a rotary axis to position the workpiece at different angles, which is ideal for the slicing of CVD diamond cubes. Launched in 2020, the first system was shipped to Element 6, a De Beers subsidiary specializing in lab-grown diamond products.

Laser Microjet for diamond shaping

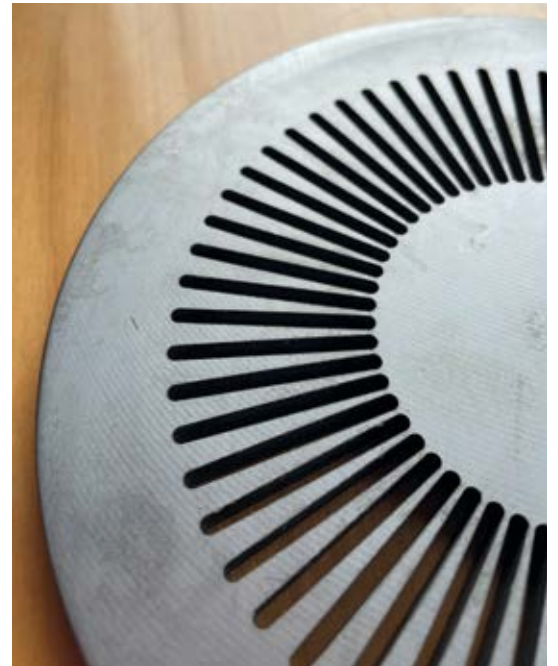
In November 2020 Synova launched the DaVinci Diamond Factory, a system that transforms rough diamonds into brilliant cut diamonds with up to 57 facets in a single operation, reducing throughput time from weeks to a few hours. It polishes a 57-facet round brilliant in a different way, first shaping the facets on the pavilion. This is where the laser beam can cut off large diamond chips that can be used for smaller gems. After

shaping all the facets, the spindle rotates 90 degrees so that the laser beam can do the girdle bruting. Unlike in the manual procedure, this is the last operation. Synova shipped the first DaVinci machine in September 2021 and, by the end of that year, the group counted 120 employees with 400 LMJ systems sold worldwide.

Expansion and future vision

With a two-year order backlog, Synova was experiencing a production bottleneck. Although construction of an 800 m² assembly hall in Duillier has been completed, there was a need to urgently build up additional production capacity. A plant in Rottweil, Southwest Germany, belonging to Mikron Germany was available for use. Synova took over this plant in June 2021, expanding its manufacturing capacity. In addition to assembling LMJ systems, this facility includes a micromachining center (MMC) with a showroom.

The company celebrated its 25th anniversary in 2022 with 150 employees in the group in November 2022, having set its vision for the future on building energy-efficient machines in an environment with a minimal carbon footprint. It is now developing a system for the online monitoring of machine performance in the field to prevent machine failures. Such data, combined with AI, will enable the real time detection of extreme machine conditions and fore-



Slotted silicon disk

casting of critical spares requirements, such as for laser diodes.

*

Text: Nitin Shankar, Ecublens, Switzerland, e-mail: nitin@vtx.ch

Synova S.A.

Route de Genolier 13
1266 Duillier (Nyon)
Switzerland
phone: +41 21 552 2600
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Holographic recordings without compromise

Tunable lasers help streamline the fabrication of holographic optical elements

Stefan Trotzky & Niklas Waasem



Source: Kodesignphoto / Shutterstock

Widely tunable continuous-wave optical parametric oscillator (OPO) systems help meet the demands on holographic optical elements (HOEs) for many use cases, including head-up displays and augmented reality devices. The wide tuning range allows for direct adjustment of the replay wavelength with little to no need for modification of the holographic recording geometry. HOEs fabricated using these OPO systems in conjunction with advanced photopolymer materials offer precisely controlled replay properties and exceptional diffraction efficiency.

Holographic optical elements (HOEs) are versatile alternatives and complements to conventional refractive and reflective optics. With few exceptions, the manufacturing of HOEs based on holographic recording requires monochromatic light with a long coherence length and narrow linewidth, typically provided by lasers operating in a single longitudinal mode. The wavelength of the recording light is a key process parameter as it directly affects the spectral behavior and selectivity of the HOE at replay. Widely tunable continuous-wave optical parametric oscillator devices are becoming increasingly

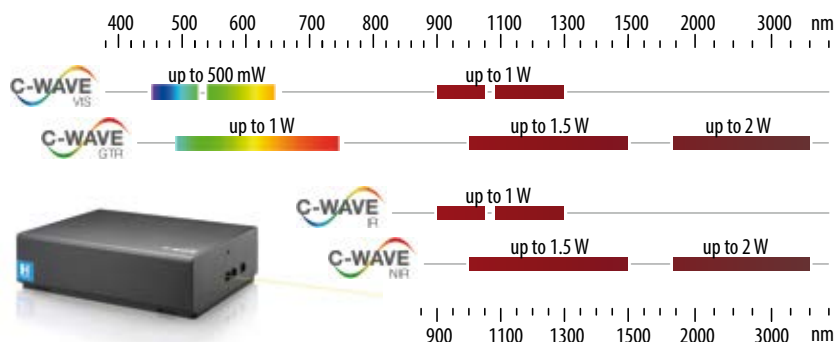
popular in applied holography, offering unparalleled wavelength coverage in the visible and near-infrared (NIR) spectral range in a single device with coherence and stability properties that match holography's stringent requirements.

The OPO's wide tuning range translates into equally wide ranges of HOE replay wavelengths with little or no adjustment of the holographic recording geometry. This enables the drastic simplification of recording tools and straightforward adjustment of exposure recipes to compensate for any post-processing shifts. The tunability of the OPO system's output wavelength

is a crucial feature, enabling the use of highly efficient scanned-beam exposure approaches. This is demonstrated using a single recording geometry to produce an array of slant volume holographic gratings (VHG) whose notch spectral band centers were defined by adjusting only the recording wavelength supplied by the OPO systems. Importantly, most of these recording wavelengths did not correspond to commonly available laser wavelengths – they were only achievable thanks to the free tunability of the OPO sources.

Captured in a state-of-the-art photopolymer material, the holographic

Fig. 1 Wavelength coverage for the C-Wave VIS and C-Wave GTR OPO platforms. A combination of the two platforms provides gap-free tuning from 450 to 765 nm, covering the spectral region suitable for holographic exposures of industrial photopolymer films. The direct OPO output at NIR wavelengths of 900 to 3,500 nm is also accessible for metrology and alternative applications.



filters themselves exhibit anomalous reflection-like behavior with high diffraction efficiency (DE) giving optical densities up to 4, as well as linear angle tuning around normal incidence. Collectively, this array of filters covers the full visible spectrum. The capability presented here is straightforwardly extended to more complex VHGs such as HOEs with optical power, wavelength-multiplexed waveguide couplers, and free-space holographic image combiners.

HOEs and VHGs

HOEs are an unconventional category of optics that implement optical function through conversion of an input electromagnetic wave to an output whose local phase and amplitude relative to the input wave are defined by the hologram. The local relation between input and output waves is described by the diffraction caused by the hologram's physical structure. Some simple examples are holographic diffraction gratings, holographic notch filters (HNFs), and holographic diffusers. The ability to redirect incident light with an HOE gives rise to waveguide-coupling elements where the diffracted wave propagates inside the underlying medium by

means of total internal reflection. Spatially varying HOEs can produce optical power, transforming lens-like behavior into a small volume, with obvious benefits for the miniaturization and integration of image capture and display devices. Hereby, the implementation of free-form aberrations can be used, for example, to compensate higher-order aberrations in a combined optical system.

VHGs are realizations of HOEs that, unlike surface-relief gratings, implement the hologram in a volume of material by means of a modulation of the material's index of refraction (phase VHGs). A typical recording process for VHGs uses two or more beams of coherent light that are overlapped to interfere inside a photosensitive medium, creating dark and bright regions. Common recording media are photopolymers, where photopolymerization in the bright regions of the interference pattern combined with diffusion of monomers from the dark to the bright regions materializes the hologram [1]. State-of-the-art photopolymers achieve a relative refractive-index modulation (RIM) amplitude on the order of 4 %, with continuous improvement towards higher amplitudes ongoing [2]. The currently achiev-

able refractive-index amplitudes already offer high DEs well exceeding 99.9 % – not considering Fresnel losses – for films of only approximately 10 mm in thickness. In addition, the available RIM may be shared between VHGs with different optical functions through multiplexing. The bare photopolymer recording process is enhanced and further functionalized if a liquid crystal component is added to form a holographic polymer-dispersed liquid-crystal [3], that has the liquid-crystal phase separate from the photopolymer phase during the recording process to realize very high RIM and actively switchable HOEs.

A VHG's diffraction is selective in both wavelength and direction of the incident light. For reflection VHGs (diffraction occurs towards the same side of the film as the incident light), the DE for incident light with wavelength λ_{rep} is maximized at the Bragg condition for first-order diffraction

$$\lambda_{\text{rep}} / n(\lambda_{\text{rep}}) = 2\Lambda \cos(\theta), \quad (1)$$

where $n(\lambda_{\text{rep}})$ is the average refractive index of the hologram's medium at the incident light's wavelength, Λ is the spatial period of the RIM, and θ is the relative angle between the wave vector of the incident light in medium. The grating

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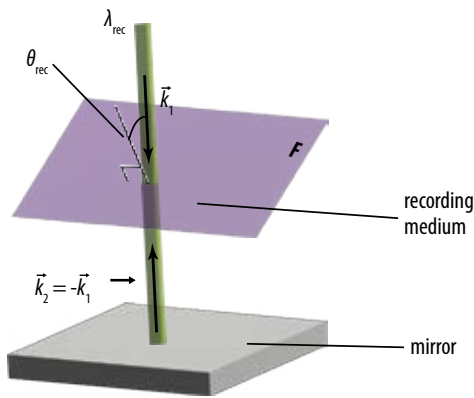


Fig. 2 Illustration of the recording geometry: the collimated beam from the OPO source with wavelength λ_{rec} is scanned over a flat mirror that retro-reflects the beam. The recording substrate is placed between the laser beam source and mirror with a finite tilt angle θ_{rec} .

vector $\vec{G}$ is defined to be perpendicular to the grating planes inside the holographic medium and has a magnitude of $|\vec{G}| = 2\pi/\Lambda$. The direction and magnitude of $\vec{G}$ are primarily set by the holographic recording geometry and the recording wavelength. Shrinkage of the photopolymer during the recording process and subsequent curing steps, however, further modify $\vec{G}$. At the Bragg condition, the diffracted wave is constructed by reflection about the grating vector. While being defined inside the grating medium, Equation (1) is readily translated for light parameters in an adjacent medium (i.e., air) using Snell's law of refraction. The quantitative DE at the Bragg condition and away from it primarily depends on the thickness of the grating medium and the RIM amplitude of the grating. Transmission VHGs have a DE that is also centered around Equation (1). However, rediffraction of the diffracted light into the path of the originally incident light can reduce the DE at the Bragg condition, causing overmodulation.

Advantages of tunable lasers in VHG recordings

It is evident that the recording wavelength λ_{rec} is an important process parameter in the manufacturing of HOEs, directly connecting to the replay wavelength via the grating period of the VHG, Λ . Free and continuous tunability of λ_{rec} constitutes freedom to optimize the recording geometry for a desired replay geometry without the need to accommodate potential adjustments to achieve a target λ_{rep} . In cases where the recording and replay wavelengths are

both fixed by circumstances or design, the only available option to ensure successful replay is to tune the geometry of the recording. Especially for complex optical functions, this can prove difficult and, in some cases where $\lambda_{\text{rep}} < \lambda_{\text{rec}}$ even impossible. Finally, when VHGs with equivalent optical functions for different replay wavelengths are multiplexed into the same medium, free adjustment of λ_{rec} for the individual VHGs becomes the only viable option to achieve a set of target replay wavelengths without having to use multiple recording geometries. Examples of such multiplexed HOEs are red-green-blue (RGB) waveguide couplers or free-space combiners suitable for use in head-up or head-mounted augmented reality (AR) displays.

OPOs combine wide wavelength tunability with the long coherence lengths necessary for high-quality holographic recordings. Additionally, their output spectrum is intrinsically free from any incoherent background such as amplified spontaneous emission. Modern implementations achieve a high degree of stability at high output powers with active locking and automatic tuning that requires minimal manual effort from the operator. OPOs, unlike lasers, require coherent pump light for the parametric conversion process. The output wavelength is always longer than the pump wavelength. Practical implementations of OPO systems that emit visible light generally convert visible or NIR pump light into an NIR wavelength before converting the OPO output back to visible light via second harmonic generation (SHG). This avoids the need to find ultraviolet pump laser sources with sufficient power and stability for direct OPO conversion to visible wavelengths. The C-Wave OPO family from Hübner Photonics uses pump systems based on high-power fiber lasers to achieve Watt-level SHG output powers in the visible spectrum [4].

The C-Wave VIS/IR platform provides an SHG output covering 450 – 650 nm with a degeneracy gap around the pump wavelength at typically 525 – 540 nm. High conversion efficiencies for both the OPO and the SHG stages are obtained by means of resonant enhancement in actively stabilized bow-tie cavities, achieving typical SHG output powers of up to 500 mW – and at times higher – for a pump power of 5 W. The C-Wave GTR

platform complements the C-Wave VIS/IR platform by covering its degeneracy gap with an uninterrupted tuning range of 500 – 765 nm that also extends the accessible spectrum in the red region beyond 650 nm [5]. The SHG output for the C-Wave GTR platform is up to 1 W for a pump power of approximately 8 W. The combined tuning ranges of both OPO systems are well matched to the sensitivity of the state-of-the-art Bayfol HX photopolymers, including recently emerging IR sensitized variants [2].

Recording of uniform slant VHG filters

HNFs are among the simplest VHG components. In concept, they resemble dielectric interference filters, with alternating planes of high and low-index materials contributing to constructive backward diffraction for the angles and wavelengths that match the Bragg condition, as shown in Equation (1). However, as they are fabricated optically, HNFs have certain advantages in their manufacture (e.g., requiring no costly vacuum deposition processes) and much greater flexibility in optical function: whereas dielectric notch filters all diffract specularly (the angle of diffraction equals the angle of incidence), HNFs can be recorded such that the grating planes are not aligned with the surface normal of the component. These so-called slant gratings reflect anomalously. Here we demonstrate the benefits of holographic recording using tunable OPO laser sources by applying them to record slant HNFs. In commercialized form, these HNFs are available as the holoOPTIX SLANT filter family from Meta Materials Inc. ('Meta'). The concepts described with this illustrative example are readily extendable to other unconventional optical functions, including waveguide-coupling HOEs, off-axis free-space combiner HOEs for augmented or virtual reality, and color-multiplexed VHGs.

The target replay geometry for the HOEs presented here is the diffraction of light incident along the surface normal direction with high efficiency into a direction 45° off normal incidence outside the grating medium. This geometry effectively realizes anomalous reflection of light within the spectral band of high diffraction efficiency. We choose a recording geometry that differs from the target replay geometry (see Fig. 2): coherent laser light from the OPO is delivered

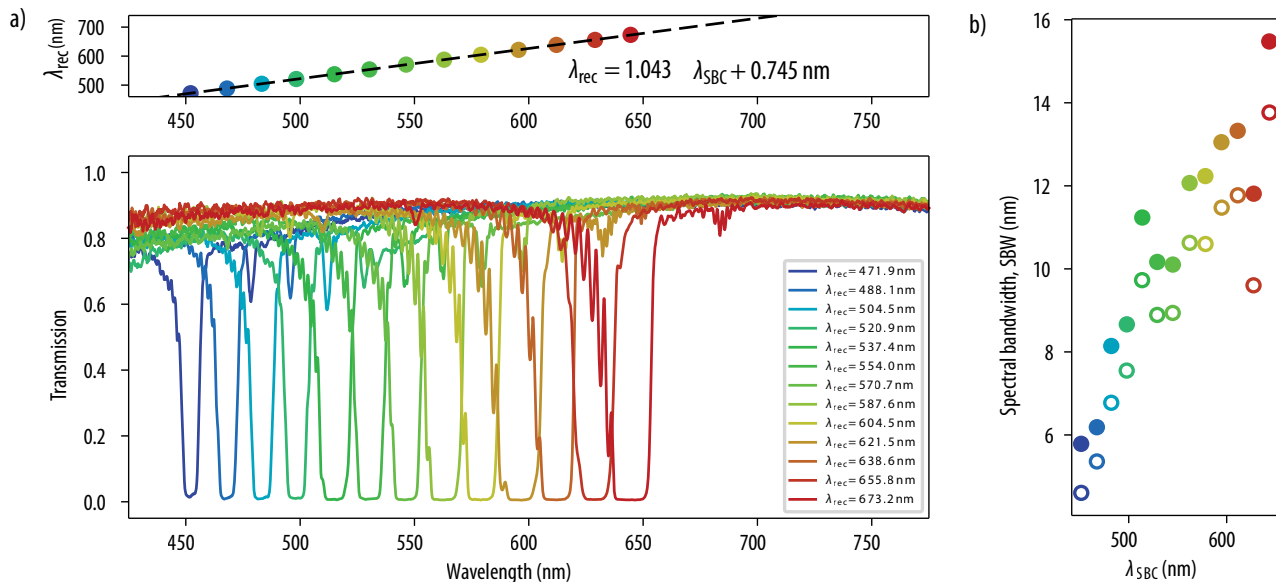


Fig. 3 (a) Transmission spectra for 13 slant VHGs recorded with different recording wavelengths λ_{rec} for light incident along the surface normal direction of the HOE. The light is s-polarized in the diffraction context. The recording wavelength is plotted in the top panel as a function of the measured λ_{SBC} together with a linear fit. The value of the slope combines the difference in recording and replay geometries, geometric shrinkage, and refractive-index change. (b) The spectral bandwidth at $T = 0.1$ as a function of λ_{SBC} for the 13 VHGs, obtained for s (closed symbols) and p-polarized (open symbols) light.

to a scan head, where it is collimated. The scan head moves the collimated beam over the target active area of the VHG. A static flat mirror retro-reflects the scanned beam to effectively form a pair of synchronously scanned counter-propagating beams. The resulting time-averaged interference pattern has a uniform orientation and fringe spacing. Our scanned-beam approach has the advantages that it offers high uniformity and is readily scalable to large active areas without the need to increase the power of the recording light.

The recording medium, Bayfol HX120 photopolymer film [6], is mounted between the scan head and the retro-reflecting mirror. It is tilted with respect to the mirror surface such that the interference pattern inside the medium records a VHG whose grating vector encloses a finite angle with the surface normal of the recording plate. The pre-shrinkage grating vector is $\vec{G}_0 = 2\vec{k}'_1$, where $\vec{k}'_1$ is the refracted wave vector of the incident light inside the recording medium. We calculate a tilt angle of $\theta_{\text{rec}} = 21^\circ 24'$ and $\lambda_{\text{rec}} = 548.2$ nm to achieve the target anomalous reflection angle $\theta_{\text{ARA}} = 45.0^\circ$ in the absence of any shrinkage. The target slant angle enclosed by the grating vector and the surface normal vector in this calculation is $13^\circ 58'$. Here we use an average refractive index of $n = 1.51$ (published for HX120) for the recording and replay scenarios, noting that the true refractive index depends on wavelength due

to dispersion. Starting from this initial estimate, we adjust θ_{rec} and λ_{rec} based on measurement feedback that includes all post-processing steps to achieve $\theta_{\text{ARA}} = 45.0^\circ$ with a replay wavelength of $\theta_{\text{SBC}} = 532$ nm, finding $\theta_{\text{rec}} = 22^\circ 24'$ and $\lambda_{\text{rec}} = 556$ nm.

Neither the initial estimate nor the final value of λ_{rec} correspond to common laser wavelengths, emphasizing the enabling role of the OPO source for this recording approach. We note that the target replay geometry could in principle be obtained using a common laser wavelength λ_{rec} , of, for example, 532 nm, with a finite relative angle between the two interfering beams. In such a scheme however, the angles of both beams would need to be adjusted to account for shrinkage and postprocessing shifts, while also ensuring overlap of both beams at the recording medium. Such a geometry-tuned approach would complicate the exposure setup compared to the simpler retroreflection geometry used here and would be incompatible with our scanning approach.

True advantages of a tunable laser source in practice

To demonstrate the potential of OPO-enabled recording-wavelength tuning, we produced a library of thirteen slant VHG filters, all using the recording geometry described above with a fixed θ_{rec} , by tuning only λ_{rec} between 470 and 670 nm. The irradiance and dosage of the exposure were optimized

for each recording wavelength to yield saturated recordings with minimal haze or spurious gratings.

Fig. 3a shows the transmission spectra $T(\lambda)$ of the thirteen different slant VHG filters covering spectral bands of high diffraction efficiency between 450 and 650 nm, where the low transmission in the respective stopband of each filter is synonymous with a high diffraction efficiency.

Conventional interference notch filters always blue-shift with angle detuning about normal incidence. Slant HNFs can be tuned towards the blue or red region depending on the direction in which the filter is tilted. By exploiting this property, the array of the thirteen filters shown here achieves full spectral coverage between 445 and 653 nm using tuning angles of $\pm 5^\circ$.

Outlook

In summary, we have presented recordings and measurement results for slant VHGs with effectively anomalous reflection within the diffraction band. The VHGs were produced with a scalable scanned-beam recording approach, enabled by the use of two widely tunable OPO sources that enable the recording of a set of VHG filters whose notches fully cover the visible spectrum without any changes to the exposure geometry being necessary. We have shown typical spectral data for the VHGs along with their unique and attractive angle-tuning characteristics.

The role of the OPO sources and their tunability during the initial adjustment of the exposure geometry and for compensation of shrinkage and deformation during exposure and postprocessing have been discussed. In a production context, this role is further expanded to adjustments of the VHG replay wavelength to meet customer-specified and application-specific targets. Additionally, the ability to produce VHGs in a single holographic mastering step as demonstrated here significantly reduces the complexity of the process flow compared to that of a master-copy process that necessarily includes the procurement and management of a master hologram. Moreover, direct holographic mastering allows much greater flexibility and adaptation of the recorded HOE – ultimately on a piece-by-piece basis. The free tuning of the recording wavelength in this approach is an indispensable capability for this approach.

While demonstrated here with a single exposure wavelength at a time, the same recording approach can be readily extended to multiplexed VHGs with a single holographic exposure using two or more tunable OPO sources. Such an exposure – scanned or static – enables efficient, on-target manufacturing of single-film waveguide couplers and free-space image combiners for full-color head-up or wearable displays for the AR market, for example. Other examples include RGB diffuser screens with tailored emission profiles and single-film color-combination filters for light-projection units. Meta's capabilities include the use of three Hübner Photonics C-Wave OPOs to independently control the wavelengths of RGB multiplexed recordings, offering full wavelength flexibility and optimization for complex HOE designs.

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Authors

Stefan Trotzky

joined Meta in 2017 and is currently a principal optical scientist in its photonics R&D division. He holds an MSc (diploma) degree in physics from the Carl von Ossietzky University Oldenburg, Germany, where he studied ultrafast photoluminescence in conjugated polymers. He has over ten years of experience as an academic research physicist and research assistant in quantum many-body physics, quantum optics, and analogue quantum simulation, working with ultracold atoms in Germany and Canada.



Niklas Waasem

is a regional sales manager and quantum application specialist at Hübner Photonics. He has a PhD in physics from the University of Freiburg, Germany, where he studied high-resolution spectroscopy. He has been working at Hübner Photonics for eight years and has specific experience in the development and sales of unique high-end tunable lasers that can be used in quantum, nanophotonics and holographic applications.



Stefan Trotzky, Meta Materials Inc., 60 Highfield Park Dr, Dartmouth, NS B3A 4R9, Canada; e-mail: stefan.trotzky@metamaterial.com, Web: <https://metamaterial.com> ■ Niklas Waasem, HÜBNER Photonics GmbH, Wilhelmine-Reichard-Str. 6, 34123 Kassel, Germany, e-mail: niklas.waasem@hubner-photonics.com, Web: <https://hubner-photonics.com>

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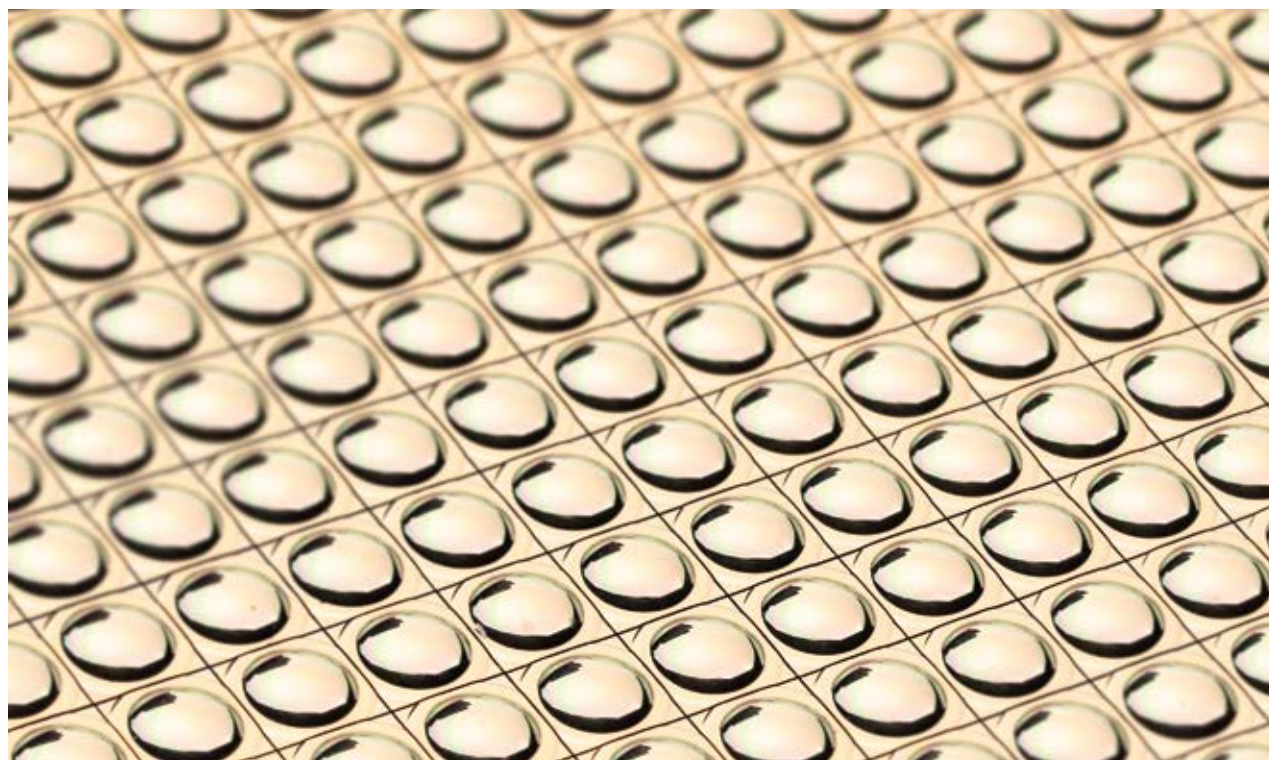
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Every breath you take

Laser absorption spectroscopy allows unprecedented focus on the air we breathe

Mark Naples



Source all images: Umicore

ESG. Three small letters perhaps, but they are having a huge impact on science, industry, and everyday life. In industries that operate in hazardous environments, such as oil and gas mining and refineries, those letters stand for much more than environmental, social, and governance policies. They represent a framework around which an entirely new operational structure must be built, changing every level of a business from the top down.

A foundation of this structure relies on mitigating the hazards posed both in the workplace and the broader environment. Interest in the quality of our air has intensified from both the public and lawmakers as the climate crisis continues to dominate the global agenda, and investor relationships are increasingly dependent on alignment with global net zero goals and ethical standards.

Data is the only thing that can chart our route across this uncertain terrain and into a more sustainable future. And it is impossible to acquire this data without the intelligent sensors required to collect it. By using sensors to inform hazard mitigation and other ESG policies, businesses can maximize safety,

minimize disruption and downtime, and protect people and business assets.

The climate risk disclosure rule is just one policy set to have an impact in the near future. Proposed by the globally influential US Securities and Exchange Commission (SEC), this rule would require public companies to provide more detailed reporting of emissions produced and any other environmental risks, as well as net zero plans. This has huge implications for everyone working at publicly-traded companies, from the executive level down – not least because the UK, EU, Japan, and other key markets are following suit, with an end goal of a standardized reporting system.

▲ Umicore has extensive experience in designing a wide range of complex and high performance infrared filters for many different wavelengths.

Sustainability is at the top of the agenda

Whatever form these legislative changes take, and no matter how broad or specific they might be, they will all share a common theme: improved transparency. And the sensing technology required to achieve this is no longer a pipe dream, nor is it only available for the most highly sensitive applications. It is more affordable and accessible than ever, enabling any company to monitor their industrial gas usage, emissions, or



Umicore is a global leader in the design and manufacture of precision IR filters. Widely used to detect the presence of noxious or flammable gases in the atmosphere, IR filters are a key component of preventative maintenance safety systems critical to the oil, gas, and energy sector.

even just the general air quality around the workplace.

It means industrial gas detection is a mature market and one which continues to expand as devices become cheaper at the compliance end of the market and smarter at the top end. Umicore Coating Services, one of the world's leading IR coating materials manufacturers, works with OEMs who are focused on functionality and cost for low-cost markets while also assisting in driving advances in connectivity, allowing end users to operate equipment in ways they have not before.

Laser absorption spectroscopy is the most powerful tool for detecting trace gases and unlocking this connected, sustainable future. It is widely used in the monitoring of atmospheric greenhouse gases, pollution, and respiration processes, including human breath analysis. The detection is based on light; specifically, how it is absorbed as it passes through a medium. And, as interest in

air quality has dramatically increased from a variety of stakeholders in recent years, sensor manufacturers are seeking out high-performance filters at competitive prices.

Thanks to a fast speed of response, fail-to-safety operation, and the ability to work in inert atmospheres, IR detection has fast become the go-to method of detection. From well heads and production sites to offshore platforms and refineries, filters can be the difference between life and death in extreme cases. However, more positively, they can also be used to drive operational excellence to new heights by making granular details about air quality and gas emissions more transparent.

The right wavelength

On a global scale, the world's focus is on reducing two damaging greenhouse gases (GHGs). Carbon dioxide (CO_2) and methane (CH_4) – CO_2 because it is by far the most prevalent GHG, and CH_4 because of the severe impact it has when first emitted into the atmosphere. GHGs are generated at almost every step in the production, delivery, processing, or refining of fossil fuels, but the most severe impact stems from fuel consumption.

Almost every industry has a part to play in cutting emissions – and the only way to do this is to identify where they can be cut. This means infrared (IR) sensors, as small as they are, have a vital role to play in our planet's future. IR gas detection works using emitters within the sensor to generate beams of IR light. This light passes through a sampling chamber containing a filter. The filter's role is to block out light of a

certain wavelength, meaning only the required wavelengths make it past the filter, where the light reaches a detector. This detector then measures the intensity (or attenuation) of the IR light, which can determine the precise concentration of gas that may be present. Due to the dependence of the absorbance on the wavenumber, different gas components can be distinguished using the absorption spectrum.

These filters can be made using a wide variety of substrates, for example silicon, germanium, or quartz. Whichever substrate is used, all have their benefits depending on the spectral requirements of the filter and the environment the sensor will be installed in. This ensures an adequate percentage of light can be allowed through the sensor with minimal interference – essential for detecting trace amounts of gases. Newer gas analyzer instruments use a laser diode mounted on a thermoelectric cooler to tune a laser's wavelength to the specific absorption wavelength of a particular molecule. They exploit their high-frequency resolution, which results in enhanced sensitivity – more significant levels of interaction between gas molecules and light in the order of parts per billion – and discrimination, as they are tuned to specific gas compounds. This eliminates the potential for false alarms, which is a serious issue with other gas detection technologies on the market.

Other benefits of these sensors include rapid response times and accurate results without the requirement for additional gases to operate. This technology has advanced to the point of detectors that continuously

Company

Umicore Coating Services

A subsidiary of the € 3.9 B, Belgian-owned material and technology company, Umicore Coating Services has amassed over thirty years of experience in the provision of ultra-low absorption laser coatings, as well as other types of coatings and filters for infrared systems. With more than 2,500 proven coating processes, its state-of-the-art facility in Dundee can repeatedly manufacture optical coatings with exceptional spectral and environmental performance.

<https://eom.umicore.com>

monitor combustible gases and vapors within the lower explosive limit and provide alarm indications. These can be deployed within oxygen-deficient or enriched areas, require little calibration, and are immune to sensor poison, contamination, or corrosion.

Streamlining businesses

With a Point IR gas detector, one objective is to produce a device that does not require constant recalibration. This gives maximum confidence in the operational performance of the detector and reduces the cost of ownership. Maximized system uptime and performance are key benefits of IR gas detection over catalytic bead-based detectors, which require frequent calibration to correct a perpetual loss of sensitivity throughout their operational life.

Other big factors in this device's success are its filters and optical component configurations. By comparison, many models use software to mask design inadequacy, and this can lead to performance issues under various weather conditions and the occurrence of false alarms. The development of advanced internal fault diagnostics and false alarm rejection algorithms ensures many modern-day products boast the highest level of operational integrity. The price and performance of devices are following a trajectory that is putting technology in the hands of those who most need it.

Identifying the threat

As part of a global effort to bring the world's industries to carbon neutrality in line with net zero goals, Umicore IR filters are increasingly deployed within

fixed, portable and personal gas detection solutions to help oil and gas customers monitor and reduce fugitive methane emissions. They move seamlessly from our state-of-the-art production facility in the UK and into a range of turnkey detection technologies that are helping customers to meet their ESG targets.

Early detection enables operators to address leaks and other identified risks, minimize other production losses, and maintain compliance with ever-evolving legislation. Non-dispersive infrared sensors that detect noxious, harmful, or corrosive gases in the atmosphere in the parts per billion remain a critical component when it comes to ensuring the health and wellbeing of industrial workers, as well as being integral to a robust preventive maintenance system to ensure that a site runs at optimal performance whilst complying with all health-and-safety policies.

Each particle matters – a small step in a global fight against climate change. It is a fight that we cannot win until we know our enemy – and infrared spec-



Umicore's GASIR chalcogenide glass is an ideal material for both high-performance infrared imaging systems and high-volume commercial applications.

troscopy is the tool that will identify that enemy.

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Author

Mark Naples, general manager at Umicore Coating Services and previously commercial manager, has almost two decades of experience working across the optics, sensing, and imaging industries. Well versed in planning and execution to bring disruptive technologies to market, Naples possesses significant business development experience in building robust supply chains and solution implementation at global brand companies.



Mark Naples, Umicore Coating Services Ltd, Kinnoull St, Dundee DD2 3ED, UK; phone: +44 1382 833022; e-mail: coatingservices@umicore.com; Web: eom.umicore.com/en/infrared-solutions, [in](https://www.linkedin.com/company/umicore) umicore, [t](https://twitter.com/UmicoreGroup) UmicoreGroup

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Plant manufacturer integrates laser measurement technology

Körber insists on quality in the details



Source all images: Körber Technologies

Production systems for the luxury food and tobacco industries are complex, achieve very high throughput rates and often run 24/7. In order to ensure the products' high quality, the Körber 'Technologies' division counts on seamless monitoring of the entire manufacturing process in the plant.

High expectations in quality assurance also apply to the laser-based perforation systems that the company integrates into its lines. Based on Körber's specifications, MKS developed a customized Ophir OEM sensor to measure the laser power, which can be integrated directly into the equipment. For maintenance tasks, the plant manufacturer also uses and recommends another Ophir OEM quad sensor to measure the position and power of the laser beam.

Sophisticated machines

In automated production plants, every process step must be implemented optimally. It is important to consider all contingencies when designing the system, to eliminate potential interference factors, and to continuously monitor the manufacturing quality at numerous points within the process. This is where the core competencies of the Körber technologies division, part of the international Körber Technology

Fig. 1 Körber is specialized in developing and producing customized systems for the luxury food industry. The complex production systems, including software and measuring equipment, are individually configured for customers.

Group, come to the fore: the company specializes in developing tailor-made systems – including software, measuring instruments and flavorings – for the luxury food and tobacco industry. In particular, their cigarette and filter

Companies

Körber Technologies

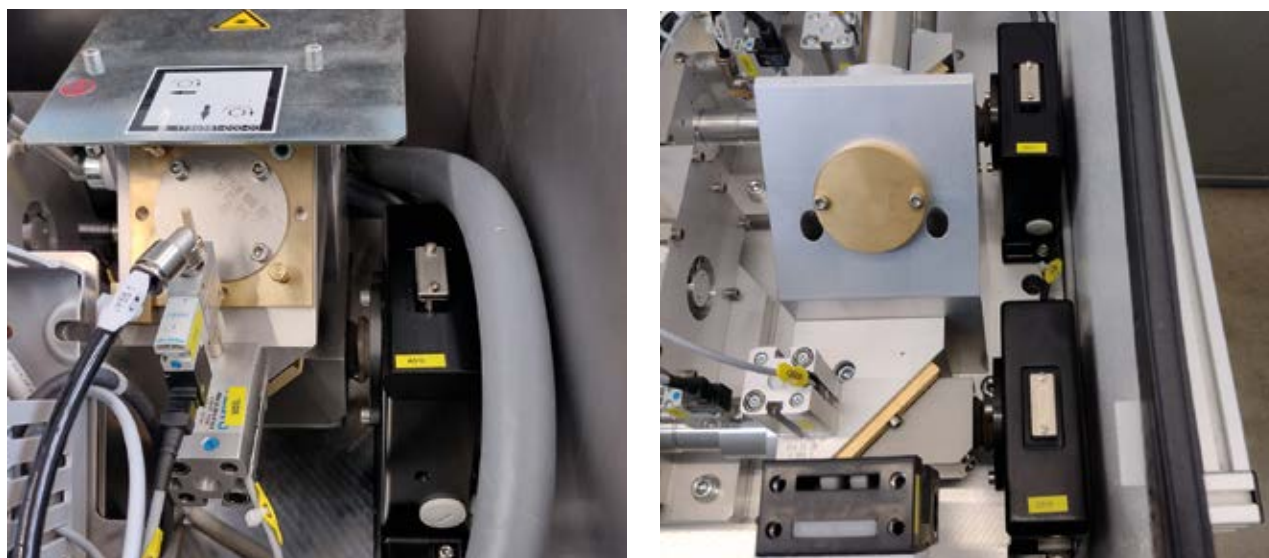
The Körber Business Area Technologies stands for cutting-edge technologies. These technologies enable you to transform your factory into a Factory of Excellence and to take productivity to a whole new level. This means higher output, higher quality, greater precision, higher speed, more flexibility, more automation, more digitization, greater reliability and better efficiency.

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MKS – Photonics Solutions Division

Spectra-Physics, Ophir and Newport are brands within the MKS Instruments Photonics Solutions Division. This division provides a full range of solutions including lasers for precision industrial and scientific research applications, laser and LED measurement, beam profiling, precision motion control, optical tables and vibration isolation systems, photonics instruments, temperature sensing, opto-mechanical components and optical elements.

www.mks.com



Figs. 2 / 3 The Ophir power sensor (on the right in the photos) was individually combined with the control electronics for Körber and integrated in a special housing as an OEM sensor. This allows the sensor technology to be installed directly in the respective Körber production line, as shown in the two examples above (on the left LASERPORT 1000 with two beam sources and two sensors; on the right the LASER 250S with one beam source).

machines set standards worldwide. The company's solutions also include the Laserport laser-based perforation system, which uses a CO₂ laser to perforate cigarette filters at lightning speed. The developers integrated power gauges into the production plant to ensure the laser's functionality and therefore also the correct perforation of the filters.

Individualized development

It was already clear during the development of the first Laserport that one of the critical parameters to record was the laser power. Initially, the company used sensors that had been developed in-house for this purpose, but to ensure the quality and maintenance of the sensors over the long term, they decided instead to purchase the power sensors from specialized suppliers. MKS Instruments convincingly presented its Ophir sensors – these were modified into OEM sensors according to Körber's requirements. In particular, the spatial limitations within the machine had to be taken into account: the Ophir 150-UA-1-C-HUI OEM power sensors were precisely adapted to these dimensions and given a new housing, as were the Ophir 600-BB-34-OEM QUAD sensors that measure the laser position and power.

Regular power measurement

The pure power sensors are installed directly in the machines or, if desired, they can be retrofitted. They ensure that the pulsed CO₂ laser (100 to 500 watts) is working as specified and that the filters are perforated correctly. A beam splitter (99 % mirror) directs a

part of the laser beam onto the sensor and determines the average power. These readings are very quick and are displayed on a separate screen on the line. On a Körber system, it is possible to produce up to 20,000 cigarettes per minute; up to sixty long holes with a diameter or width of 1/10 mm are shot through each filter. Also, each cigarette is checked with regard to the degree of ventilation achieved. If too little air flows through the filter, those batches have to be rejected. Stefan Meißner, development engineer at Körber Technologies, explains: "We have full confidence in the Ophir sensors, as they work reliably and are very robust. They immediately provide our customers with advance notice if the laser power starts to drop, which gives them time to prevent wastage."

Flexible laser maintenance

In addition to the built-in verification of the laser beam at the processing level, the Ophir 600-BB-34-OEM QUAD sensors can be used to check the overall settings of the laser unit. Maintenance is generally carried out every six months, but at a minimum it is done once a year outside production hours. It can be performed either by the Körber service team or, after appropriate training, by the users themselves. During maintenance, the processing optics that focus the laser beam are removed and cleaned according to the manufacturer's instructions. On this occasion, the positioning of the laser source and its output power are checked and adjusted using the Ophir sensor. Should there be any abnormalities in the production pro-

cess with regard to the degree of filter ventilation, users can also quickly and easily test whether the laser unit is out of adjustment, for example.

Positive cooperation

The Körber Business Area Technologies (formerly Hauni) also uses the Ophir laser sensors in its own laboratory for research and development. So far, any challenges that have arisen were always addressed and a solution found, thanks to the close cooperation between the two companies. According to Stefan Meissner, the development horizon already played an important role in the procurement process, and now that foresight is paying off: "Our systems are known for having a long service life. Some of our customers ask for spare parts 25 years after purchasing them! In MKS, we have found a partner who will still be able to offer us the right Ophir sensor – even many years later."

*

Text: Dagmar Ecker, MBE, Claro PR.

MKS | Ophir

Roland Heinze
Guerickeweg 7
64291 Darmstadt, Germany
phone: +49 6151 708-0
e-mail: roland.heinze@mksinst.com

Körber Technologies

Stefan Meissner
Kurt-A.-Körber-Chaussee 8-32
21033 Hamburg, Germany
phone: +49 40 72 50-4556
e-mail: stefan.meissner@koerber.com

Precision marking of glass with excimer lasers

Laser-generated microstructures and material modifications serve as colored marks

Jörg Meinertz, Lukas Janos Richter, Clemens M. Beckmann, and Jürgen Ihlemann



Source all images: Institute for Nanophotonics

Current laser marking of glass by CO₂ lasers is mainly based on the generation of cracks or melt pits. Improved quality in the form of damage free, high contrast, and high resolution marking is possible by using deep ultraviolet emitting excimer lasers. Various methods of ablative microstructure formation or nanoparticle implantation are available to achieve colored marks on glass formed by opalescence, chemical modification, or plasmonic absorption.

Laser marking in general is a well-established technology. Metals, plastics, ceramics, and composite materials are routinely marked for decoration, branding, identification, traceability, and anti-counterfeit purposes. However, precise, high-resolution laser marking of glass materials is still a challenging task. As glass is transparent in the visible and the near UV spectral ranges, IR or deep-UV lasers have to be used to process it because absorption of the laser radiation is a prerequisite for initiating a modification. Marks can be made by adding material that is somehow burnt in by the laser, or the laser melts or ablates material in order to create visible pits or cracks on or near the surface. CO₂ lasers with their emission at 10.6 μm are

routinely used for such processes. However, as the achievable resolution scales with the wavelength, IR light does not provide the spatial resolution required for μm and sub- μm patterning. Femtosecond lasers operating in the near IR or visible ranges can provide better resolution, but in this case the absorption process is based on multiphoton absorption, posing stringent conditions on focusing and focus control, which does not provide high resolution and high speed at the same time. Hence, it is preferable to use lasers emitting in the deep UV for the fast and high-resolution marking of glass. UV lasers offer high spatial resolution and sufficiently high pulse energy to provide glass modification on a large area at high speed. The

▲ **Fig. 1** IFNANO logo (diffractive mark) – the two different color gradients originate from different structure periods of the grating pattern.

ArF-excimer laser emitting at 193 nm is optimally suited to obtain controlled, crack-free patterns with high resolution. Some glass marking applications of this excimer laser are already well established, e.g. the ‘semi-visible’ marking of spectacle lenses with the company logo of the manufacturer. But excimer lasers can effect much more than creating such inconspicuous labels on glass. We demonstrate here three processes creating high contrast, tunable marks on glass on the basis of excimer laser irradiation.

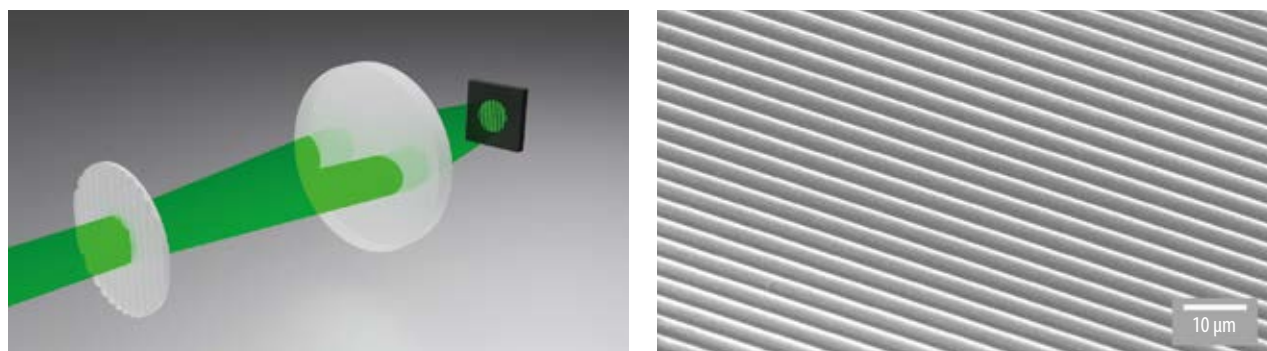


Fig. 2 Diffractive marking on soda lime glass, (a) mask projection utilizing the plusminus first diffraction orders of a phase mask for two beam interference, (b) SEM of line pattern

Diffractive marking

With diffractive marking, a laser interference pattern is created on the glass work piece which, at sufficiently high laser fluence and interference contrast, leads to a periodic ablation pattern [1]. What remains is a regular microrelief which, when illuminated, produces brilliant spectral colors similar to what is known from holographic security features on banknotes (Fig. 1).

To generate the interference pattern, the laser beam is split – preferably by a diffractive beam splitter (phase mask) – into two or more beams that are then recombined by a lens or other optical system. High contrast is obtained, even with the limited spatial coherence of an excimer laser, by arranging the components so that the phase mask is imaged by the combining lens on the surface of the work piece (Fig. 2a). Fused silica phase masks having periodic patterns with a line pitch of typically a few tens of μm [2] are projected (demagnified) to structures of a few μm pitch on the work piece. With a modulation depth of a few hundreds of nanometers, such patterns exhibit good visibility. Fig. 2b shows a periodic surface pattern on soda lime glass made by this method using 193-nm laser radiation. A square or circular aperture combined with the phase mask serves for pixel images on the work piece, each containing an inter-

ference grating. By moving the beam or the work piece, a pixel-based mark such as the logo depicted in Fig. 1 can be written on the glass object. If sub- μm patterns are desired, the image projection is best accomplished with a high-NA Schwarzschild objective.

Although one single laser pulse is sufficient to create a diffractive pattern on the irradiated area, the high fluences of $>1 \text{ J}/\text{cm}^2$ required for significant single pulse ablation increase the risk of inducing micro cracks. To avoid these cracks, the application of several pulses per position at moderate fluence is recommended. For the fabrication of large area marks, this constraint is considered in the following procedure: without a pixel mask, a much larger area is irradiated with each pulse. The glass workpiece is continuously moved perpendicular to the line pattern, and the movement and repetition frequency of the laser are synchronized with one another, so that the interference patterns of successive pulses overlap coherently. The intensity maxima of each pulse thereby superimpose with those of the previous one. The degree of overlap of successive spots determines the number of pulses applied at each position. Such multipulse, on-the-fly processing enables areas to be marked on a square centimeter scale within a few seconds as it is unnecessary to stop the motion.

Special imaging optics ensure improved homogeneity of the laser-generated microreliefs and also enable the geometry of the laser spot to be adapted to the given processing goal. In particular, extremely elongated laser spots of, for example, $10 \text{ mm} \times 0.5 \text{ mm}$ can be produced with which correspondingly large areas can be processed by scanning this ‘line beam’ across the surface. Markings with a predetermined outer contour can be generated by using contact or proximity masks. Finally, the method is also suitable for reliably marking moderately curved glass surfaces.

Black marking

Black marks are very attractive for visible or machine reading because of their high contrast. On glass, they can be generated by locally fusing in soot or black pigments with a CO_2 laser. In many cases, however, the introduction of foreign material into the glass is undesirable or not permitted, for example in medicine or pharmaceutical packaging. In such cases, it is possible to modify some glass types without adding additional material. For instance, the irradiation of TiO_2 -containing glass with an ArF

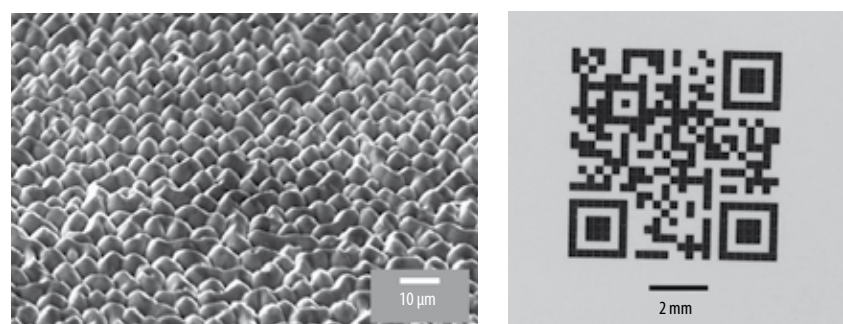


Fig. 3 Black mark on Schott SF11 glass, (a) SEM of humpy surface, (b) QR-code

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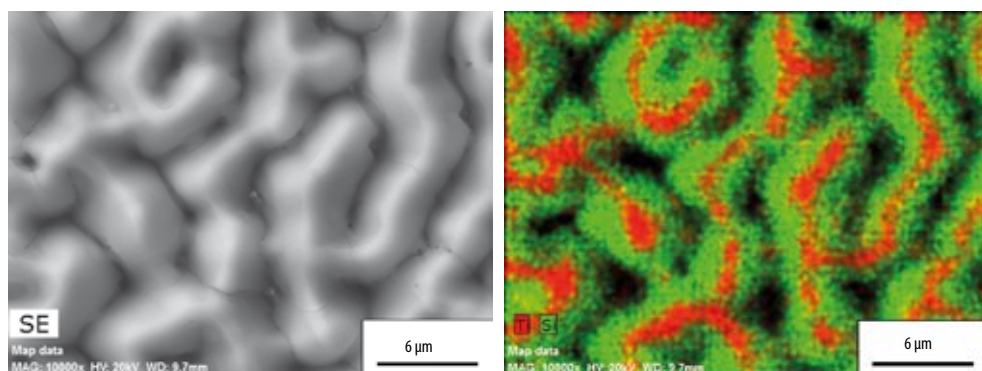


Fig. 4 EDX analysis of a laser-irradiated spot on Schott N-F2 glass, (a) SEM micrograph of the hilly surface, (b) element mapping of Ti (red) and Si (green) of the same surface.



Fig. 5 Plasmonic marks made by laser implantation of gold nanoparticles: (a) QR-code, (b) Computer generated hologram

excimer laser (193 nm, 20 ns) at moderate fluences around 200 – 400 mJ/cm² causes a phase separation of Ti-rich and Si-rich phases near the glass surface, which leads to a humped, light-scattering surface microstructure [3] (Fig. 3a). An analysis by energy dispersive x-ray spectroscopy (EDX) shows that a Ti-rich phase is located on the top of the hillocks, whereas the Si-rich phase is situated more in downhill positions (Fig. 4). Together with a similarly produced reduction of TiO₂ to TiO_x with $x < 2$, this leads to a blackening of the glass surface. Substoichiometric TiO_x is strongly absorbent of visible light, in contrast to stoichiometric TiO₂. Black patterns, codes or labels with a high resolution can be produced using mask technology or scanning processes (Fig. 3b).

In contrast to when longer wavelengths are used, no special ambient atmosphere is required when using a wavelength of 193 nm; the marking process can be carried out in an air environment. The marking is high-contrast, scratch-resistant and temperature-stable. It is particularly suitable for high-index glasses, which are nowadays produced using titanium oxide instead of lead oxide to avoid health risks. Flint glasses commonly used in optics, such as N-F2 and N-SF11 (Schott), contain around 10 to 30 % titanium oxide.

Plasmonic marking

The absorption behavior of metallic nanoparticles can be used to produce colored markings. Gold or silver nanoparticles color glass due to their

plasmon resonance in the visible spectral range. In order to place such nanoparticles locally resolved in the glass, the glass is first coated with a thin film of the metal. Laser irradiation melts the metal and the underlying glass surface, forming metal nanoparticles typically 5 nm to 100 nm in size that are embedded (implanted) into the glass. The dispensable metal film is removed from the non-irradiated area, leaving the mark only at the laser irradiated spot. This process is viable but inefficient because of using processes like vacuum evaporation of the metal and removal of most of the metal afterwards. A more practicable method that enables spatially-defined insertion of the nanoparticles without complicated process technology is desirable. One feasible way is laser transfer implantation (LTI) in which, for example, a gold-coated transparent film is pressed onto the glass object and irradiated from the rear with a pulsed KrF excimer laser (wavelength 248 nm) [4]. This forms gold particles that penetrate the glass surface, which is simultaneously heated by the laser radiation. The LTI method is a combination of the well-known laser-induced forward transfer (LIFT) and laser implantation. A laser wavelength of 248 nm is chosen here because carrier foils with sufficient transmission at this wavelength are available (e.g. low-density polyethylene), which is not the case for 193 nm. Almost any markings can be made in the glass with the help of suitable mask technology or scanning processes. The resulting color impression can be varied by choosing the irradiation parameters. As the plasmon resonance (for gold around 550 nm) depends on the size, shape, density, and environment of the nanoparticles, the color can be tuned in this way from red thru violet to brown; silver nanoparticles result in a yellow color. As the laser wavelength is in the deep UV, structure resolutions down to the µm range are possible, which cannot be achieved with CO₂ lasers that

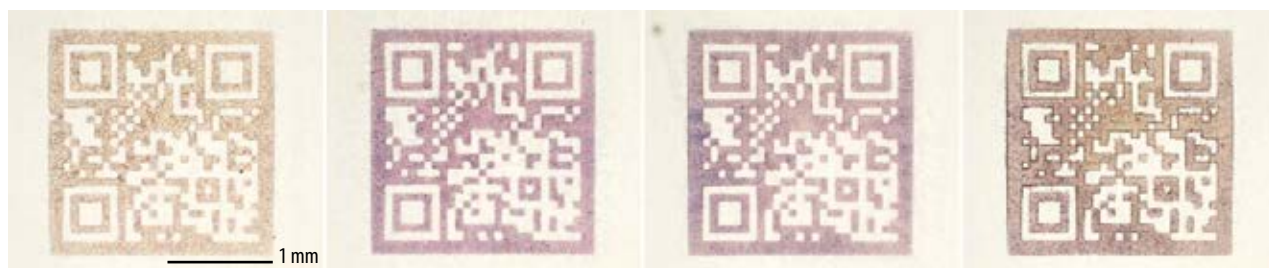


Fig. 6 The color impression of the plasmonic marks can be tuned by changing the laser irradiation parameters.

are normally used for marking. A few laser pulses are sufficient to apply a mark in the form of a logo, a data matrix or QR code, a computer-generated hologram (CGH) or lettering. Whereas the QR-code displayed in Fig. 5a was fabricated in a pixel-by-pixel mode, the whole mask containing the complete CGH-design of 256×256 pixels was projected in one step, resulting in a CGH-pattern with a pixel size of $16 \mu\text{m}$ on the glass (Fig. 5b). The QR-codes exhibiting various color shades (Fig. 6) were prepared by mask imaging as well. The applicability of laser transfer implantation has been demonstrated for various types of glass, such as soda-lime glass, borofloat glass and flint glass.

Conclusion

Excimer lasers are the perfect choice for high contrast and high resolution marking of glass surfaces. Mask projection enables fast processing. Diffractive marking and black marking work without additives. Diffractive marking is applicable to any glass type; black marking is limited to glass con-

taining titanium. Plasmonic marking is based on the laser implantation of gold nanoparticles.

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Authors

Jörg Meinertz is a project manager at the Institute for Nanophotonics. He studied physics at the University of Bremen, where he also obtained his PhD working on ultrafast laser spectroscopy of semiconductors. His research interests are laser micromachining, diffractive optics, and simulation.



Clemens Beckmann has experience in laser processing, glasses, and thin films. He joined the IFNANO in 2017 as a doctoral candidate and obtained his doctoral degree in the surface processing of dielectric materials by excimer lasers. He studied physics at Göttingen University.



Lukas Janos Richter studied physics at the Georg-August-University in Göttingen and at the University of Groningen. He completed his master's degree at the IFNANO in 2018 and has been a PhD student in the 'short pulses / nanostructures' group since 2019.



Jürgen Ihlemann is head of the nanostructure technology group at the Institute for Nanophotonics Göttingen, Germany. He received his diploma in physics and PhD in physical chemistry from the University of Göttingen. His research interests are UV-laser micro and nanomachining, patterning of surfaces and thin films, and ultrashort-pulse laser ablation.



Dr. Jürgen Ihlemann, Institut für Nanophotonik Göttingen e.V., Hans-Adolf-Krebs-Weg 1, 37077 Göttingen, Germany; phone: +49 551 503544, fax: +49 551 503599; e-mail: juergen.ihlemann@ifnano.de, Web: www.ifnano.de

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Automating serial laser processing with cobots

High-precision surface finishing in tool and mold making



Source all images: Botzian & Kirch

No more limitations due to the character set or material properties: laser markers can label a wide variety of workpieces of different materials, quickly and durably.

Until now, when workpieces needed to be marked with a serial number, bar-code or logo, one could only choose the method of the lesser evil. Mechanical marking machinery such as needle embossers, scoring or engraving machines, on the one hand, have a limited character set and can damage sensitive surfaces. Stickers or prints, on the other hand, come off easily, become quickly illegible, and take a toll due to the material and manufacturing costs.

Thanks to the intuitive laser systems from Botzian & Kirch, these problems are a thing of the past. The 'piggy' laser markers label components precisely and gently at the touch of a button – no prior clamping is necessary. Different laser types and powers are available depending on the material properties and the desired motif. It is possible, for instance, to temper or ablate various metals and to foam plastics. Operating the system via the straightforward and user-friendly software is quick and easy to learn. For serial laser processing, mobile cobots can be used to automate positioning and the marking process.

“In the automotive industry in particular, but also in other areas of tool and mold making, each individual workpiece must be clearly labeled to avoid confusion and allow tracking throughout the product life cycle,” explains Michael Botzian, a laser marking specialist at

▲ Using the piggy laser markers, a wide variety of motifs, from graphical logos up to complex codes, can be created on different materials – regardless of whether they are metallic or polymeric in nature.

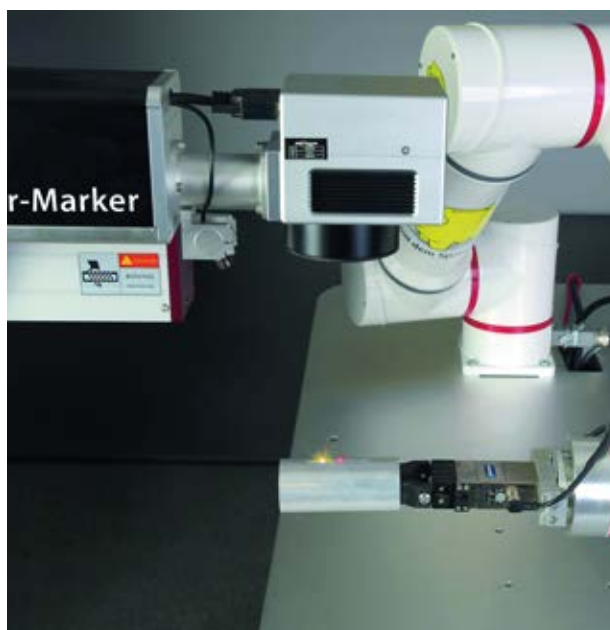
Botzian & Kirch. “Many manufacturers use needle embossers or scoring machines for this purpose.” Yet these devices have their limitations: components need to be clamped, which takes time and can damage sensitive surfaces or coatings. These methods usually allow only limited character sets, such as letters, numbers and barcodes. Other labeling techniques such as prints or stickers require cost-intensive consumables. In addition, mechanical influences might compromise their adhesion and readability over time. All these conventional methods are therefore being replaced more and more by laser systems, which can quickly produce legible and robust



The red frame indicates the area to be laser-processed so that components can be precisely aligned.



In addition to sequences of letters and numbers, the software automatically generates barcodes and QR codes as needed, so that components can be identified using a standard scanner or smartphone.



For serial laser processing, mobile Cobots can be used to automate positioning and the marking process

markings on various materials. Until now however they have been considered expensive in acquisition and complicated in operation. To dispel widespread prejudices and finally establish this useful technology in tool and mold making, Botzian & Kirch's surface finishing specialists have added the practical 'piggy' laser markers to their portfolio.

Simple as well as complex motifs at the touch of a button

To ensure a trouble-free marking process, the laser systems are versatile enough to meet the requirements of the individual applications as well as the general conditions on site. Different types of lasers can be installed: "For stainless steel, we usually use a fiber laser; for aluminum, a MOPA laser tends to be most suitable, whereas UV lasers are the first choice for many plastics," explains Botzian. If different types of lasers are combined, the same machine can be used for tempering or ablating metals and foaming plastics. Speed, frequency and power – up to 50 W – can also be varied to best suit the material properties and the desired result. A higher pulse repetition rate enables deeper material removal so that, for example, a stamp with the company logo can be quickly lasered instead of having to be eroded in a time-consuming process.

The in-house developed operating software makes the piggy laser markers easy to handle. It resembles a simplified CAD program into which graphics and characters in common file formats

can be either imported or entered manually. Then, only the final size and – depending on the motif – the filling and border need to be specified in the piggy interface before the laser is ready to start. If required, the software can automatically create barcodes or QR codes based on the text input, so that the marked components can be easily identified using a standard scanner or smartphone. "Thanks to the intuitive design, new users of the piggy laser markers usually only need four to five hours of instruction," notes Botzian.



After that, a wide variety of motifs from graphical logos up to complex codes can be realized on different materials using a single device – regardless of whether they are metallic or polymeric in nature.

The choice is yours: manual operation or automation with cobots

With an integrated Class 1 laser housing, the piggy laser marker cabin models offer optimum safety for personnel and the surrounding area. They are therefore particularly suitable for open spaces or workshops where no separate laser protection is provided. The largest of the

three models can handle one or more components with a total marking area of up to $700 \times 700 \times 300$ mm. Should even more flexibility be required, an open system in table-top or mobile design can be used. These call for appropriate safety precautions during handling, but limit the size of the workpieces being marked only in terms of height to a maximum of 1150 mm. The open models are also the first choice if the laser marking process is to be automated.

"The piggy laser markers can be used to mark not only individual components but also series of pieces quickly and easily," points out Martin Freisen, a specialist in cobot technology at Botzian & Kirch. "For this type of repetitive task, we use our new collaborative robots, which make it very easy to automate the laser marking process." These so-called cobots are very mobile robot arms with six joints. Depending on the model, they place workpieces weighing up to 10 kg underneath the laser, initiate the marking process and then pass the component on to a downstream system. "With the help of the cobots, laser marking not only saves time and material compared to other labeling methods, but also personnel," concludes Freisen.

Botzian & Kirch GmbH

Michael Botzian / Martin Freise
Heinz-Fröling-Str. 9
51429 Bergisch Gladbach, Germany
phone: +49 2204 30 660
fax: +49 2204 30 6629
e-mail: bo@diesparschweine.de
Web: <https://diesparschweine.de>

Is laser technology profitable even for small quantities?

Compact stand-alone systems for metal cutting and marking



Source all images: JustLaser

Relying on laser technology for metal cutting or marking has many advantages in practice. The processes work without contact. This protects the processed material and the tool, because a light beam does not wear out. Also, no other processing method is as flexible in terms of shaping. Tools do not have to be changed and the workpieces do not have to be clamped in time-consuming preparation. Until now however, the high purchase prices were an obstacle to using laser technology – especially for cutting – even for smaller quantities or prototype production. But in the meantime, there are also affordable systems suitable for such applications.

Laser systems have become established in series production to cut metal (Fig. 1). The technology scores with high precision and quality as well as speed – even the smallest cuts can be made quickly and easily. The technology is also significantly more efficient than CNC milling: with laser cutting, for example, deburring takes place automatically in the same work step. Even complex shapes or designs are no problem for the laser. No swarf is produced so there is no contamination at the workstation, and the

material around the interface remains undamaged. In addition, handling the workpieces is simple as mechanical devices and time-consuming clamping are not necessary. However, the technology often has a decisive disadvantage: the usual laser cutting systems are often too inflexible for small series or prototype production away from the inline production line. Mass production would have to be stopped for small series or prototypes, which is not justifiable for economic reasons.

Fig. 1 Relying on laser technology for metal cutting, even for smaller quantities or prototype production, has many advantages in practice.

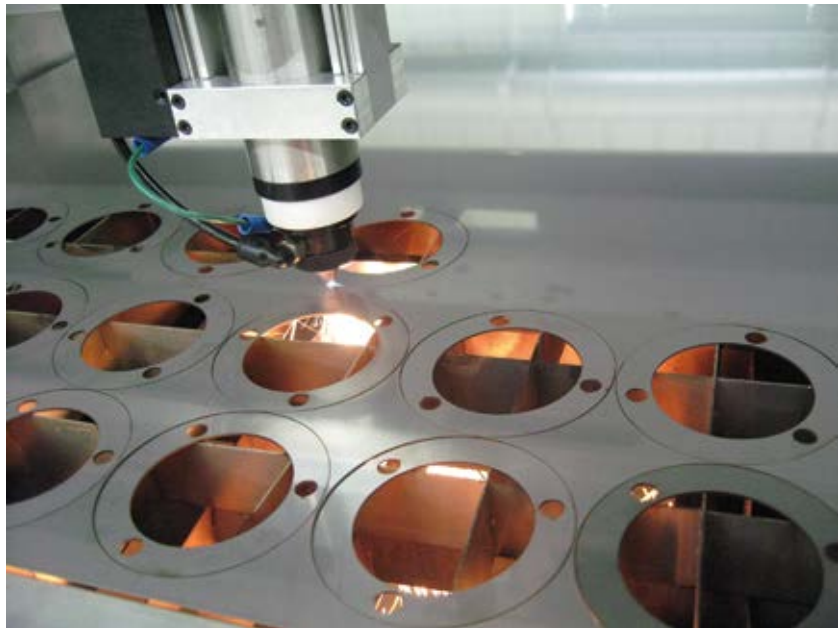


Fig. 2 The stand-alone laser cutter is particularly suitable for the production of prototypes or small batches.

An innovative stand-alone laser cutter

JustLaser has a practical solution in its program especially for applications that need flexible laser systems to cut metal and to be used as stand-alone devices outside of series production: the Just-Cut (Fig. 2) is a compact fiber laser system with a laser power of up to 3 kW for processing thin sheets up to 6 mm thick. It can cut a wide range of metals, such as V2A and V4A stainless steel, steel, aluminum, brass, or copper. With an optional round engraving device, it is also possible to process rounded and cylindrical workpieces such as pipes with diameters of up to 153 mm. The high-power fiber laser offers high operational reliability and beam quality as well as long-term tested reflection protection.

The laser cutter is housed in a compact enclosure, so it consumes little floor space. Thanks to its class 2 safety rating, it does not require a protective room and can be used in high-traffic areas such as busy factory floors. Two convenient sliding doors at either end of the machine provide good accessibility. Sliding access windows are also installed on both sides. The processing area inside is 1320 × 1270 mm. Powerful CNC laser software is available as an option to increase system efficiency and machine throughput, for example, using nesting and NC functions such as common line, ridge and bridge cutting, and lead-in functions. Another option is the k-vision package, a sophisticated hardware and software solution that allows printed material to be cut to a precise fit. This means that today, thanks to the

comparatively low investment, there is nothing to stop laser technology being used for smaller quantities or in prototype production, even away from automated production.

Laser marking: efficient, flexible and fast

Laser technology can also show its advantages in product marking. Permanent markings or engravings for workpiece or product identification are in demand in many sectors today (Fig. 3): in the automotive industry or machine tool manufacturing as well as in medical technology, electronics manufacturing, jewelry, watches or the design of advertising materials. Cross-industry buzzwords in this context are traceability, quality control, branding, individualization or personalization of certain



Fig. 3 Permanent markings or engravings for workpiece or product identification are in demand in many sectors today.

Company

JustLaser

JustLaser GmbH specializes in laser machines that engrave, cut or mark a wide variety of materials such as metals, wood, acrylics, plastics, textiles and many more. The company, located in the Wels area of Upper Austria, employs an experienced team of experts with an average of over ten years of industry experience. JustLaser's precise laser cutters, engravers or markers are simple but effective tools for industrial and commercial companies. In addition to the headquarters in Thalheim near Wels in Upper Austria, there are currently six showrooms and service centers in Germany, a training center in Vienna and branches in Italy and France, plus two cooperation sites in Switzerland.

www.justlaser.com



Fig. 4 Two compact system solutions for laser marking and cutting

products. With the JustMark galvo lasers (Fig. 4), the company has two compact systems in its product range that are suitable for both marking and engraving and can therefore be used very flexibly in commercial or industrial operations. They can be used quickly and easily in a wide variety of production areas and are equally suitable for individual pieces or for small to medium quantities. In comparison to other systems, the purchase is low-risk due to the optimum price/performance ratio. Technically, the compact lasers also have a lot to offer: a special feature in this price class, for example, is the autofocus that always guarantees accurate focus and thus avoids scrap.

Since the Z axis can be controlled, stepped workpieces can also be marked and engraved. The machining area is

large and freely accessible despite the compact system dimensions of 610×382 mm or 335×239 mm. The beam path is virtually dust-tight, and two air cooling systems controlled by temperature sensors on the laser source and in the housing prevent overheating. In a potentially damaging situation, the laser is switched off in good time before critical temperature buildups occur, which increases the system service life.

In practice, however, marking is usually not enough – files have to be imported for this purpose and completed jobs have to be logged, and the software supplied with the system offers all the prerequisites for this. All common vector and raster formats can be imported, as well as text or Excel files. Serial and batch numbers can be gen-

erated automatically and barcodes in various formats can be created. Processed laser jobs can be logged with a time stamp. The user can then process this data as required and then knows, for example, which serial number was processed at what time.

JustLaser GmbH

Christian Dürr
Head of Product Management and Service
Oberer Luß 6/2
89155 Erbach bei Ulm
Germany
phone: +49 7305 9580240
e-mail: christian.duerr@justlaser.com
Web: www.justlaser.com

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3D-printed GRIN tools for synchro speed polishing

A first experimental study towards the use of hardness-gradient polishing tools for micro-optics manufacturing

Additive technologies allow the flexible production of gradient index (GRIN) polishing tools with specifically adaptable removal functions. These were successfully developed and investigated for synchro speed polishing.

The use of micro-optical systems – usually with diameters and radii ranging from dozens of micrometers to a few millimeters – has increased tremendously with applications ranging from medical optics such as endoscopy and implants, to optical transmission systems for fiber coupling, space missions, and laser diode beam shaping devices, as well as virtual reality (VR) applications, or lidar. Due to their small dimensions, it is almost impossible to apply on machine, in-situ, in-process quality control during their manufacture. The use of stable manufacturing processes is therefore crucial.

Two different approaches are feasible to achieve this: (a) the invention and development of new fabrication technologies such as the direct 3D printing of optical elements or the application of metasur-

faces, and (b) inventions and developments to also enable the use of established state-of-the-art fabrication technology for the production of microlenses.

A new process, gradient index (GRIN) polishing, which allows a high degree of design freedom in the configuration of polishing agent carriers was presented in 2022. This follow-up paper reports on a first experimental study towards its implementation.

OST – Eastern Switzerland University of Applied Sciences, Campus Buchs (OCB)

IMP Institute for Microtechnology and Photonics

Dr Oliver Fähnle, Dr Kerstin Kern, Jan Allaart, Prof Dr Henrik Surberg
e-mail: oliver.faeahnle@ost.ch
Web: www.ost.ch

Ernst Abbe University of Applied Sciences, Jena (EAH)

SciTec Department

Prof Dr Jens Bliedtner, Christian Schulze, Sebastian Henkel, Volker Heineck
e-mail: jens.bliedtner@eah-jena.de
Web: www.eah-jena.de/scitec



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Precision Optics

Dr Jürgen Bode, Michael Wagner
e-mail: juergen.bode@satisloh.com
Web: www.satisloh.com



<https://doi.org/10.1002/phvs.202300014>

Measuring the thickness of thin sintered layers precisely

Considering the influence of sintering on optical constants, the thickness of sintered Al_2O_3 layers in quartz tubes can be accurately determined

Optical thickness determination with miniaturized spectrometers is a commonly used technique that works quite well in many applications. For sintered materials however, this technique must be extended by the determination of the optical constants of the sintered material. This can be done using a combination of scanning electron microscopy and effective medium approaches. In this article, we demonstrate this for the optical thickness determination of sintered Al_2O_3 layers in quartz tubes.

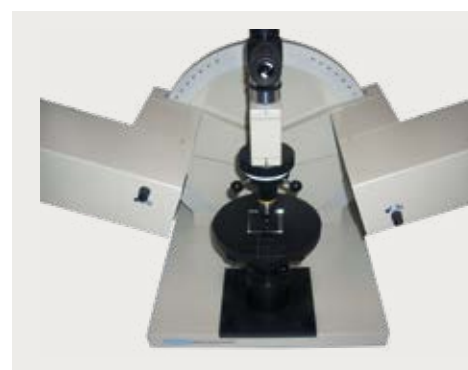
The production of safe drinking water consists of several treatment steps. One step is the cleaning of the water from bacteria and viruses. This process is done in the water treatment facility with UV lamps that deactivate the DNA of

the germs in the water. However, the mercury-based UV lamps reduce their UV intensity over time by forming HgO at the quartz wall. This reduces their usable lifetime and their energy efficiency. It is usual to coat the inner surface of the tubes with a sintered Al_2O_3 layer to protect the quartz tube and stabilize the long-term UV output.

Dr Michael Quinten
Wissenschaftlich-technische Software

Dr Michael Quinten,
52457 Aldenhoven, Germany
phone: +49 2464 2649
e-mail: ulmi.quinten@dn-connect.de

Faiza Houta, now:
Bundesamt für Sicherheit in der Informationstechnik (BSI), Bonn, Germany



Source: Dr Quinten Wissenschaftlich-technische Software

Ellipsometric thickness measurement of thin films



<https://doi.org/10.1002/phvs.202300013>

The future of optical measurement technology

A review of new developments in optical metrology and industry trends in the digitalization and integration of these solutions for in situ and inline measurements

Antonio Castelo-Porta



Source: Sensofar

Optical metrology is one of the key technologies in today's manufacturing industry. It can be generally defined as the science of measuring with light, and it is widely used to evaluate the physical properties of products (or some of their parts or components) and to monitor large infrastructures and facilities. In this article we will review some of the current technologies for optical measurement in different manufacturing industries, the new developments and the trends related to the continuous demand for high-precision and high-efficiency solutions.

When we talk about optical metrology, we refer to a group of characterization techniques that involve the detection and measurement of light, a) emitted by a source, or b) reflected or transmitted by an element under inspection. They can be performed at one or various angles, depending on the requirements of the object being analyzed. White light interferometry, optical microscopy, confocal microscopy, spectroscopy, ellipsometry or reflectometry are some of the most common techniques used

and they present several advantages over other traditional measurement options. They are non-contact, non-destructive, accurate, fast, and reliable; characteristics which make them a great solution in very different applications for inspection, quality control, and process control purposes [1]. The range of parameters monitored is also very wide. They can measure the dimensions of manufactured parts, the size of specific features, surface properties, the thickness of layers and coatings, light sources and dis-

Fig. 1 Sensofar's autonomous areal confocal profilometer 'S mart 2'

play characteristics ... Optical fiber sensors are also very interesting solutions for predictive maintenance, temperature and strain measurement or electrical and magnetic parameter control because they can be used in harsh or dangerous environments due to the ability to control the process remotely. They are very flexible options with application in very different industries.

The new developments of micro-optics and optical components, medical devices and products, electronic displays, or automotive parts has driven the need for more precise manufacturing processes and, as a consequence, evolved metrology tools. Apart from the usual demand for increasingly better resolution and precision, nowadays it is critical to measure more complex structures and features of larger sizes or wider angles. Increasingly tight tolerances for parameters such as dimensions and thickness must also be maintained. So, fast and reliable methods of measurement are critical to save time in the control process and, in the case of large samples, to avoid possible errors when overlapping measurements in consecutive areas of the same piece. Optical metrology devices' advantages have allowed the industry to meet these new requirements, and the combination with robotic arms and other motorized systems is making it possible to cover the increasing demand for in-line measurements.

Metrology and industrial digitalization

Recent developments have made it possible to work with innovations such as smart multisensor systems or virtual metrology, transforming the role of metrology from only a post-production activity to a real-time inspection and analysis process. The increment on the digitalization of factories through Industry 4.0-related technologies is leading to the collection and use of data from different production devices, machines, or processes. In this environment, optical metrology techniques offer their advantages to become fast control and verification solutions, often in combination with automated positioning systems or industrial robots. These measurement devices can work close to assembly and production cells, performing the inspection before, during, and after the process, and storing the data associated with each product. This way, all relevant information about the characteristics of a piece can be obtained along the manufacturing process and then unequivocally assigned to a digital item for quality control purposes.

Following this trend, the Sensofar Metrology company (Terrassa, Spain) has recently launched the only autonomous areal confocal profilometer



Source: Mitutoyo

Fig. 2 New ROBOTAG system for high speed inline inspection and measurement

in the market, the S mart 2 (Fig. 1). Its powerful features and compact design turn it into a breakthrough in the optical field. In order to scan with the most suitable technology, the S mart 2 comes with three systems to measure within the same head: active illumination focus variation, confocal and interferometry. This solution has been designed to fulfill the automation typically required in manufacturing lines and to be exceptionally easy to integrate. All the electronics are included inside the narrow head to allow its installation in zones that will not interfere with the user or the manufacturing operation.

The manufacturer, Mitutoyo (Kawasaki, Japan), has also adapted one of their most interesting devices to be mounted in a robotic arm in order to improve the accuracy and speed of the measurements. The new ROBOTAG solution integrates a vision system with their well-known tunable acoustic gradient index of refraction lens (TAGLENS). The combination provides clearer images due to the improved depth of focus, excellent repeatability and higher efficiency. This is thanks to the ultrafast varifocal property of the TAGLENS, which always maintains the focus regardless of height difference, position tolerances or curved surfaces.

Organization

EPIC – European Photonics Industry Consortium

EPIC is the world-leading photonics industry association representing more than 800 members across 35 countries. EPIC promotes the sustainable development of organizations working in the field of photonics, EPIC fosters a vibrant photonics ecosystem by maintaining a strong network and acting as a catalyst and facilitator for technological and commercial advancement. EPIC publishes market and technology reports, organizes technical workshops and B2B roundtables, supports EU funding proposals, advocacy and lobbying, education and training activities, standards and roadmaps, pavilions at exhibitions.

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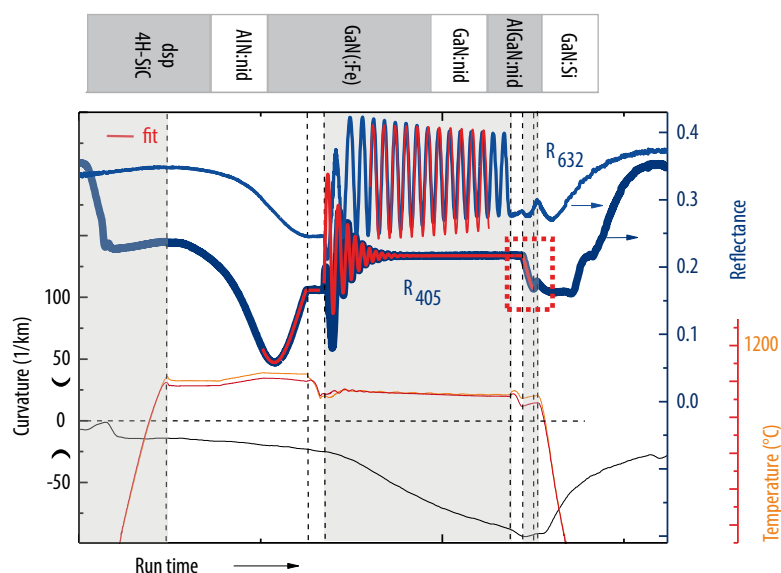


Fig. 3 In-situ measurement of the layers grown on a wafer (Source: LayTec)

These particular characteristics of the TAGLENS are related to its unique physical design that uses a silicon-based fluid with special thermal and viscous properties and a piezo ring to enclose the liquid medium. The ROBOTAG system will soon be fitted with a broadband pulsed light source (PLS) to perform accurate 3D-shape inspection and improved inline measurements (Fig. 2).

New solutions for optical components manufacturing

Manufacturing of optical components requires not only accurate fabrication and polishing but also precise measurement. The increase of efficiency and repeatability of the manufacturing methods means very little if the final piece cannot be measured accurately. Several metrology technologies are already well established in this industry to measure the different critical parameters (radius of curvature, flatness, roughness, thin film thickness, transmittance ...), including profilometry, confocal microscopy, ellipsometry, or interferometry.

A lot of work has been done on the quality control of thin films, a very common element in the optical components industry. They have been widely used in recent years to obtain functional coatings on the optics' surface (such as protective or antireflective coatings) or to manufacture different types of filters and mirrors. Metrology is crucial to ensure the quality of the final product produced with the different deposition techniques available on the market. One critical need for this industry is the spectral measurement

of components with optical coatings, both in the existing parts and in the new developments. The EssentOptics Europe company (Vilnius, Lithuania) offers different solutions for fully unattended spectral measurements of flat components and lenses (including aspherics). These devices can measure transmission and reflection over a broad wavelength range, from UV to VIS and MWIR (and soon-to-be LWIR). One of their most interesting applications is the characterization of linear variable filters, an optical component with a lot of applications in spectroscopy for biological and life science research. They have designed a new technique: it is being tested and fine-tuned in collaboration with the Omega Optical company.

Other interesting optical components are multizone filters (MZF) that offer spatially varying spectral performance on a single substrate. Many diverse applications can benefit from their functionality, such as earth observation. These components comprise several individual tight-spec narrow bandpass filters being either coated on a single substrate or assembled from tiny individual filters. Measurement of MZF filters represents a true metrology challenge due to the wide variation of their designs and sizes. The EssentOptics Europe company also offers solutions for their characterization, based on an XY-MZF motorized stage and a specific software package for their spectrophotometers to map and measure the filter fully unattended.

Finally, when talking about the production of lenses, an important parameter to control is the central thickness

as it can severely affect the path of light through this component. From a manufacturer's point of view, it is crucial to control the repeatability of this parameter in a set of lenses with the same specifications to ensure the high quality of the final product. Trioptics (Wedel, Germany) has developed the OptiSurf LTM (lens thickness measurement), a precise center thickness measurement system with a precision of $\pm 0.5 \mu\text{m}$ for single lenses and doublets with a glass thickness of up to 150 mm. The technology behind this solution is high precision, low-coherence interferometry and it is equipped with vibration damping and a self-centering mechanical clamping chuck to allow simple and operator independent handling. Another advantage is the software's workshop-optimized user interface enabling a seamless integration of the OptiSurf LTM into any production process.

Metrology in the semiconductor and consumer electronics industries

Production in the semiconductor industry is really demanding. First, as the goal is to manufacture as many wafers per hour as possible, there is great time pressure and all the processes involved must be extremely fast and/or offer a very timely fault detection and control loop. Second, the high cost of the materials used means that it is critical not to produce bad parts. Optical metrology solutions are the perfect option for high-speed measurements and defect detection, and several technologies have been adapted in recent years to meet the special requirements of this industry. They have now established themselves as essential tools in semiconductor production to check the increasingly complex and small 3D structures as well as the thin layers with thickness requirements down to nanometers that are produced.

One interesting application is in-situ control of the epitaxial growth of thin-film layer structures on semiconductor wafers. This process is necessary for the fabrication of products such as VCSELs, μLEDs or power transistors and there are several important parameters to control: wafer temperature, reflectance, growth rate and layer thickness, chemical composition of the grown material and the wafer bow. LayTec (Berlin, Germany) has developed

different integrated optical metrology solutions for this application, including the optical tools, the special algorithms and the material databases for analysis of the measured data (Fig. 3). LayTec's tools are integrated into deposition systems such as metal-organic chemical vapor deposition (MOCVD) systems and are used in the front end of the semiconductor device manufacturing process. They are integrated into control loops and used for feedback control in real time and run-to-run control as well as for fault detection during this process.

The subsequent downstream processes in semiconductor front end production can also require optical measurement tools. One application is wafer mapping to characterize the wafers after epitaxy. Optical techniques such as white light reflectance and photo luminescence are used to measure layer properties (such as thickness and composition) for the whole layer stack and quantify the uniformity (or non-uniformity) to allow 'in-spec'/'out-of-spec' decisions. LayTec also offers optical measurement tools for this application that use the information from the in-situ measurement described above. This 'connected metrology' approach facilitates the complex analysis of the sometimes very complex layer stacks. The same concept is continued into the subsequent (plasma) etching process by offering optimized integrated optical metrology for the measurement of etch rates, layer thickness and endpointing. With the knowledge (i.e. the measured data) from the upstream processes (epitaxy and mapping), the endpointing can be achieved much more precisely than with conventional metrology.

Also related to the semiconductor and consumer electronics industries, a very recent case study performed by Sensofar Metrology (already mentioned above) has focused on the effect of temperature changes on the evolution of the shape and texture of a silicon wafer. Sensofar has a lot of experience in the measurement of the roughness of wafers, the thickness of transparent layers or the detection of defects in conductive vias filling processes, and they have been testing their solutions in rapid thermal processing (RTP) on wafers. This is an important step in silicon wafer manufacturing in which the wafer is rapidly heated to high temperatures for a short period of time, then slowly cooled in a controlled manner in order to impart the desired semiconducting properties to the wafer. In this process, some thermal stress can be induced in the wafer, leading to other problems that may affect the final performance of the device. A key method of evaluating the effects of temperature change during the manufacturing process is to measure the surface roughness of the wafer as a function of temperature, but it has historically been a difficult procedure due to imaging issues caused by spherical aberrations. In this study, the surface roughness has been observed by an interferometry technique using a Sensofar Linnik objective lens in conjunction with a thermal chamber (Fig. 4). On the one hand, this combination of both systems has allowed the temperature to be raised precisely to values similar to those during the manufacturing process while observing the sample through microscopy; on the other hand, it has eliminated the problems related with spherical aberrations to obtain accurate measurements of 3D

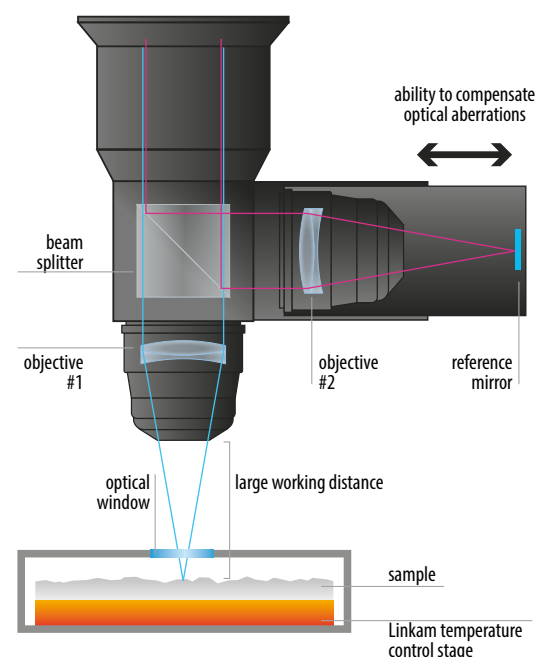


Fig. 4 Setup to measure surface roughness of the wafer during rapid thermal processing (Source: Sensofar)

topographic profiles. The feasibility of the proposed configuration has been proven to carry out successful roughness and waviness measurements at different temperatures, and different behaviors of the surface topography have been observed depending on the chip design.

Conclusion

Optical measurement technologies are being increasingly applied in various different industries, and they have proven to be the most efficient and versatile tools to perform both quality and process control in several applications. Recent developments are focused on solving some of the limitations of the previous systems and on measuring the new and more demanding products and features of the semiconductor, consumer electronics, automotive, optical components and medical industries with higher accuracy. There is a clear trend in the market to integrate these solutions into robotic arms and other positioning systems to perform in situ measurements and to deliver valuable information in real time during the manufacturing processes.

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- [1] Y. Shimizu et al.: Meas. Sci. Technol. 32 (2021) 4, 042003

Author

Antonio Castelo-Porta is a physicist specialized in optics and a program manager at the European Photonics Industry Consortium (EPIC). After obtaining a PhD in applied physics with a specialization in the laser processing of materials, he explored the industry as a sales engineer and sales manager for several added value distributors and manufacturers. At EPIC, Antonio is in charge of the development of the laser and medical fields, and all related technology and applications. He has a strong interest in new technology involving photonics, such as ultrafast lasers, new medical devices and spectroscopy solutions.



Dr. Antonio Castelo-Porta, EPIC – European Photonics Consortium Industry, 17 Rue Hamelin, Paris, France, e-mail: antonio.castelo@epic-assoc.com, Web: www.epic-assoc.com

Expertise in spectral analysis and photonics

AHF analysentechnik is your expert partner in optical filter designs and microscope accessories for industry and research laboratories. AHF offers products which have proved their quality in many fields of applications, such as fluorescence microscopy, multiphoton spectroscopy, cell analysis, laser and Raman spectroscopy also including super-res-

olution techniques with optical resolution beyond the Abbe limit (TIRF, STED, PALM, STORM, etc.).

The range of products covers hard-coated singleband, multiband and interference filters, beamsplitters, dichroics and mirrors from prestigious manufacturers available as single filter or filter sets completely mounted in micro-



scope-specific cubes. Customized filter designs, prototyping and OEM solutions can also be provided. Powerful LED light sources, image splitters and tools for quality monitoring of fluorescence imaging systems are part of the portfolio as well.

AHF started in 1981 and has grown over the years. Its customers benefit from long-term and interdisciplinary expertise. The team of AHF gives manufacturer-independent product advice and helps the customer to find the right optical filter design or accessory equipment for his specific application and instrument. In many cases, optical filters and LED light sources can be provided for testing.



AHF analysentechnik AG

Kohlplattenweg 18
72074 Tübingen, Germany
phone: +49 7071 970 901-0
e-mail: info@ahf.de
Web: www.ahf.de

Laser World of Photonics, Hall B1, Booth 200

Hübner Photonics

Hübner Photonics is committed to supplying high performance and innovative lasers that meet or exceed the market's expectations concerning quality, reliability and robustness. Hübner Photonics offers the full range of:

- Single and multiline lasers by Cobolt
- CW tunable lasers
- Laser combiners
- Femtosecond lasers
- Terahertz imagers and spectrometers

Through continuous technology development, customer orientation and an ISO certified quality management system, Hübner Photonics has become a preferred supplier of lasers to major instrument manufacturers and leading research labs for cutting-edge applications in the areas of fluorescence microscopy, flow cytometry, Raman spectroscopy, metrology, holography, nanophotonics and quantum research. Hübner Photonics has manufacturing sites in Kassel, Germany and Stockholm, Sweden with direct sales and service offices in USA.

HÜBNER Photonics



HÜBNER Photonics GmbH

Wilhelmine-Reichard Strasse 6
34123 Kassel, Germany
phone: +49 6251 770 6686
fax: +49 6251 860 9917

General enquiries:
e-mail: info.de@hubner-photonics.com

Sales enquiries:
e-mail: sales@hubner-photonics.com

Web: www.hubner-photonics.com

Laser World of Photonics, Hall B2, Booth 214

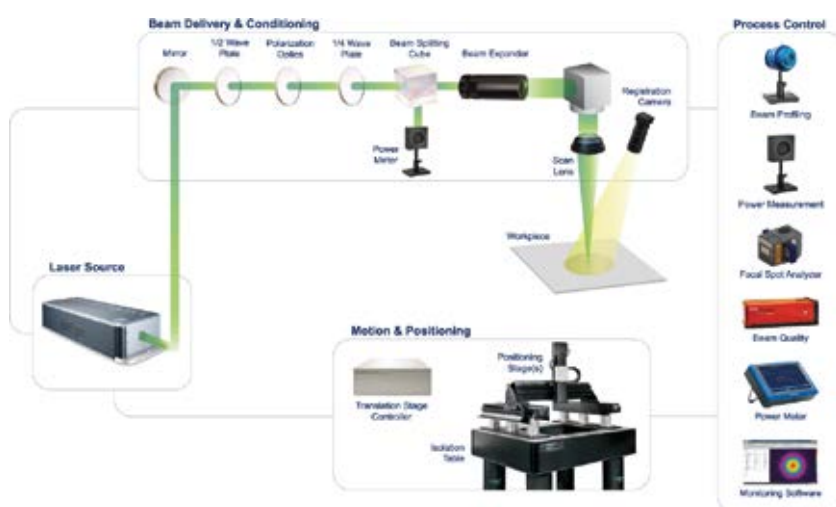


Enabling the technologies that transform our world

MKS Instruments is a trusted partner of the world's largest electronics and industrial companies. We leverage leading-edge science and engineering capabilities to offer solutions that improve process performance and productivity for our customers.

MKS Photonics Solutions enhance our customers' capabilities and productivity in the semiconductor, electronics and packaging, and specialty

industrial markets: Spectra-Physics combines groundbreaking laser technologies with deep application expertise to deliver industry leading lasers for precision industrial and scientific research applications. Newport provides a full range of solutions including precision motion control, optical tables and vibration isolation systems, photonic instruments, temperature sensing, optical and opto-mechanical components.



Ophir specializes in laser and LED measurement products, including laser power and energy meters and laser beam profilers. Ophir also provides high-performance IR thermal imaging lenses and optical elements as well as optics for CO₂ and high-power fiber laser material processing.

Ophir Spiricon Europe GmbH MKS Instruments

Guerickeweg 7
64291 Darmstadt, Germany
phone: +49 6151 708-0
e-mail: Info-Ophir-EU@mksinst.com
Web: www.ophiropt.com

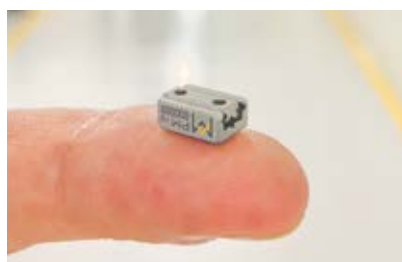
Laser World of Photonics, Hall A3, Booth 219

Precision linear guides and frictionless slides

PM is the leading European manufacturer of standard and customized precision linear bearings, linear slides, miniature slides, rotation bearings, sub-assemblies and engineered-to-spec motion systems. We are a family-owned company in the Netherlands and employs more than 200 people. Known as a trusted partner for hundreds of global players operating semiconductor industry, optical and metrology sectors, medical technology to industrial automation, space and defense industries.

PM has over 50 years in-depth manufacturing knowledge and critical products are made in house. With the manufacturing capabilities extremely small sized products up to large machined products (example vacuum chambers, accurate large machine elements and frames) can be supplied.

The product portfolio of linear bearings includes ball, cross roller and needle roller linear bearings. Besides linear bearings, PM is specialized in linear slides and offers various minia-



ture slides. The newest innovation is the extremely compact cross roller linear slides MSR which includes anti-cage creep technology and offers a highly accurate movement at high speeds.

Other products are the compact and flat rotary table bearing for precise rotary motion and the goni bearings which offer precision and low friction curved motion, originally developed for use in optical lenses applications

Furthermore, the portfolio includes customized xy-stages, positioning systems and advanced motion systems with accuracies at sub-micron level. With a deep expertise solutions can be offered that meet the specific requirements of



a wide variety of industry applications. Assembly of the products is done in conditioned low-dust assembly rooms, for semiconductor and medical customers ultrasonic cleaning, assembly and qualifying in cleanroom classes 6 and 7 is offered.

PM B.V.

Galileistraat 2
7701 SK Dedemsvaart, The Netherlands
phone: +31 523 612 258
e-mail: info@PM.nl
Web: www.PM.nl

Toptica Photonics



Toptica has been developing and manufacturing high-end laser systems for scientific and industrial applications for twenty years. Our portfolio includes diode lasers, ultrafast fiber lasers, terahertz systems and frequency combs. The systems are used for demanding applications in biophotonics, industrial metrology and quantum technology. Toptica is renowned for providing the widest wavelength coverage of diode lasers on

the market, providing high-power lasers even at exotic wavelengths.

Toptica develops and manufactures high-end laser systems for scientific and industrial applications. OEM customers, scientists, and over a dozen Nobel laureates all acknowledge the world-class exceptional specifications of Toptica's lasers, as well as their reliability and longevity.

Founded in 1998 near Munich (Germany), Toptica became one of the leading laser photonics companies by aiming for, and consistently delivering high-end specifications. Toptica's diode lasers are appreciated for excellent coherence, wide tuning range and ideal beam profiles.

Toptica's 490 employees take pride in developing customized systems. In close collaboration with several universities and institutes, latest scientific discoveries are frequently incorporated into commercial products. With a global



distribution network, Toptica provides exceptional service worldwide.

Short profile Toptica Photonics

Founded: 1998

Employees: 490 (2023)

Revenues: 130 Mio. €

Legal form: Aktiengesellschaft (AG), private ownership

Presidents: Dr. Wilhelm Kaenders, Dr. Thomas Renner

Chairman: Dr. Dieter Schenk

TOPTICA Photonics AG

Lochhamer Schlag 19
82166 Graefelfing / Munich, Germany
phone: +49 89 85837-0
e-mail: sales@toptica.com
Web: www.toptica.com

Laser World of Photonics, Hall B2, Booth 103

Infrared filters & coatings by Umicore Coating Services

Umicore Coating Services is a leading supplier of infrared precision optical filters and coatings. With over 35 years' experience in thin-film design and manufacture, we develop custom solutions for low-volume prototyping to full production scale-up of the most demanding optical coating applications.

Utilising the latest thin film analysis and design software, Umicore Coating Services delivers industry leading spectral and environmental performance of IR Filter and Coating requirements.

We supply a range of bandpass optical filters ideally suited to environmental/gas detection and analysis applications.

With a centre wavelength anywhere on the NIR to FIR spectrum with steep-edge and deep blocking capability, Umicore can offer:

- Narrow/wide/dual bandpass
- Short/long wavepass
- Notch
- Dichroic beamsplitters
- Circular variable filters
- Complete filter wheel assemblies
- Custom and stock filters

CO₂ laser coatings

Our high power CO₂ laser coatings are capable of meeting demanding laser damage thresholds.

We design and develop coatings that deliver ultra-high reflection with low absorption at the 10.6 μm and 9.3 μm wavebands, including laser alignment coating wavebands:

- Phase retarders
- Mirrors
- Partial reflectors
- Brewster polarisers

Thermal imaging

We design complex spectral coatings suitable for the most demanding thermal imaging applications on a range of substrates. Choose from either our standard 3-5 μm or 8-12 μm designs, or have tailor made designs to your specific application requirements.

- High Efficiency Anti-Reflection (HEAR)
- High Durability Anti-Reflection (HDAR)
- Diamond-Like Carbon (DLC)



Prototype design service

We support innovation and R&D projects by offering a prototype design service to deliver proof-of-concept samples and first article inspection reports for new product development.

Your trusted partner

We work closely with our customers through a consultative approach to develop custom IR designs that balance performance reliability with production efficiency.

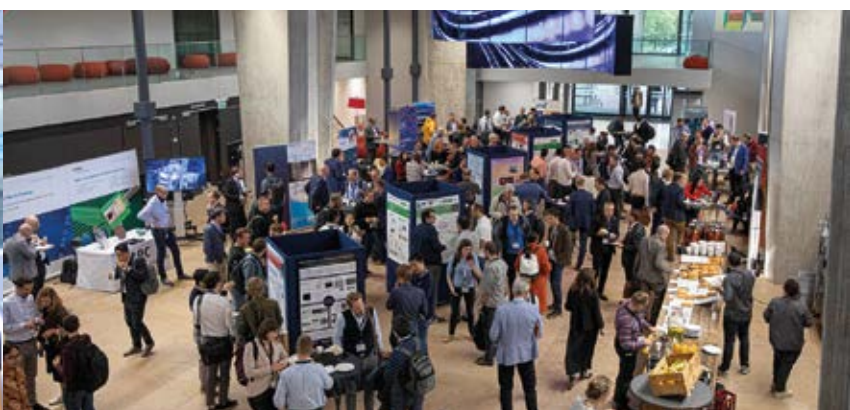
Contact us to discuss your IR Filter & Coating applications

Umicore Coating Services Ltd

Kinnoull Street
Dundee DD2 3ED, United Kingdom
phone: +44 1382 833022
e-mail: coatingservices@umicore.com
Web: https://eom.umicore.com



Source: Messe München



Source: PhotonDelta

April 17 – 21, 2023**Hannover Messe**

Hanover, Germany

www.hannovermesse.de**April 19 – 21, 2023****Optics and Photonics International Exhibition OPIE 2023**

Yokohama, Japan

www.opie.jp/en/ (conference: <https://opicon.jp>)**April 23 – 26, 2023****International Conference on UV LED Technologies & Applications ICULTA 2023**

Berlin, Germany

www.iculta.com**April 24 – 27, 2023****SPIE Optics + Optoelectronics 2023**

Prague, Czech Republic

<https://spie.org/conferences-and-exhibitions/optics-and-optoelectronics>**April 25 – 26, 2023****5. OptecNet Jahrestagung**

Fürstenfeldbruck, Germany

<https://optecnet.de/ueberblick>**May 4 – 6, 2023****21st EMVA Business Conference**

Seville, Spain

www.business-conference-emva.org**May 7 – 12, 2023****CLEO**

San Jose, CA, USA

www.cleoconference.org**May 9 – 11, 2023****Sensor + Test**

Nuremberg, Germany

www.sensor-test.de**May 9 – 11, 2023****Rapid.Tech 3D**

Erfurt, Germany

www.rapidtech-3d.com**May 9 – 12, 2023****Control**

Stuttgart, Germany

www.control-messe.de**May 30 – 3 June, 2023****124. Jahrestagung der DGaO**

Berlin, Germany

<https://dgao.de/jahrestagung>**June 5 – 8, 2023****Photonics for Quantum 2023**

Rochester, NY, USA

<https://spie.org/conferences-and-exhibitions/photonics-for-quantum>**June 6 – 9, 2023****EPHJ**

Geneva, Switzerland

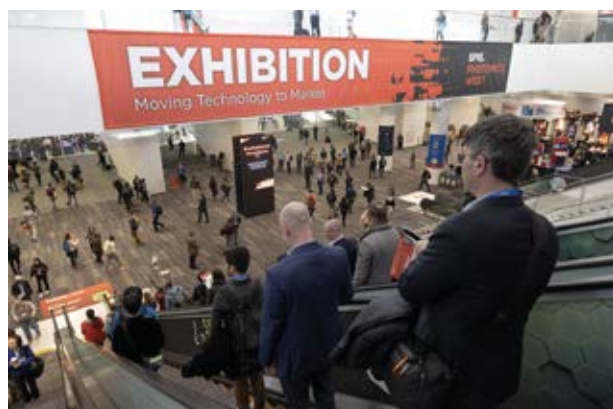
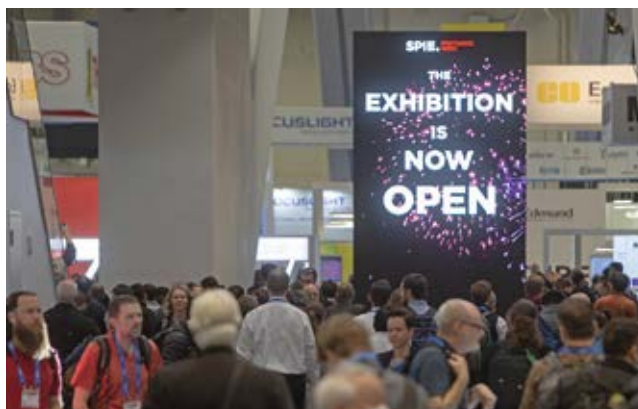
<https://ephj.ch>**June 27 – 30, 2023****Laser World of Photonics**

Munich, Germany

<https://world-of-photonics.com>Read event previews and reviews on www.wileyindustrynews.com/en/events

"It's great to be back and meeting people face-to-face again"

Review: SPIE Photonics West, 28 January – 2 February 2023, San Francisco, California, USA



"The exhibition is now open" – SPIE Photonics West 2023 (Source: SPIE)

SPIE marked a triumphant Photonics West with more than 22,000 registered attendees from 85 countries across the international optics and photonics community. Held at San Francisco's Moscone Center from 28 January to 2 February, the largest annual photonics conference – which includes BiOS, Lase, Opto, Quantum West, the BiOS Expo, the Photonics West exhibition, and the co-located AR|VR|MR conference and exhibition – hosted over 1,400 exhibitors, and featured over 4,500 technical presentations.

"That was one of the best Photonics Wests ever," said SPIE CEO Kent Rochford. "The energy, engagement, and enthusiasm at the Moscone Center during the week was out of this world. AR|VR|MR over at Moscone West was a hive of activity, and the Quantum West program has become a must-attend event. But most of all, it was wonderful to see the networking, research-sharing, and business that went on all week among world-leading scientists, engineers, students, and business people. What a great return to Photonics West."

The exciting week showcased the latest technologies and discoveries of a diverse and thriving optics and photonics industry, bringing together researchers, innovators, engineers, and business leaders from across the globe. With the 15th annual Prism Awards honoring the top new optics and photonics products, and the fast-paced Startup Challenge pitch competition (cf. p. 12), Photonics West showcased and recognized the best optics and photonics technologies, trends, and entrepreneurial opportunities, while Quantum West's talks and

panels offered keen insights into this growing commercial ecosystem.

The week also included extensive professional-development opportunities, a comprehensive range of technical presentations on everything from the latest laser applications to biomedical and healthcare innovations, live demonstrations on the exhibition floor, and a 25-company job fair. And on top of it all, Photonics West featured a packed calendar of special events, from EDI workshops to the highly popular Paws for a Break sessions with therapy animals, and focused networking events aimed at increasing global collaboration and advancing careers.

In addition, a program of fifty courses offering expert-led professional development and learning included a top-rated "Optical technologies and architectures for virtual reality, augmented reality, and mixed reality head-mounted displays" taught by 2023 SPIE president and Google AR director Bernard Kress.

While the week held myriad opportunities for attendees to learn, network, and share their latest advancements, it was the buzzing exhibitions, including 52 companies at AR|VR|MR, that best showcased the increasingly vital photonics industry and the importance of in-person meetings.

"It has been fun to see everybody back and excited to see what is in store for the coming year," said Ibsen Photonics senior business development manager Heidi Olson. "We have had new leads and have also been able to reconnect with a lot of projects that had slowed because people just weren't here or weren't connecting. It has been fun to see the new

opportunities re-emerging. It finally feels more like 2019, except I think it is even better now: the layout is so open, so the whole thing feels like one cohesive show."

"We have been very pleased with the number of attendees, with quite a good mixture from industrial to scientific researchers," added MKS senior director of product marketing Scott White. "And we have been very pleased with how many attendees have been showing up with real projects to talk about. It is great to be back and meeting people face-to-face again."

"Honestly, we are right back where we were before the pandemic," noted Hamamatsu senior marketing coordinator Alison Kohyama. "There has been a great amount of traffic at the booth, people seem to be even more engaged, wanting to discuss their projects, because they haven't been able to in a while." For Kohyama and her colleagues, SPIE Photonics West offered an extra, company-focused bonus: "It has actually been wonderful because a lot of us don't get to see each other anymore, so as far as networking within the company it has been great too – we haven't been able to do that in-person in a long time."

Also during the Photonics West week, SPIE invited applications for the 2023 SPIE Endowment Matching Program.

SPIE Photonics West 2024 will take place 27 January to 1 February at the Moscone Center in San Francisco. The call for papers for the 2024 event will open in spring of 2023.

<https://spie.org>

ICULTA 2023 – International Conference on UV LED Technologies & Applications



23 – 26 April 2023, Berlin, Germany

The conference series will continue in April as an in-person event in Berlin, Germany, following the great success and increasing demand from the UV LED community.

Since the Covid-19 pandemic, UV LED technologies have moved into the international focus of attention. The demand, once focused on disinfection, has now opened up applications across all sectors worldwide. From the disinfection of air and surfaces with UV LED based systems in public areas to controlling viruses, fungi and bacteria in health care and for medical treatment, the technology has moved out of niche applications. The compact, envi-

ronmentally friendly and flexible light sources continue to enable many new applications in curing materials, plant growth lighting, environmental monitoring, and medical diagnostics – to name just a few.

The ‘International Conference on UV LED Technologies & Applications’ was initiated by the Advanced UV for Life network. Together with the International Ultraviolet Association (IUVA), the conference has been held twice so far – in 2018 and 2021. This internationally-recognized and appreciated conference series continues with ICULTA 2023. This year’s event is jointly organized by the Advanced UV

for Life e.V. association and the Ferdinand-Braun-Institut Berlin in cooperation with the International Ultraviolet Association (IUVA).

The Advanced UV for Life brings together research leaders in the field of UV radiation sources and users of UV technology. It pools the competencies from industry and science along the entire value chain – from concept and UV semiconductors to UV applications in medicine, disinfection, life sciences, environmental technology, sensing, and manufacturing technologies.

www.iculta.com
www.advanced-uv.de

EMVA Business Conference 2023 in Seville

4 – 6 May 2023, Seville, Spain



In the first week of May the EMVA Business Conference will once again unite business leaders and technical experts within the machine vision industry from Europe and around the world to present and discuss the trends and challenges of the vision-tech business. The pivotal event for the machine vision and image processing industry provides a unique

platform in Europe for networking, establishing contacts, and exchanging ideas. CEOs, managing directors, corporate strategists, marketing directors, technical managers, and other executives of our business will meet in a unique atmosphere with plenty of space to exchange market intelligence and news of innovative technologies. As 2023

marks the 20th anniversary of the European Machine Vision Association, this will also be the occasion to celebrate this birthday in Spain, where the EMVA was founded two decades ago. More information and registration at

www.business-conference-emva.org

Control – international trade fair for quality assurance

9 – 12 May 2023, Stuttgart, Germany



Control is one of the most important, large international trade fairs covering the field of quality assurance (QA) and will be held for the 35th time this year. “We are pleased that more bookings have already been received than at the same time in 2022”, reports project manager Fabian Krüger from trade fair promoters P. E. Schall. “At nearly 37 %, the proportion of foreign exhibitors already exceeds the figures for 2022,” he says. “The innovations in quality control and quality assurance presented in Halls 3, 5, 7 and 9 are sure to arouse lots of interest and curiosity,”

promises Krüger. The reason: measurement and test technology continues to develop at a rapid pace – on the one hand because new fields of application are opening up, and on the other hand because increasing automation continues to be a key driver. “As representatives of the exhibitor community as a whole, our exhibitor advisory committee recently reiterated the importance of Control,” explains the project manager: “Control is by far the world’s best trade fair in the field of quality assurance. It is unique throughout the global market because it features different types of metrology, and is relevant for all industry sectors.”

For many companies it is not only relevant, but rather indispensable as well and Control has evolved into a firm entry in the trade fair calendar for the metrology sector. “We are looking forward to the 35th Control with special anticipation,” explains Bettina Schall, managing director of trade fair promoters P. E. Schall. “Exhibitors as well as expert visitors appreciate the thematic focus of Control as an industry highlight. This makes it a highly esteemed business platform. Highly present, pragmatic and practice-oriented – this will be the hallmark of Control, to which we will warmly welcome all industry players.”

www.control-messe.de

Sensor+Test 2023

9 – 11 May 2023, Nuremberg, Germany

The leading international trade fair for sensor, measuring and testing technology will be held at the exhibition center in Nuremberg again (cf. p. 9). More than 350 exhibitors are expected at the Innovation Dialog. With the lifting of many Corona restrictions worldwide, the interest of international exhibitors in particular has also grown considerably.

“We will welcome our exhibitors and visitors again in the exhibition halls of NürnbergMesse in May,” Holger Bödeker, managing director of AMA Service GmbH, is pleased to say. “We expect more than 350 exhibitors in Halls 1 and 2 this

year. Even if this does not quite bring us up to the figures of the exhibition before Corona, Sensor+Test will not lose anything in terms of attractiveness, but will even gain with numerous highlights.”

The participation of international exhibitors is also positive. In addition to Switzerland, from which most companies have been coming for many years, a large number of British companies will be present in May. Several companies and delegations from China have also confirmed their participation.

The extensive supporting program, which has already characterized the Sen-

sor+Test for many years, will again be accompanied by a top-class lecture forum in 2023.

From May 8 – 11, the SMSI 2023 – Sensor and Measurement Science International Conference – will be held as a presence event in Nuremberg for the first time, after it had only brought together numerous national and international scientists, developers and experts digitally in 2021.

In the run-up to the event, a whole range of innovations and topics can be found on the website at:

www.sensor-test.de



CLEO 2023

9 – 11 May 2023, San Jose, California, United States

CLEO returns to the San Jose McEnery Convention Center 7 – 12 May for the conference and 9 – 11 May for the exhibition for a live, in-person event.

For more than forty years, the Conference on Lasers and Electro-Optics has served as the proving ground for innovators and breakthrough technologies. It is the global stage where next-generation innovations reach the marketplace. Now more than ever, it is essential to stay connected with your customers and develop new relationships. Participating in CLEO enables

you to reach a global audience of buyers and industry leaders while connecting with innovative professionals looking for opportunities to forge a career in the industry.

Join industry-leading companies and connect with innovators that understand the value of face-to-face marketing and have positioned themselves in this lucrative marketplace. CLEO is where products are launched, business gets done and your company prospers.

CLEO 2023 will have a show floor theater that hosts technical sessions, timely

talks on the latest business trends and the Plenary Sessions. To further enhance the show floor experience, Technology Showcase sponsorships are the perfect opportunity to educate attendees on your company's products and services during 20-minute sessions in the Theater. The Hub will host a Student Lounge, and the show floor will stay open late to host the Conference Reception.

www.cleoconference.org

19th Rapid.Tech 3D

9 – 11 May 2023, Erfurt, Germany

Among the early bird registrants for Rapid.Tech 3D were international companies such as Arburg, Farsoon, FIT, Stratasys, Toolcraft and Trumpf. In addition to established suppliers and users of industrial 3D printing technology and services, Rapid.Tech 3D will again provide a platform for start-ups and innovative university projects in 2023. To this end, Messe Erfurt is offering special exhibition areas and is once again providing compact stands for the big, all-inclusive display in the ‘Additive Area’.

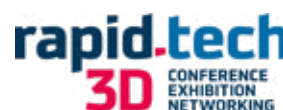
The AM specialist conference will be at the heart of Rapid.Tech 3D once again in 2023. The advisory board and

trade fair team have further streamlined its structure and tailored it to provide an even better fit to users' needs. The new trade forums on “Plant Engineering and Process Technology” as well as “Post-Processing and Quality Assurance” will address precisely the topic that is currently of most concern to users of additive technologies: ensuring reliable end-to-end AM process chains. The trade forums on “Software & Processes, Design, and New Applications in AM” will also share key insights. Industry-specific AM innovations will again be on the agenda in the Medical Technology, Mobility and Aviation

trade forums. The latest findings from research will be presented at the AM Science forum.

Rapid.Tech 3D already welcomed numerous international guests in 2022. The trade visitors, numbering over 2,500 in all, came to Erfurt from 18 countries. They learned about new products and services in additive manufacturing from 97 exhibitors from eleven countries, including the US, the United Kingdom, Austria and Switzerland. Visitors were delighted with the conference program, which featured ground-breaking keynote addresses and trade forums.

www.rapidtech-3d.com



21st EPHJ – The World of High Precision

6 – 9 June 2023, Geneva, Switzerland



The very best of the high-precision community – whether in watchmaking jewellery, microtechnology or med-tech – are looking forward to meeting in Geneva for EPHJ. The show will be a fine opportunity for representatives of brands and finished products to explore and discover, with great interest, the very best of what the market has to offer while having time to expand the number of actual contacts they can make in a few days or even in just a single day.

2022 has seen a strong recovery in the high-precision sectors, especially in the Swiss watch and jewellery industry,

which has set new records for export sales. This trend had already become clear during the last EPHJ in June '22. The subsequent satisfaction survey of exhibitors revealed that 84 % of them had done business at the show or had very promising prospects for the near term.

Some might think – and understandably so – that attending a trade show is not really necessary when order books are full and personnel have too much work already, but EPHJ's two-decades history and market expertise prove the opposite.

EPHJ is and will remain the only platform in the world where nearly 20,000 Swiss and international visitors meet every year representing all the major watch and jewellery brands, as well as medtech and microtechnology companies.

Save the date: Swissphonics 'Photonics 4 Masterpieces', Thursday, 8 June 2023.

<https://ephj.ch>

Laser World of Photonics, World of Quantum & Automatica

27 – 30 June 2023, Munich, Germany



Automatica is back this year: the exhibition is changing its rhythm to be co-located with Laser World of Photonics. Both world-leading exhibitions will be held simultaneously for the first time in June 2023, followed by a simultaneous recurrence under one roof every two years.

Dr Reinhard Pfeiffer, managing director of Messe München explains: "Both Laser and Automatica cover a wide range of production-related topics and offer solutions across sectors. And they have overlaps that can be leveraged. This will result in added value for exhibitors and visitors of both leading exhibitions, making their attendance and presentations even more worthwhile." So lasers are indispensable for welding, cutting, marking, and sensing in highly automated production lines. And what would robotics be without optical and laser-based machine vision? At the same time, the economic benefits of many laser applications can only be harnessed in combination with robots.

This results in a win-win situation for both exhibitions: expanded coverage, improved cost efficiency for both exhibitors and visitors, and increased attention and appeal for two popular co-located leading exhibitions focused on future-oriented trend technology.

Dr Wilhelm Kaenders, chairman of the exhibitor advisory board and mem-

ber of the board at Toptica Photonics, also sees the advantages: "A co-located Automatica is a perfect complement to Laser. Automation components such as robots, machine vision systems and the like are particularly important in the sector of laser systems for production engineering. Optical metrology is another field in which the solutions presented at both exhibitions mesh like gears. This makes for advantageous co-location and creates a catalyst for innovation."

Also co-located with Laser again will be the World of Quantum exhibition, complemented by the World of Photonics Congress. With almost 9,000 trade visitors, 75 exhibitors, and 128 specialist presentations, the premiere of World of Quantum in 2022 gave everyone involved a taste for more. There was a spirit of optimism, and the quantum community immediately made the new platform its own to establish networks. "Our basic idea for setting up World of Quantum as an independent trade fair within Laser World of Photonics proved to be a resounding success," as exhibition director Anke Odouli explains, saying that there are extensive synergies between both trade fairs, since quantum technology is largely based on photonics and makes use of precision lasers and photonics components for many of its solutions.

The overlaps between the young World of Quantum and the established world's leading trade fair for photonics components, systems and applications have a major influence on the trade fair concept. After all, alongside the exhibition area with leading players from the field of quantum technology, it also provides space for information about the latest projects and a networking area. All three pillars – exhibit, inform, and network – create points of contact between the exhibitors of both trade fairs and the professional visitors. Partners from both worlds come together, can exchange expertise, envisage projects, or also get in touch with investors.

The concurrent events will be particularly attractive to many visitors because both exhibitions will be accompanied by an outstanding supporting program and fascinating presentations. With more than 6,000 participants, the World of Photonics Congress is one of the largest conferences for the photonics and laser industry, which covers all the latest advances in technology and science.

<https://world-of-photonics.com>

<https://world-of-quantum.com>

<https://automatica-munich.com>

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Laser beam sources: Solid-state lasers

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www.zuendoptics.com

Filters, optical

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Free-form optics



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LOGO?

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Phone +423 388 92 00
info.mbo@materion.com
www.materion.com/balzersoptics



Zünd precision Optics Ltd
Prismastr. 5
CH-9444 Diepoldsau
Tel. +41(0)71 737 74 00
Fax +41(0)71 737 74 10
info@zuendoptics.com
www.zuendoptics.com

Mirros, UV

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Balzers, Liechtenstein
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info.mbo@materion.com
www.materion.com/balzersoptics

Optical Components

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+49 (0) 6431 9860 – 0
info@bm-optik.de / www.bm-optik.de

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Balzers, Liechtenstein
Phone +423 388 92 00
info.mbo@materion.com
www.materion.com/balzersoptics



Zünd precision Optics Ltd
Prismastr. 5
CH-9444 Diepoldsau
Tel. +41(0)71 737 74 00
Fax +41(0)71 737 74 10
info@zuendoptics.com
www.zuendoptics.com

Prisms

B&M Optik GmbH
Am Fleckenberg 20, 65549 Limburg
+49 (0) 6431 9860 – 0
info@bm-optik.de / www.bm-optik.de

Optics Balzers AG
Balzers, Liechtenstein
Phone +423 388 92 00
info.mbo@materion.com
www.materion.com/balzersoptics



Zünd precision Optics Ltd
Prismastr. 5
CH-9444 Diepoldsau
Tel. +41(0)71 737 74 00
Fax +41(0)71 737 74 10
info@zuendoptics.com
www.zuendoptics.com

Windows, optical

B&M Optik GmbH
Am Fleckenberg 20, 65549 Limburg
+49 (0) 6431 9860 – 0
info@bm-optik.de / www.bm-optik.de



Zünd precision Optics Ltd
Prismastr. 5
CH-9444 Diepoldsau
Tel. +41(0)71 737 74 00
Fax +41(0)71 737 74 10
info@zuendoptics.com
www.zuendoptics.com

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Interested?

Please contact:

Änne Anders

**Phone: +49(0) 62 01 – 606 552
aanders@wiley.com**

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Laser welding

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www.evossys-laser.com
sales@evossys-laser.com

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3D-Laserscanning-Entspiegelungsspray
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info@polytec.de

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info@polytec.de

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info@polytec.de

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info@polytec.de

Transmission/reflection measurement of thin films



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www.essentoptics.com

Velocity measurement

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info@polytec.de

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info@polytec.de

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Application development/ Application laboratories

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www.ilt.fraunhofer.de

Optical development and engineering companies

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Steinbachstraße 15, 52074 Aachen
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Please contact:

Änne Anders

Phone: +49(0) 62 01 – 606 552
aanders@wiley.com

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For advertising please contact

Änne Anders phone +49(0)6201 606-552
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DATES & CONTENTS

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16 January 2023 Publishing date
12 December 2022 Advertising deadline
15 November 2022 Editorial deadline

Focus: Photonics West

- Spectroscopy
- Laser Sources
- Optical Components

SPIE. PHOTONICS WEST

2

5 April 2023 Publishing date
3 March 2023 Advertising deadline
6 February 2023 Editorial deadline

Focus: 20th Anniversary Issue

- Laser Materials Processing
- Optical Measurement
- Industrial Machine Vision
- ➔ with Company Profiles

3

20 June 2023 Publishing date
15 May 2023 Advertising deadline
17 April 2023 Editorial deadline

Focus: LASER World of PHOTONICS **LASER** **PHOTONICS**

- Laser Systems
- Photonics for Quantum Technology
- Ultrashort-pulse Laser Sources
- ➔ with Product Reports

4

01 September 2023 Publishing date
01 August 2023 Advertising deadline
05 July 2023 Editorial deadline

Special section: Digital Tools, Design Software and Simulations

- Fibers and Fiber Optics
- Optoelectronics, Silicon photonics, PICs
- Optical Systems and Components

5

19 October 2023 Publishing date
15 September 2023 Advertising deadline
21 August 2023 Editorial deadline

- Additive Manufacturing
- Laser Plastics Processing
- Laser Welding und Cutting

Trade fairs



6

05 December 2023 Publishing date
02 November 2023 Advertising deadline
05 October 2023 Editorial deadline

Focus: Automotive applications

- Lasers Welding and Cutting
- Beam Forming, Beam Analysis
- Laser Materials Processing

High Precision Laser Cutting of Electrical Steel

Improved mechanics and laser synchronization provide a unique combination of precision, high overall throughput, and guaranteed part repeatability

Electrical steel is the typical material for the production of electric motors and generators. The material is characterized by its high magnetic permeability and low electrical resistance. The laser cutting process is used to produce high-precision parts for these applications. The process involves a laser beam cutting through the steel, which is then guided by a CNC system. The result is a highly precise part that meets the requirements of the application.

Four-Color Laser Engine for Efficient Confocal Microscopy

Direct modulation at 561 nm using FODL technology enables unique performance

Frequency-doubled diode laser technology (FODL) enables direct modulation at 561 nm with unique performance. This technology is used in confocal microscopy to achieve high-resolution imaging. The FODL engine consists of a diode laser, a frequency doubler, and a direct modulation circuit. This setup allows for efficient and precise laser modulation, leading to improved microscopy results.

Coherence Matters

Coherence is a key property of light that determines its ability to form interference patterns. In many applications, such as in optical communications and quantum computing, maintaining coherence is crucial. This article discusses the importance of coherence and how it can be managed in various optical systems.

Fiber Optic Components

Fiber optic components are essential for many modern communication and sensing systems. These components include connectors, couplers, and filters, among others. They enable the efficient transmission and manipulation of light signals through optical fibers.

Lasers for Machine Vision

Lasers are used in machine vision for a variety of applications, including object detection, measurement, and classification. Laser-based systems provide high-contrast images and precise measurements, making them ideal for industrial inspection and quality control.

Technical Article

"Full Paper" including company information box, author biographies, and contact addresses. Text 10,000 to 16,000 characters, 4 – 6 figures including one opening graphic or photography (300 dpi, or vector format)

Application Report

Addressing the use of a device / technology with a customer / partner. Text: 6,000 to 10,000 characters, 2–4 figures including one opening graphic or photography (300 dpi, or vector format)

Product Report

Addressing a new device / technology with technical details / application example(s). Text 2,000 to 5,000 characters, 2 – 3 figures including one large format opening photography (300 dpi, or vector format)

Edmund Optics Features New Products

Edmund Optics, a leading provider of optical components, has introduced a new line of products. These products include high-precision lenses, mirrors, and filters, designed for a wide range of applications. The new products are made from high-quality materials and are manufactured using advanced techniques, ensuring superior performance and reliability.

Contact:

Advertising: Anne Anders, +49 6201 606 552, aanders@wiley.com ■ **Editorial:** Dr. Oliver Dreissigacker, photonicsviews@wiley.com

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Wiley-VCH GmbH
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Editorial:
 Dr. Oliver Dreissigacker (od; responsible), Stephanie Nickl (sn)
 Phone: +49 (0)6201 606-181 / -030

Boschstr. 12, 69469 Weinheim, Germany
 Fax: +49 (0)6201 606-328
 e-mail: photonicsviews@wiley.com
 www.photonicsviews.com

Contributing Editors:
 Dr. Christel Budzinski (cb)
 Carsten Heinisch
 Jan Oliver Löffken

Copy editing: Matthias Erler, David Jayne

Subscriptions:
 Wiley GIT Reader Service
 65341 Eltville, Germany
 Phone: +49 (0)6123 9238 246
 Fax: +49 (0)6123 9238 244
 e-mail: WileyGIT@vusevice.de
 Our service is available for you from Monday to
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Advertising:
 Anne Anders (responsible)
 Boschstraße 12, 69469 Weinheim, Germany
 Phone: +49 (0)62 01 60 65 52
 Fax: +49 (0)62 01 60 65 50
 e-mail: aanders@wiley.com

Nicole Schramm (Executive)
 Boschstraße 12, 69469 Weinheim, Germany
 Phone: +49 (0)62 01 60 65 59
 Fax: +49 (0)62 01 60 65 50
 e-mail: nschramm@wiley.com

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 JP Morgan AG, Frankfurt, Germany
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