Volume 20 December 2023 / January 2024

6

PhotonicsViews

OPTICS • PHOTONICS • LASER TECHNOLOGY

COVER STORY

A quarter-century of innovation

FOCUS SECTION

Automotive applications of optics, photonics, and laser technology

WILEY

published in media partnership with

EPIC EOS

publishing medium of

PHOTONICS GERMANY DGaO

New Decade
New Logo
Same Mission

20 YEARS

EPIC
EUROPEAN PHOTONICS INDUSTRY CONSORTIUM

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.

PLATINUM SPONSORS

HAMAMATSU
PHOTON IS OUR BUSINESS

PI

TRUMPF

GOLD SPONSOR

Altechna

SILVER SPONSORS

art photonics

Edmund optics | europe

FOCUSLIGHT
Never stop exploring

Ibsen photonics

JENOPTIK
MORE LIGHT

LASER COMPONENTS

LIONIX INTERNATIONAL

LUMIBIRD
MORE THAN LASERS

OptoSigma

SUSS MicroOptics

What's driving the automotive sector?

Photonics as a key enabler of low carbon transportation right now

As Europe comes to terms with climate change and the actions needed to reach net zero by 2050, the automotive industry is under the spotlight to both accelerate the electrification of vehicles and to look long-term for other solutions that deliver easy, cheap, and environmentally sound travel.

The world demands absolute safety, total convenience and zero emissions. How we wrestle with these conflicting demands is a big issue as we move towards fully autonomous driving, with lidar and AI providing safe, expert driving and navigation using vision and illumination.

There have always been a wide variety of applications for lasers in the automotive industry: welding bodies, trimming interiors, joining polymers, gear trains, and engine parts to name a few. On top of these, the use of laser marking to give permanent traceability is a must-have in all manufacturing today – facilitated by hugely more efficient fiber lasers, and with the cost per watt tumbling year on year.

With the electrification of cars – and buses, trucks, trains, and aircraft, too – we see the vehicles moving from the drawing board of mechanical engineers to the computer screens of 3D designers that integrate more electronics and photonics 'under the hood' than ever before. 3D printing with lasers creates metallic assemblies with more strength and less weight. Batteries have become more efficient, but their capital cost is still around forty percent of the cost of the car. This drives the construction of gigafactories in the USA and Europe as we realize that our dependency on Chinese-made batteries is too high. Laser welding of dissimilar and highly reflective metals is a growing market, together with structuring applications to make the anode and cathode surfaces more efficient.

I wonder if we are looking far ahead enough. Do hydrogen fuel cells or ammonia internal combustion engines stand a chance of being viable by 2050? How much will autonomous driving and solar power charging alter our car usage in the years to come, not to mention the 'flying cars' that drone technology promises to deliver soon?

Dave MacLellan

Source: Anode Marketing

Dave MacLellan
executive director
Association of Industrial Laser Users AILU

AILU
ASSOCIATION OF INDUSTRIAL LASER USERS

PhotonicsViews
OPTICS • PHOTONICS • LASER TECHNOLOGY

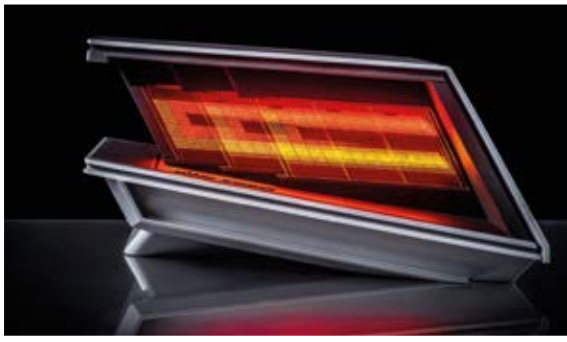
26 Spectral imaging made easy

30 Laser processes are shaping e-mobility in Europe

37 Switching from opaque to transparent

Contents

6/2023



Previews

Cover:

Laser rack systems for quantum technology research at the University of Saarland: six laser rack systems, two DFCs, and many Toptica lasers for atom-atom entanglement over 20 km of fiber.

p. 24

VDMA and Spectaris against PFAS ban

The PFAS consultation phase of the European Chemicals Agency (ECHA) has come to an end. A survey by the two industry associations Spectaris and VDMA shows the shortcomings of the chosen process. According to the associations, the EU's planned general ban on the PFAS group of substances would be an enormous threat to high-tech industries.

The substance group of per- and polyfluoroalkyl substances (PFAS) is of enormous importance for industrial production because these substances hardly show any wear even under extreme temperatures or in aggressive environments – such as acid processes. This means that PFAS are virtually indispensable for many production steps, for example in the manufacture of medical devices, semiconductors or in clean rooms, because there are no alternative substances that have similar quality or safety.

Of course, very careful handling of dangerous substances is necessary in order to protect people and the environment as much as possible. But of course it is also necessary to take a more differentiated approach, as well as to carefully weigh up the benefits and risks that can arise when using these substances. Manufacturers of medical technology products, semiconductors and other high-tech devices rely on the use of PFAS components – and are therefore concerned that a general ban planned by the EU on all approximately 10,000 PFAS would cause considerable economic and social damage.

The responsible European authority ECHA gave companies the opportunity to express their concerns about the planned ban until 25th September 2023. Large numbers of companies from the medical technology and mechanical and plant engineering sectors took advantage of this opportunity. Approximately every second company took part in the consultation process, as a recent survey by the two industry associations Spectaris and VDMA among their member companies showed.

The survey also shows that only some of the applications were covered by the consultation process. Around a third of all companies have their products affected, but are unable to submit exceptions due to the difficult data situation. For these cases too, the ECHA envisages a blanket immediate ban, similar to frying pans and raincoats, which massively endangers the ability of German high-tech companies to survive and innovate, but ultimately also affects the supply of essential products to the population.

In a press conference in Frankfurt, Stefan Dräger, CEO of Drägerwerk, and Dr Stefan Rinck, CEO of Singulus Technologies and chairman of the research and innovation committee in the VDMA, discussed the possible effects of a general PFAS ban. Stefan Dräger: "Their durability makes these materials so indispensable. The development and approval of alternatives, if they exist at all, would not be feasible within the proposed deadlines because their clinical validation and biocompatibility testing are very time-consuming, not least due to the high regulatory requirements for medical technology."

www.vdma.org
www.spectaris.de

Best business prospects for additive technologies

"Even though the weak economy is clouding the outlook for the next six months, the mood in our industry remains positive," says Dr Markus Heering, managing director of the additive manufacturing working group within the VDMA, summarizing the results of the fall 2023 survey among the member companies. While 38 % of respondents expect growing sales in the domestic market and only 35 % export growth in the coming six months, the outlook is all the more positive the further into the future it goes: more than half of the members surveyed expect a return to growth in the German market in the next twelve months. In the two-year outlook, 70 % expect rising sales in Germany and 62 % export growth.

Europe remains the most important export region for almost four-fifths of respondents. The USA follows in second place with 59 % of the mentions, ahead of the EU-27 countries. By contrast, exports to Asia and China remain at a low level. Before the pandemic, every third member surveyed named China as one of the most important export markets. In the current fall survey, Asia including China now accounts for only 13 % of the mentions.

Entire value chain is represented

The additive manufacturing working group in the VDMA brings together players from all areas of the additive process and value chain. The largest groups are AM service providers and manufacturers of AM components for their own use. Users of purchased AM components, providers of AM equipment and their suppliers, and post-processing specialists are also strongly represented. Most respondents continue to cite prototyping as the focus of additive manufacturing during product development. But 29 % now use AM processes in volume production. Other applications include tools, spare parts and demonstrators. According to the survey, this distribution will remain for the time being.

AM industry looks to the future

Two-thirds of the members surveyed had a positive view of the last fiscal year. 30 % reported growth in the single digits – and a further 36 % in the double digits. Of these, as many as 16 % reported in the fall survey that their sales had increased by more than a fifth within the last twelve months. "However, we are registering with concern that business development slowed down in the last half of the year and that one fifth of our member companies had to report declining sales, in some cases significantly," reports Heering.

Against this background, the current reluctance to invest is understandable. Only a quarter of those surveyed plan to invest more in AM in the coming half-year. In contrast, two-thirds want to maintain their current level of investment. However, the overall positive mood is already taking hold in the medium term. In the outlook for the coming twelve months, 44 % of respondents say they plan to increase their AM investments again. "Given the difficult economic conditions, this is proof that the AM industry is keeping a firm eye on its future," explains Heering.

www.vdma.org

Major automation order for electric vehicle production in North America

Prodomax has secured a contract with an existing customer for the turnkey design, construction, and commissioning of four robot welding assembly lines.

Prodomax, based in Barrie, Ontario, Canada, currently employs around 180 employees and specializes in process automation in the automotive industry. "As a specialist for fully automated assembly lines, we have established ourselves as a reliable partner of the US automotive industry," says Bradley Parcher, general manager of Prodomax.

Companies of the 'non-photonic portfolio' of the Jenoptik group offer products, automation solutions as well as services for industrial customers, and above all, support the trend towards more flexibility and efficiency in production processes, especially in the automotive industry.

www.jenoptik.com

Prodomax automation line (Source: Jenoptik)

Coherent: billion dollar investment from Denso and Mitsubishi Electric

The silicon carbide semiconductor business enters into long-term supply agreements to satisfy 150 and 200-mm substrate and epitaxial wafer demand.

Under the terms of the transaction that was announced in May, Denso and Mitsubishi Electric will each invest $ 500 M in exchange for a 12.5 % non-controlling ownership interest in the business, with Coherent owning the remaining 75 %. Prior to the completion of the transaction, Coherent will separate and contribute the business to a subsidiary, control and operate it, under the continued leadership of Sohail Khan, Coherent's EVP for new ventures and wide-bandgap electronics technologies.

Market estimates indicate that the silicon carbide (SiC) total addressable market will grow from $ 3 B in 2022 to $ 21 B in 2030, representing a 28 % compound annual growth rate.

The transaction builds on Coherent's more than two decades of demonstrated leadership in SiC materials. In recent years, the company has aggressively invested to scale its manufacturing of 150 mm and 200 mm substrates to address this underserved market.

Over the past two years, Coherent has invested aggressively in capital and R&D for SiC as part of its ten-year, $ 1 B commitment announced in August 2021. The closing of this $ 1 B combined investment into the business will accelerate the company's capital plans in the coming years. Specifically, the investment will fund the manufacturing expansion of the business's substrates and epitaxial wafers and, in combination with the concurrent supply agreements, enhance its position in the market.

When incorporated into electric vehicles and industrial infrastructure, SiC-based power electronics have demonstrated the potential to significantly reduce carbon dioxide emissions and accelerate the transition to a cleaner and more energy efficient world.

Through the rapidly growing demand for SiC power devices, Coherent, Denso, and Mitsubishi Electric will accelerate their contribution to sustainable energy consumption and the decarbonization of society.

The transaction is expected to close in the first quarter of calendar year 2024.

www.coherent.com
www.denso.com
www.mitsubishielectric.com

Windshield with built-in thermal camera to improve driving safety

Lynred and Saint-Gobain Sekurit have developed a windshield that incorporates both visible and thermal cameras side-by-side.

The windshield with an enhanced detection system is designed to help car makers improve the reliability of collision mitigation systems.

Source: Saint-Gobain Sekurit

Video-demonstration of windshield for PAEB systems

The sensor system enables thermal imaging through standard windshields. It detects and classifies pedestrians up to 140 meters away in all weather and lighting conditions.

Saint-Gobain Sekurit has developed crystal-based technology to create a transparent area in the windshield that aligns both the visible and thermal imaging cameras. The crystal meets Federal Motor Carrier Safety Administration (FMCSA) requirements and is integrated while maintaining the original performance of the wiper system and the thermal comfort of the passenger compartment.

Lynred supplied a VGA thermal sensor (640 × 480 resolution) equipped with Umicore lenses, and configured the camera data input with the pedestrian detection algorithm.

Traditionally, the heat sensors were mounted behind the grille, exposing them to mud, dirt impacts, and other elements. Positioning the visible and heat sensor systems behind the windshield increases AEB's reliability by improving visibility in all scenarios.

www.lynred.com
www.saint-gobain.de

AM Solutions partners with EOS, FKM, Shapeways

Under the brand name AM Solutions, Rösler Oberflächentechnik offers numerous equipment solutions and services in additive manufacturing / 3D printing. New cooperations have been sealed in the wake of the Formnext trade fair in Frankfurt, Germany.

EOS and AM Solutions have joined forces to focus on advancing the entire additive manufacturing process chain. In order to make the leap to mass production, the individual steps leading to the finished product must become increasingly automated and significantly more economical. There is a lot of potential in the interfaces.

Both companies are owner-managed, develop and produce their machines in Germany and embody the values of successful, medium-sized German companies. EOS and AM Solutions are working to take selective laser sintering (SLS) to the next level on an industrial scale.

FKM Additive Manufacturing, headquartered in Biedenkopf, Germany, provides high-quality 3D printed products on an industrial scale to customers around the world and is a technology leader in industrial powder bed laser melting. FKM's purchase of an S2 system from AM Solutions marks the beginning of the partnership.

Marie Langer (EOS) and Stephan Rösler (AM Solutions) shake hands at Formnext (Source: Rösler)

On Thursday at Formnext, AM Solutions signed an agreement with leading digital manufacturing and 3D printing expert Shapeways Inc, which will – just like FKM – join its beta partner programme for the C2.

www.solutions-for-am.com
www.eos.info ■ www.fkm.net
www.shapeways.com

€ 300 M to drive next-generation optoelectronic semiconductor technologies

The German federal government and the Free State of Bavaria intend to provide IPCEI funding of 300 million euros to boost the further development of semiconductor technology. The envisaged Important Project of Common European Interest (IPCEI) funding will support AMS Osram in making its own investments in the research and development of innovative optoelectronic components at its Regensburg, Germany, location.

Source: AMS Osram

The company presented its project, launched within the scope of the IPCEI ME/CT, at a German Federal Ministry for Economic Affairs and Climate Action (BMWK) event on September 18, 2023. With the envisaged public funding, the BMWK confirms that this project is of European significance – and supports the related investments in cooperation with the Bavarian Ministry of Economic Affairs, Regional Development and Energy.

The application for public subsidies is subject to the official notice of the grant. The amount will be mainly invested in the research and development of innovative optoelectronic semiconductors and their manufacturing processes, thus creating four hundred new high-tech jobs. In addition, AMS Osram will invest in new clean room and laboratory facilities for research, development and pilot production – perfectly equipped for working on various innovative applications (e.g. UV-C LEDs for disinfection and near-infrared emitters for lidar for autonomous driving), as well as on applications in the context of Industry 4.0.

Another special focus will be microLEDs for use in an all-new type of display. Automation and artificial intelligence (AI) generally play a major role in Regensburg, enabling the company to break new ground at its production facilities. The construction of the first pilot assembly line for 8" wafer production is currently underway in order to launch the cost-efficient large-scale production of highly innovative microLEDs in the very near future.

https://ams-osram.com

Call on the EU to support building a resilient supply chain for PICs

A group of CEOs presented the EU Commission with a 4.25 billion euro plan to support growth of the industry that is critical to applications including high speed internet, data security, autonomous vehicles and quantum computing.

Source: Smart Photonics

Smart Photonics's CEO Johan Feenstra (l) handed over the PIC strategy to the EU's Thomas Skordas and Lucilla Sioli

The plan calls for € 4.25 B in funding over eight years and a range of recommendations to enable the European integrated photonics industry to become a global leader and have the ability to supply EU customers autonomously. Photonic integrated circuits (PICs) open the door to the creation of smaller, faster and more energy-efficient devices. They are already being used in a range of innovations in tele and datacom, autonomous vehicles, quantum communication and agriculture.

The CEOs of XFAB, Smart Photonics, Aixtron, Phix Photonics Assembly, VLC Photonics, Almae, Ligentec, and PhotonDelta unveiled the plan at PIC Summit Europe in front of more than 500 members of the global photonics and semiconductor communities.

https://smartphotonics.nl

New collaborative center of excellence for cutting-edge microscopy

Leica Microsystems has launched a joint venture with the University of Oxford, UK, covering optical and super-resolution microscopy, artificial intelligence, correlative microscopy, and EM specimen preparation. The center of excellence will be hosted by the Micron bioimaging facility within the department of biochemistry at the University of Oxford and will feature imaging solutions from Leica Microsystems, such as the Stellaris 5 confocal microscope platform and the Mica microhub.

Source: Leica Microsystems

Ribbon-cutting ceremony for the center of excellence in Oxford

In pursuit of a joint mission to advance scientific research and promote state-of-the-art microscopy techniques, this new partnership brings together the expertise of Leica Microsystems, known for its precision microscopy and imaging instruments, with the academic excellence of one of the world's leading universities.

Integral to the center's mission is the advancement of learning by establishing a collaborative culture of training and nurturing a network of future talent. It will provide a place for experts from across the scientific community to come together and share knowledge through workshops and seminars. Furthermore, immersive training sessions will help scientists to experience the latest microscopy and imaging technologies, such as super resolution live cell imaging with the Stellaris STED microscope or correlations between cryo EM and microscopy using Cryo CLEM.

"We are excited to partner with the University of Oxford's Department of Biochemistry to establish this center of excellence," says Darin Stell, senior VP global commercial operations at Leica Microsystems. "By combining our technological expertise with the academic strength of Oxford, we aim to accelerate scientific discoveries and inspire the next generation of scientists." Throughout its nearly 175-year history, Leica Microsystems has prided itself on partnerships with some of the world's leading research institutions. Darin says, "This new collaboration with the prestigious University of Oxford is part of our strong commitment to the UK scientific community, helping scientists to stay at the forefront of cutting-edge global research."

To celebrate the start of the collaboration, an inauguration day was held at Micron Oxford on September 22, attended by representatives from the University of Oxford and Leica Microsystems. The event featured scientific talks from renowned researchers as well as microscopy showcases that provided the chance to get hands-on with the latest innovations.

www.leica-microsystems.com

Peter Leibinger receives the LIA's Schawlow Award

Source: Trumpf

Dr-Ing eh Peter Leibinger

The chairman of Trumpf's supervisory board has received the Arthur L Schawlow Award of the Laser Institute of America (LIA) which recognizes outstanding achievements that lead to a fundamental understanding of laser technology and its application in industry, medicine, or daily life. The award is considered one of the most prestigious in laser research. Past recipients include Nobel laureates Theodor Hänsch and Gérard Mourou.

The LIA recognizes Peter Leibinger's extensive contributions to the photonics industry and his dedication to science and research. He is a leader in this field and has contributed significantly to the commercialization of the technology. Gilbert Haas, interim executive director of the LIA, said, "Peter Leibinger has advanced laser technology for decades. His innovative leadership, ardent support, and advocacy of lasers in science, politics and society contribute to the advancement of laser technology and applications worldwide."

The award ceremony honoring Peter Leibinger took place on Wednesday, October 18 at The Palmer House Hilton in Chicago, Illinois.

www.trumpf.com

www.lia.org

ALSO OF INTEREST

Your daily quantum of photonics news

WIN NEWS

Coherent wins 2023 IOP Business Innovation Award

The Axon laser has won one of three Business Awards from the Institute of Physics. The trophy was presented in a ceremony held October 30.

Creaform invests in its service centers

Company inaugurated new local service centers and is planning to open more.

University of Rochester awarded $18 million for new laser facility

The National Science Foundation has provided funding to design and prototype key technologies for EP-Opal.

The 2023 winners of Applied Photonics Awards

Fraunhofer IOF Young Scientists Awards for Innovative Theses presented.

Industry Awards at ECOC 2023

This year's awards went to Coherent, RAM Photonics, Marvell, Lightwave Logic, Huawei, China Mobile, Ciena, Keysight, and Infinera.

Lithuania and Taiwan deepen their collaboration

Marking a significant milestone in the advancement of laser technology and the emergence of new technologies, a Lithuanian laser laboratory was inaugurated in Taiwan on 11 September.

PI wants to work more closely with scientists

Physics Instruments (PI) relocates areas of research and development as innovation hubs in the immediate vicinity of universities and colleges.

Subscribe to the bi-weekly newsletter

WIN NEWS

Rewarding Quantum Effects: five award winners announced in four categories

The Quantum Effects Award, presented in 2023 for the first time, honors outstanding innovations that combine the traditional world and the quantum world, are used in different industries, facilitate individual services and open up new prospects.

An expert jury, chaired by Dr Daniel Stadler, deputy cluster manager at NanoMikro-WerkstoffePhotonik NRW and the quantum technologies spokesman for OptecNet Deutschland, judged the entries and chose the following companies as winners in the particular category:

Quantum Computing Hardware

Eleqtron GmbH (Germany) develops quantum computers based on ion trap technology. The use of Eleqtron's 'Magic' technology enables the company to construct its quantum computers with the aid of established technology that can be found in every smartphone, and to substantially speed up the availability of quantum computers for industry.

Award winners, presenters and moderators group picture (Source: Wiley)

Quantum Computing Software

Since error correction is a key element for the development of freely programmable, error-resistant quantum computers and their importance for more sustainable AI, the jury decided to present two awards.

Q-CTRL (Australia) conceived technology to minimize the number of qubits needed for error correction, thereby making quantum computers more robust. A large number of the available qubits are currently used to improve the reliability of the results.

Multiverse Computing (Spain) develops software solutions that provide services for companies, e.g. for optimization tasks, on modern quantum computers. Thanks to the company's software solution, AI can be trained up to 1,000 times faster with the aid of quantum computing data.

Quantum Sensing

NVision Imaging Technologies GmbH (Germany) tackled early detection of cancer by using quantum physical effects to improve diagnostics. Their technology allows the use of MRI scanners for close and routine examinations of tumor activity. Whereas changes in the development of tumors (growth or decrease) can currently only be detected over a period of months, the technology from NVision can already observe a change within one week.

Quantum Communication

Aliro Quantum (USA) provides a complete solution for secure quantum communication networks for companies. The solution includes design, emulation, integration and scaling of the network.

The official award presentation was held on the first day of the Quantum Effects trade fair. The trophies were handed over by jury chair and moderator Dr Daniel Stadler, Dr Nicole Hoffmeister-Kraut, Baden-Württemberg Minister for Economic Affairs, Labor and Tourism, Petra Olschowski, Baden-Württemberg Minister for Science, Research, and Art, Dr Gustav Kalbe, EU Commission, and Dr Volkmar Denner, speaker of the QuantumBW network.

messe-stuttgart.de

ERC starting grant: ultrafast lasers for materials processing

Source: RUB

Professor Clara Saraceno

Femtosecond lasers can be used to create high-precision microstructures, such as those needed for smartphone displays and automotive technology. Professor Clara Saraceno from Ruhr University Bochum aims to introduce a cheaper and more efficient laser technology to the market. To this end, she is receiving a proof-of-concept grant amounting to 150,000 euros from the European Research Council (ERC). The project entitled "Ultrafast 2.1 µm Holmium Lasers for GHz ablation" (Giga2u) will run for 18 months.

"New lasers that are faster and more efficient, while generating lower costs, could be a key technology for the market," points out Clara Saraceno, head of the photonics and ultrafast laser science group.

As part of her ERC 'Ter Aqua' starting grant, Clara Saraceno is currently developing femtosecond lasers that operate at wavelengths of 2.1 microns and with repetition frequencies in the GHz regime. They require less energy and are potentially more reliable than systems currently deployed in industry. They also promise lower costs and faster production speeds. So far, however, the systems have only been used for research applications, such as spectroscopy.

The Giga2u proof-of-concept grant is intended to demonstrate the potential of the technology for industrial applications. Such a system would be of interest primarily for processing glass and polymers, but also for ablating aqueous tissues. The latter could be useful for future directions in laser surgery application. The research group headed by Saraceno hopes to develop a compact and stable laser prototype and explore the technology's market potential. In the process, the group also intends to lay the groundwork for establishing a start-up.

www.rub.de

New managing director for Trumpf Photonic Components

Dr Thomas Harrer is the new head of the Trumpf subsidiary in Ulm, Germany, effective December 1, 2023. The 58-year-old takes over the role from Dr Berthold Schmidt, who has been managing the business in Ulm on an interim basis in addition to his duties as a member of the management board of Trumpf and as CTO. Harrer began his career at Trumpf in 1999 as an advisor to the group managing director for research and development. After earning his doctorate in electrical engineering, he held various management positions within the group. He is currently responsible for the optical systems business field and the Laser Application Center within the laser technology division.

Source: Trumpf

Dr Thomas Harrer

"I am very pleased that we were able to win Thomas Harrer for the management. He brings with him a high level of technological expertise and has a very good network in the industry and within the group," said Trumpf CTO Berthold Schmidt.

In his new role, Dr Harrer will continue to expand the VCSEL and photonics business and the technological know-how of the subsidiary.

www.trumpf.com

Management change at Instrument Systems Korea

Jaeho Choi took over the management of the Korean subsidiary of the light measurement technology manufacturer Instrument Systems as of 1 October 2023. With his many years of professional experience in the fields of display, optics and sensing, he will be responsible for strategically strengthening and further expanding the company in the coming years in this very dynamic business environment.

Source: Instrument Systems

Jaeho Choi

The subsidiary exclusively markets the complete Instrument Systems portfolio in Korea. It has strong engineering capacities and a production facility for components and systems for light measurement technology. Jaeho Choi succeeds Dr Jin Sung Kim, founder and former owner of Kimsoptec. Along with Jürgen Tiepermann and Dr Markus Ehbrecht, CFO and CEO of Instrument Systems, he will form the new board of directors.

In his new role Choi wants to step up efforts to tap the strategic potential of the future-oriented markets in Korea: "I look forward to the new tasks and challenges in a very dynamic business environment and would like to contribute to taking Instrument Systems Korea to the next level. We will continue the successful cooperation with Instrument Systems Munich and bring the teams in both companies closer together."

www.instrumentsystems.com

Excelitas appoints new CEO and CFO

Ron Keating

Ben Stas

Sources: Excelitas

The industrial technology manufacturer Excelitas Technologies appointed Ron Keating as its new chief executive officer and Ben Stas as chief financial officer. They succeed former CEO David Nislick and former CFO Jim Rao who have announced their retirement.

"Nearly twenty years ago, I joined Excelitas, the past thirteen of which I had the privilege of serving as its CEO," said David Nislick. "I am most proud of the culture Jim Rao and I have built, the thousands of employees across the globe who have joined our community and the significant value we have created."

"Jim and I are both committed to ensuring a smooth transition and have committed time to support the new leadership," added Nislick, who will remain on the Excelitas board of directors as an independent director.

Keating served the past nine years as president and CEO at Evoqua Water Technologies, which he took public in 2017 and sold to Xylem last year.

Stas served alongside Keating at Evoqua as the EVP, CFO, and treasurer. The two also had leadership positions at Kennametal, where they served before moving to Evoqua.

www.excelitas.com

Sven Schreiber appointed general manager

Laser Components Germany has appointed an additional managing director in Sven Schreiber. In his position as head of sales, Schreiber has been in charge of the company's sales and marketing activities since 2014. From November 2023 on, he joins company owner Patrick Paul at the helm.

Source: Laser Components

Sven Schreiber (l), Patrick Paul

Schreiber made his first contact to the photonics industry as a student of economics and business administration in the USA. In 2002, he joined Laser Components as an export manager and was instrumental in establishing the global distributor network that has been a cornerstone of the company's success story ever since.

"I have been working with Sven Schreiber for many years now," stated CEO and company owner Patrick Paul. "During this time, we realized that we always agreed when it came to important strategic decisions. Since I am going to put my main focus on the international activities of our company group, it seemed only natural to put Sven Schreiber in charge of our home market in Germany."

www.lasercomponents.com

Low-noise photoreceivers up to 400 MHz

Manufacturer: Femto Messtechnik
Product: Low-noise photoreceivers of the HCA-S series for the measurement of optical signals with bandwidths of 200 MHz and 400 MHz. The photo receivers are ideal for the highly sensitive and precise capture of pulses, even at high repetition rates and with rapidly changing signal shapes.
Features: The photoreceivers with built-in silicon or InGaAs photodiodes cover a spectral range from 320 to 1700 nm. They are fully DC coupled for accurate measurement of pulses without distortion. The incorporated ultra-low-noise transimpedance amplifier enables the sensitive measurement of optical powers down to 1 µW. An integrated offset circuit allows for compensation of the photodiode's dark current and unwanted background signals that mask the actual signal

of interest. The photoreceivers come in a well-shielded and compact metal housing for use on laboratory benches, even in narrow spaces.
Applications: Typical applications of the photoreceivers include spectroscopy, laser characterization, pulse and transient measurements, testing of communications equipment, industrial sensing, as well as general lab use in scientific applications.

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

New spectroradiometer for the UV, VIS and NIR range

Manufacturer: JETI Technische Instrumente
Distribution: Sphere Optics
Product: Portable compact spectroradiometer specbos 2501 in a compact design, with a high measurement speed and the best system parameters in terms of stray light suppression and system stability in its class.

Features: The device relies on proven technology with optimized and more powerful components from renowned manufacturers. Decisive innovations include an extended wavelength range from 200 to 1000 nm, a spectral resolution of 4 nm for the basic models and 2 nm for the high-resolution version (HiRes). Data is exchanged either via the USB-C, Bluetooth or LAN/PoE interfaces. A robust aluminum housing enables reliable measurement operation in industrial applications and harsh environments.
Common to all models are the high measurement sensitivity, simple installation and operation, NIST-traceable calibration, and the supported modes for measuring radiance and irradiance (with optional diffuser). The specbos 2501, specbos 2501-HiRes, and specbos 2501-NIR models are particularly suitable for the calibration of broadcast monitors, the color matching of digital projectors, the measurement of weighted spectra and extended light sources such as OLEDs as well as spectral measurement in goniometers. The specbos 2501-HiRes is particularly suitable for measuring laser projections and displays. The specbos 2501-UV model will also be available from February 2024.

SphereOptics GmbH
Gewerbestr. 13
82211 Herrsching
Germany
phone: +49 8152 9837890
e-mail: info@sphereoptics.de
Web: www.sphereoptics.de

Display testing at high and low luminance levels

Manufacturer: Instrument Systems
Product: Spectrally optimized LumiTop X20 and LumiTop X30 imaging colorimeters that are ideal for homogeneity measurements and error detection under special luminance conditions.
Background: The human eye adapts easily to dark and bright lighting conditions. Modern monitors take this into account by dimming their display to a low luminance when needed to relieve the viewer's eyes. When designing and manufacturing displays, the luminance and color of the display must therefore be accurately tested, even at low luminance levels from 0.001 cd/m^2 to 0.1 cd/m^2.
Features: The colorimeters are characterized by high camera resolutions of 20 and 31 MP respectively, as well as high flexibility in the field of view (a high-precision motorized lens) and an improved dynamic range from 10^{-3} to 10^6 cd/m^2. The new flicker electronics are designed for frequencies between 1 Hz and 1 kHz. Both cameras are based on the proven LumiTop principle.
Applications: High performance testing in display production. The unique combination of a high-resolution camera, fast photometer, flicker sensor and extremely accurate spectroradiometer of the CAS series makes the LumiTop system an exceptionally powerful tool for quality assurance of displays, even under very low and very high luminance conditions.

Instrument Systems GmbH
Kastenbauerstr. 2
81677 Munich
Germany
phone: +49 89 454943-0
e-mail: sales@instrumentsystems.com
Web: www.instrumentsystems.com

Corrosion inspection system

Manufacturer: Schäfter+Kirchhoff
Product: Corrosion Inspector system that automatically evaluates corrosion test panels. It was developed for rapid and objective corrosion evaluations with a high sample throughput.
Features: The system delivers a very high-contrast image with a resolution of 0.022 mm per pixel in only 1.2 s (5 s including all procedures). Color and monochrome grayscale images are supported. Implemented evaluation methods (acc. to international standards) are cross-cut classification, edge corrosion characteristics, filiform corrosion with counting/length measurement of threads, degree of delamination and corrosion, blistering, and stone impact resistance.
Application: The system was developed for rapid and objective corrosion evaluations with high sample throughput. The system supports color and monochrome grayscale images.

Schäfter+Kirchhoff GmbH
Kieler Str. 212
22525 Hamburg
Germany
phone: +49 40 853997-0
e-mail: info@sukhamburg.de
Web: www.sukhamburg.com

World's first portable wideband laser

Manufacturer: SuperLight Photonics
Product: Portable wideband laser SLP-1000 with smooth, wide spectral output that provides high-quality nonlinear pulse compression for application fields such as third harmonic surface imaging and transient absorption spectroscopy.
Background: Supercontinuum lasers, also known as wideband lasers, provide immense bandwidth while maintaining high coherence and low noise. However, today's industrial solutions are large and heavy, with limited environmental robustness, and require high power. While they deliver a wide bandwidth of colors, a dominant color usually stands out, whereas the remaining colors are at exceedingly low relative power levels.
Features: The new model is an industry-first portable wideband laser with a compact, battery-operated, and rugged design, weighing only 900 grams (32 oz) and with a form factor of less than one liter. Based on PAD (patterned alternating dispersion), it offers a coherent and stable spectral output (400 nm @ –3 dB, 1500 nm @ –20 dB) in the NIR band at a repetition rate of 100 MHz with pulse durations of around 20 fs. It contains a seed laser from Menlo Systems. The laser output is equipped with a Thorlabs-compatible screw thread (SM05), seamlessly integrating with other products from Thorlabs.

SuperLight Photonics BV
Piet Heinstraat 12
7511 JE Enschede
The Netherlands
phone: +32 479 761 825
e-mail: info@superlightphotonics.com
Web: www.superlightphotonics.com

Positioning with direct drive

Owis in Staufen, Germany, offer a wide portfolio of optical beam handling components and positioning units. The company's beam handling systems are the basis for individual assemblies and can be combined perfectly with optomechanical components as well as manual and motorized positioning units. High-precision linear, rotary and swivel movements can be performed with the positioners. Corresponding positioning controllers complete the portfolio.

Source: Owis

The range of motorized positioners has now been expanded to include linear and rotation stages with a direct drive. The ironless motor enables fast movement at a constant speed and smooth rastering in small, equidistant steps. These stages combine a powerful direct drive with a fine-resolution incremental measuring system, enabling high dynamics with maximum precision. The direct drive stages are designed for applications in the semiconductor industry, laser material processing, precision metrology, optical inspection as well as additive manufacturing.

Linear Positioning – LINPOS

The linear positioning stages of the LINPOS series are available in two versions S and M. Both are equipped with an ironless linear motor and an incremental linear measuring system. Thanks to the modular linear motor stages, different lengths of travel can be easily realized.

With an acceleration up to 20 m/s², the LINPOS S short travel stage is suited to scanning applications where fast and smooth scanning in small, equidistant steps is required. The precision cross roller guides ensure a high load capacity and smooth running. Lubrication of the guides takes place via side access, simplifying maintenance and minimizing downtime. The LINPOS S-40 with 40 mm of travel is very compact with an overall height of only 65 mm. Especially when connected to another LINPOS S, it results in an extremely compact x-y combination and the cable management system with drag chain maintains the dynamics of the lower axis without restrictions.

The long travel stage LINPOS M enables fast movement at a constant speed of up to 950 mm/s. High-precision recirculating ball bearing guides provide a high load capacity and also ensure excellent linearity and minimal angular error over the entire travel range. The guides are the only purely mechanical components and are maintenance-free for five years. The closed design with a metal cover and side seals make the LINPOS M ideal for industrial applications. An optional purge air connection serves as additional protection for the high-quality components against the deposition of particles. The drag chain can be extended to a cable management system for combination with additional axes.

Rotary Positioning – ROTPOS

The ROTPOS M rotating positioning stage is the consequent further development of the linear direct drive stages. A compact, ironless torque motor meets a high-resolution incremental angle measuring system. Both minimal incremental and continuous rotations can be performed dynamically and smoothly with great precision. The preloaded precision angular contact ball bearing supports high axial and radial loads and gives the ROTPOS M excellent rigidity. All components are maintenance-free and therefore predestined for industrial use. The free aperture of 25 mm enables transmitted-light applications, or it can also be used to feed cables or tubing through the stage.

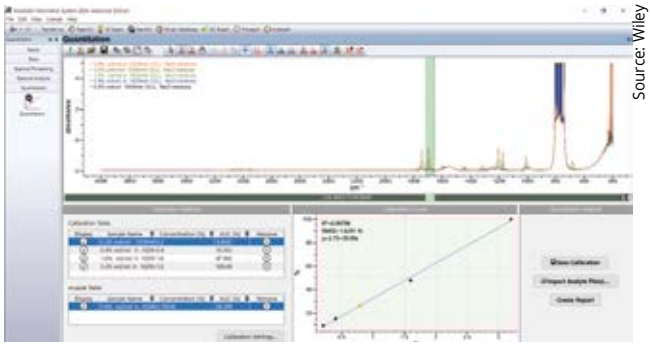
OWIS GmbH
Im Gaisgraben 7
79219 Staufen i.Br.
Germany
phone: +49 7633 9504-0
e-mail: info@owis.eu
Web: www.owis.eu

Wiley releases KnowItAll 2024

Analytical Edition comes with a new multitechnique quantitation tool and advances for spectral analysis workflows

When it comes to chemical quantitative analysis, researchers often find themselves navigating multiple software packages. Mastering multiple software packages to achieve the same level of expertise, reproducibility, and interoperability is a major pain point and a training challenge. Further disruptions to analysis occur when lab personnel are forced to switch tools, or cut and paste between packages, depending on the type of analytical technique or data format.

To overcome these challenges, Wiley's new integrated KnowItAll Quantitation option provides a single, easy-to-use tool to perform these tasks consistently in a vendor-neutral environment that supports multiple techniques (GC-MS, IR, Raman, UV-Vis, GC) and instrument formats. KnowItAll Quantitation provides users with an intuitive, step-by-step process in a single interface and includes methods for external calibration, internal calibration, and standard addition analysis.



Source: Wiley

KnowItAll 2024 Analytical Edition, the latest version of Wiley's spectral software

This release also includes many advances and improvements to the analysis, data management, processing, and reporting across multiple techniques. Wiley also included major updates to the NMR workflow and LC-MS databasing, and an optional AI-predicted IR library, based on a new AI predictive model.

KnowItAll Software offers solutions to analyze and manage multiple types of spectral and chemical data in multiple file and instrument formats. KnowItAll's integrated toolsets eliminate the need for multiple software packages and increase overall lab efficiency and staff proficiency. Combined with Wiley's spectral reference libraries, it is able to provide fast, reliable spectral analysis.

https://sciencesolutions.wiley.com

Laser treatment boosts battery performance

New strategy to engineer an improved anode material in next-generation batteries

Researchers of the King Abdullah University of Science and Technology have demonstrated the use of laser pulses to modify the structure of a promising alternative electrode material for lithium-ion batteries – two-dimensional transition metal carbides/nitrides, MXene – boosting their energy capacity and other key properties. The researchers hope that this strategy could help to engineer an improved anode material in next-generation batteries.

Graphite contains flat layers of carbon atoms, and during battery charging, lithium atoms are stored between these layers in a process called intercalation. MXenes also contain layers that can accommodate lithium, but these layers are made of transition metals such as titanium or molybdenum bonded to carbon or nitrogen atoms, which make the material highly conductive. The surfaces of the layers also have additional atoms such as oxygen or fluorine. MXenes based on molybdenum carbide have particularly good lithium storage capacity, but their performance soon degrades after repeated charge and discharge cycles.

The team, led by Husam Alshareef and PhD student Zahra Bayhan, discovered that this degradation is caused by a chemical change that forms molybdenum oxide within the MXene's structure. To tackle this problem, the researchers used infrared laser pulses for laser scribing to create small nanodots of molybdenum carbide within the MXene. These nanodots, roughly 10 nm wide, were connected to the MXene's layers by carbon materials. This offers several benefits. Firstly, the nanodots provide additional storage capacity for lithium and speed up the charging and discharging process. The laser treatment also reduces the material's oxygen content, helping to prevent the formation of problematic molybdenum oxide. Finally, strong connections between the nanodots and the layers improve the MXene's conductivity and stabilize its structure during charging and discharging.

The researchers made an anode from the laser-scribed material and tested it in a lithium-ion battery over 1000 charge-discharge cycles. With the nanodots in place, the material had a four-fold higher electrical storage capacity than the original MXene and almost reached the theoretical maximum capacity of graphite. (Source: KAUST)

Source: A. Serin, KAUST

Zahra Bayhan and Husam N Alshareef think that laser scribing could be applied as a general strategy to improve the properties of other MXenes.

Reference: *Z. Bayhan* et al.: A Laser-Induced Mo_2CT_x MXene Hybrid Anode for High-Performance Li-Ion Batteries, Small **19**(36), September 2023; DOI: 10.1002/smll.202208253

Navigation in 3D space using 2D images

Artificial intelligence extracts 3D information from 2D images

The new MonoXiver method uses each bounding box as a starting point, or anchor, and has the AI perform a second analysis of the area surrounding each bounding box. (Source: NCSU)

Photos are two-dimensional, but autonomous vehicles and other technologies have to navigate the three-dimensional world. Researchers have developed a new method to help artificial intelligence extract 3D information from 2D images, making cameras more useful tools for these emerging technologies. "Existing techniques for extracting 3D information from 2D images are good, but not good enough," says Tianfu Wu from North Carolina State University. "Our new method, called MonoXiver, can be used in conjunction with existing techniques – and makes them significantly more accurate."

The work is particularly useful for applications such as autonomous vehicles. That is because cameras are less expensive than other tools used to navigate 3D spaces, such as lidar. Because cameras are more affordable than these other technologies, designers of autonomous vehicles can install multiple cameras, building redundancy into the system. But that is only useful if the AI in the autonomous vehicle can extract 3D navigational information from the 2D images taken by a camera. This is where MonoXiver comes in.

The new MonoXiver method uses bounding boxes as a starting point, or anchor, and has the AI perform a second analysis of the area surrounding each bounding box. This second analysis results in the program producing many additional bounding boxes surrounding the anchor. To determine which of these secondary boxes has best captured any missing parts of the object, the AI does two comparisons. One comparison looks at the geometry of each secondary box to see if it contains shapes that are consistent with the shapes in the anchor box. The other comparison looks at the appearance of each secondary box to see if it contains colors or other visual characteristics that are similar to the visual characteristics of what is within the anchor box.

"One significant advance here is that MonoXiver allows us to run this top-down sampling technique – creating and analyzing the secondary bounding boxes – very efficiently," Wu says. To measure the accuracy of the MonoXiver method, the researchers tested it using two datasets of 2D images: the well-established KITTI dataset and the more challenging, large-scale Waymo dataset. "We are excited about this work, and will continue to evaluate and fine-tune it for use in autonomous vehicles and other applications," Wu says. (Source: NCSU)

Reference: *X. Liu* et al.: Monocular 3D Object Detection with Bounding Box Denoising in 3D by Perceiver, arXiv 2304.01289

https://facultyclusters.ncsu.edu

Robust computer vision systems for autonomous vehicles

Three teams have been selected to compete in "The Robust AI Grand Challenge"

The Robust AI Grand Challenge, organized in collaboration with the Future Systems and Technology Directorate, MINDEF Singapore, and DSO National Laboratories, aims to get researchers and scholars from institutes of higher learning and research institutes to develop innovative solutions to overcome the vulnerabilities of artificial intelligence (AI) models in computer vision (CV) systems for autonomous vehicles. Three teams have been selected to compete in the grand challenge – two teams from the Nanyang Technological University (NTU) and one team from the National University of Singapore (NUS). SMU Assistant Professor of Computer Science and Lee Kong Chian Fellow Xie Xiaofei will be competing as part of one of the teams from NTU.

To secure a place in the grand challenge, the NTU team has designed four work packages as part of its comprehensive research project, which commenced on July 1, 2023, and will take place over three years. The first two years of the project will be spent on developing the optimal CV technology while the third year will be focused on testing the technology in the field.

Work Package 1 is designed to provide a unified and comprehensive AV visual representation. Currently, most of the research on AV representation is centered on uni-directional sensing and object detection in a static or specific situation. Existing AV representations often employ separate models to process and recognize different types of data such as images, lidar signals that leverage a combination of three-dimensional and laser scanning, or other sensing visual

modalities. While current approaches to AV visual representation work well for the data types that they are designed for, there is a lack of integration of the different data types. This can potentially hamper the overall performance and efficiency of the AV system.

Given the complexity and costs associated with conducting experiments in the physical world, Work Package 2 is centered on synthesizing real work threats between the digital world and the physical world. By utilizing the unified representation described in Work Package 1, the research team aims to iterate and evaluate the robustness of the CV models more effectively and efficiently before they are deployed to physical AV systems. In addition, with the unified representation, the research team will be able to simulate changes in weather conditions, modify objects in the scene, or even incorporate other real-world variations such as someone running in front of the AV.

The intent behind Work Package 3 is to integrate the multiple views and modalities by reconstructing the different scenarios to improve the AV's ability to make robust and correct decisions when it is subjected to threats or attacks. The research team will also delve into the concept of adversarial repairing techniques to enhance the resilience of the AV.

Work Package 4 will deep dive into understanding the logic of the AI decision-making process. To do this, the research team will first analyze the behavior of neurons and the respective weightage associated with model predictions to gain insights into the decision logic employed by the AI system.

Once a thorough understanding of the logic of the AI decision-making process is obtained, the researchers will move on to enhance the models' robustness against such attacks by adjusting the influence of neurons and/or predicting weightage to build more resilient systems. The outcome from completing the work packages will be a robust technology where the judges will determine which of the three teams would advance to the final stage of the challenge. (Source: SMU)

https://aisingapore.org
https://research.smu.edu.sg

AI model speeds up high-resolution computer vision

New system could improve image quality or help autonomous vehicles identify hazards in real time

An autonomous vehicle must rapidly and accurately recognize objects that it encounters, from an idling delivery truck parked at the corner to a cyclist whizzing toward an approaching intersection. To do this, the vehicle might use a powerful computer vision model to categorize every pixel in a high-resolution image of this scene, so it doesn't lose sight of objects that might be obscured in a lower-quality image. But this semantic segmentation is complex and requires a huge amount of computation when the image has high resolution. Researchers from MIT, the MIT-IBM Watson AI Lab, and elsewhere have developed a more efficient computer vision model that vastly reduces the computational complexity of this task.

A machine-learning model for high-resolution computer vision could enable computationally intensive vision applications, such as autonomous driving or medical image segmentation, on edge devices. Pictured is an artist's interpretation of the autonomous driving technology. (Source: MIT)

Their model can perform semantic segmentation accurately in real-time on a device with limited hardware resources, such as the on-board computers that enable an autonomous vehicle to make split-second decisions. Recent state-of-the-art semantic segmentation models directly learn the interaction between each pair of pixels in an image, so their calculations grow quadratically as image resolution increases. Because of this, while these models are accurate, they are too slow to process high-resolution images in real time on an edge device like a sensor or mobile phone. The MIT researchers designed a new building block for semantic segmentation models that achieves the same abilities as these state-of-the-art models, but with only linear computational complexity and hardware-efficient operations.

The result is a new model series for high-resolution computer vision that performs up to nine times faster than prior models when deployed on a mobile device. Importantly, this new model series exhibited the same or better accuracy than these alternatives. Not only could this technique be used to help autonomous vehicles make decisions in real-time, it could also improve the efficiency of other high-resolution computer vision tasks, such as medical image segmentation.

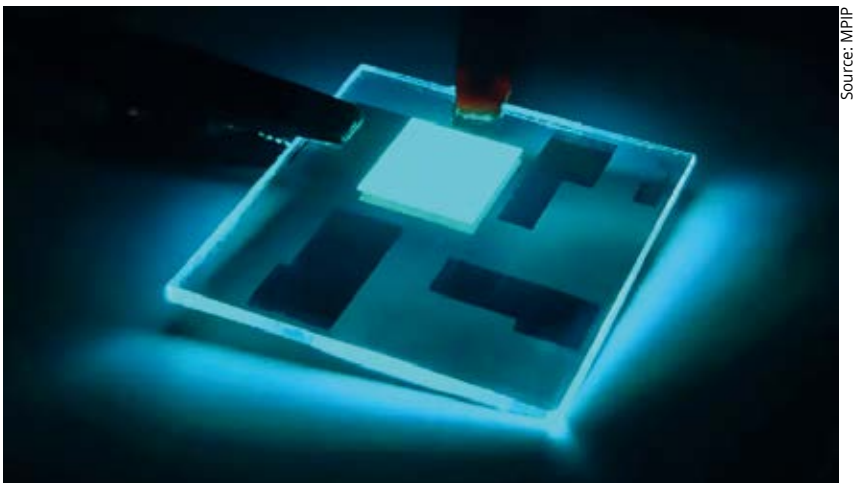
"Song Han's group has shown remarkable progress compressing and accelerating modern deep learning models, particularly vision transformers," adds Jay Jackson, global vice president of artificial intelligence and machine learning at Oracle, who was not involved with this research. (Source: MIT)

Reference: *H. Cai* et al.: EfficientViT: Multi-Scale Linear Attention for High-Resolution Dense Prediction, arXiv 2205.14756v5 (2023); DOI: 10.48550/arXiv.2205.14756

https://hanlab.mit.edu

New material concept for cheaper OLEDs

Smart approach for more cost-effective production of blue organic light-emitting diodes



Source: MPIP

In the future, a new material concept could make blue organic light-emitting diodes possible that consist of only one layer and are thus easier to manufacture.

Blue organic light-emitting diodes (OLEDs), which can be used in smartphones, televisions or other devices, are still difficult to manufacture today. A team of researchers led by Gert-Jan Wetzelaer of the Max Planck Institute for Polymer Research has now developed a new material concept that allows blue OLEDs to be manufactured easily and cost-effectively. The efficiency of the developed light-emitting diode is already comparable to commercially available ones that employ a far more complex structure.

In current screens that use organic light-emitting diodes, one pixel consists of three individual, microscopic OLEDs. An entire television screen with approximately two million individual pixels thus consists of six million light-emitting diodes. Therefore, ease of manufacture as well as high energy efficiency are highly relevant to both manufacturing costs and subsequent electricity costs.

The manufacture of blue organic LEDs has been difficult so far. Modern OLEDs are constructed in multiple layers to obtain the required efficiency. This sandwich structure, sometimes comprising up to seven layers, allows light emission efficiency of between twenty and thirty percent to be achieved.

Researchers have now developed a much simpler OLED structure. They were able to show that one active light emitting layer netween two contacts is sufficient for an efficient OLED instead of seven. It is necessary to prevent detrimental effects to this layer caused by water or oxygen. "With our material system, efficient blue OLEDs could also be produced from solution in the future," says Gert-Jan Wetzelaer. "This means that manufacturing then no longer involves a multi-step process and complex evaporation equipment, but such OLEDs can also be printed in the best-case scenario."

With their new single layer OLED concept, they were able to achieve an internal quantum efficiency of 100 % – meaning that the complete electrical energy supplied is converted into light. Due to optical losses at interfaces, which are present in every OLED, about 27 % of the light is actually emitted – a value that is competitive with the existing complex commercial OLEDs.

Reference: *O. Sachnik* et al.: Single-Layer Blue Organic Light-Emitting Diodes With Near-Unity Internal Quantum Efficiency, Adv. Mat. **35**, 2300574 (2023); DOI: 10.1002/adma.202300574

www.mpip-mainz.mpg.de

Ultrafast laser fits on a fingertip

New advance will enable pocket-sized GPS-free navigation, medical imaging, food safety inspection

Lasers are essential tools for observing, detecting, and measuring things in the natural world that we cannot see with the naked eye. But the ability to perform these tasks is often restricted by the need to use expensive and large instruments. Now, researcher Qiushi Guo, City University of New York, demonstrates a novel approach for creating high-performance ultrafast lasers on nanophotonic chips. His work centers on miniaturizing mode-lock lasers – a unique laser that emits a train of ultrashort, coherent light pulses at femtosecond intervals.

Ultrafast mode-locked lasers are indispensable to unlocking the secrets of the fastest timescales in nature, such as the making or breaking of molecular bonds during chemical reactions, or light propagation in a turbulent medium. The high-speed, pulse-peak intensity and broad-spectrum coverage of mode-locked lasers have also enabled numerous photonics technologies, including optical atomic clocks, biological imaging, and computers that use light to calculate and process data. Unfortunately, state-of-the-art mode-locked lasers are currently expensive, power-demanding tabletop systems that are limited to laboratory use.

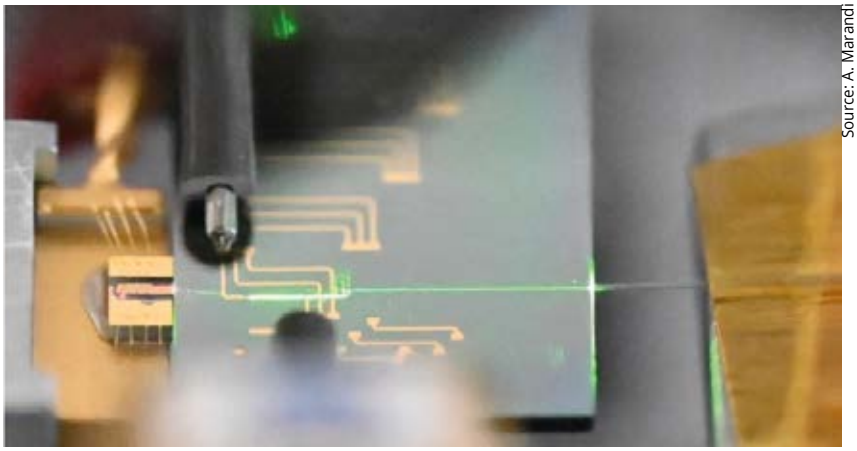
"Our goal is to revolutionize the field of ultrafast photonics by transforming large lab-based systems into chip-sized ones that can be mass produced and field deployed," said Guo, a faculty member with the CUNY. "Not only do we want to make things smaller, but we also want to ensure that these ultrafast chip-sized lasers deliver satisfactory performance. For example, we need enough pulse-peak intensity, preferably over 1 Watt, to create meaningful chip-scale systems."

Realizing an effective mode-locked laser on a chip is not a straightforward process, however. Guo's research leverages an emerging material platform known as thin-film lithium niobate (TFLN). This material enables very efficient shaping and precise control of laser pulses by applying an external radio frequency electrical signal. In

their experiments, Guo's team uniquely combined the high laser gain of III-V semiconductors and the efficient pulse shaping capability of TFLN nanoscale photonic waveguides to demonstrate a laser that can emit a high output peak power of 0.5 W.

Beyond its compact size, the demonstrated mode-locked laser also exhibits many intriguing properties that are beyond reach by conventional ones, offering profound implications for future applications. For example, by adjusting the pump current of the laser, Guo was able to precisely tune the repetition frequencies of out pulses in a very wide range of 200 MHz. By employing the strong reconfigurability of the demonstrated laser, the research team hopes to enable chip-scale, frequency-stabilized comb sources, which are vital for precision sensing.

Guo's team will need to address additional challenges to realize scalable, integrated, ultrafast photonic systems that can be translated for use in portable and handheld devices, but his lab has overcome a major obstacle with this current demonstration. "This achievement paves the way for eventually using cell phones to diagnose eye diseases or analyzing food and environments for things like E. coli and dangerous viruses," Guo said. (Source: CUNY)



Source: A. Marandi

Optical image of the chip-scale ultrafast mode-locked laser when operating

Reference: *Q. Guo* et al.: Ultrafast mode-locked laser in nanophotonic lithium niobate, Science **382**, 708 (2023); DOI: 10.1126/science.adj5438

https://asrc.gc.cuny.edu/photonics

Making a femtosecond laser out of glass

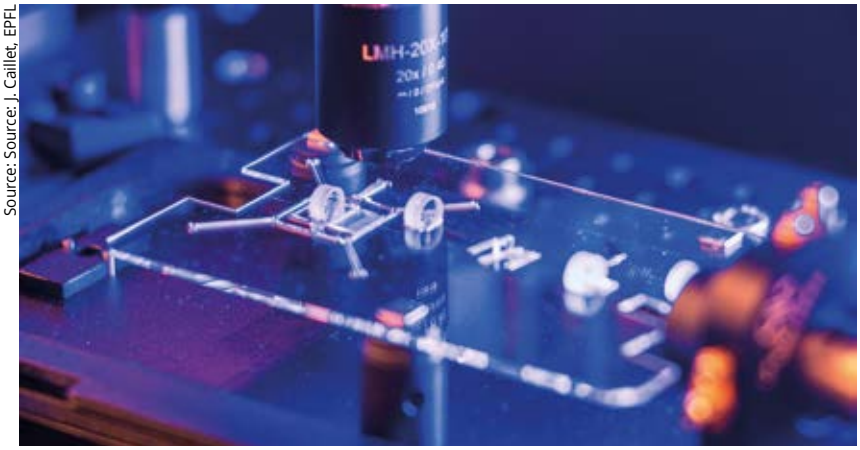
New method for manufacturing complex miniaturized free-space optical systems

Femtosecond lasers have many applications such as laser eye surgery, non-linear microscopy, spectroscopy, laser material processing and recently, sustainable data storage. Commercial devices are made by putting optical components and their mounts on a substrate, typically optical breadboards, which requires fastidious alignment of the optics.

Yves Bellouard, head of EPFL's Galatea Laboratory, and his team made a femtosecond laser out of glass, no bigger than the size of a credit card, and with less alignment hassles. Using a commercial femtosecond laser, the scientists etched out grooves in the glass that allow for the precise placement of the essential components of their laser. Even at micron-level precision fabrication, the grooves and the components are not sufficiently precise by themselves to reach laser quality alignment, so at this stage, their glass device is not yet functional as a laser. The scientists also know from previous research that they can make glass expand or shrink locally. Why not use this technique to adjust the alignment of the mirrors?

The initial etching is therefore designed so that one mirror sits in a groove with micromechanical flexures engineered to locally stir the mirror when exposed to femtosecond laser light. In this way, the commercial femtosecond laser is used a second time, this time to align the mirrors, and ultimately create a stable, small scale femtosecond laser.

Ongoing research programs at the Galatea Lab will explore the use of this technology in the context of quantum optical system assembly, pushing the limit of currently achievable miniaturization and alignment accuracy. The alignment process is still supervised by a human operator, and with practice can take a few hours to achieve. Despite its small size, the laser is capable of reaching approximatively a kilowatt of peak power and of emitting pulses of less than 200 fs. This novel femtosecond laser technology is to be spun-off by Cassio-P, a company to be headed by Antoine Delgoffe at Galatea Lab. (Source: EPFL)



Source: Source: J. Caillet, EPFL

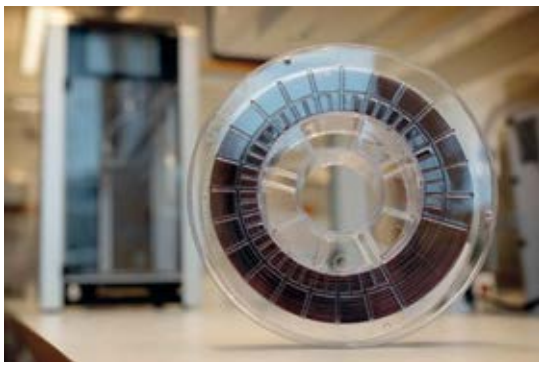
Scientists from EPFL's Galatea Laboratory make gigafemto lasers on a glass substrate.

Reference: *A. Delgoffe* et al.: All-glass miniature GHz repetition rate femtosecond laser cavity, Optica **10**, 1269 (2023); DOI: 10.1364/optica.496503

www.epfl.ch/labs/galatea

3D-printed plasmonic plastic enables large-scale optical sensor production

New type of composite material shows unique optical properties



A filament of the plasmonic plastic. Due to its flexibility, the material can be formed into almost any shape. In this particular example, the filament is intended for use in 3D printers. (Source: M. Arnesson, Chalmers UT)

In a multi-year project, researchers at Chalmers University of Technology in Sweden have developed plasmonic plastic – a type of composite material with unique optical properties that can be 3D printed. This research has now resulted in 3D printed optical hydrogen sensors that could play an important role in the transition to green energy and industry.

At the time the project began, plasmonic metal nanoparticles were being used primarily on flat surfaces and required production in advanced cleanroom laboratories. The researchers' starting point was to ask: what if we could produce large volumes of plasmonic metal nanoparticles in a sustainable way that would make it possible to manufacture three-dimensional plasmonic objects?

This is where the plastic came into the picture. The properties of plastic materials mean that they can be shaped into almost any form, are cost-effective, have upscaling potential, and can be 3D-printed. The project resulted in the development of new materials consisting of a mix or composite of a polymer and colloidal, plasmonically active, metal nanoparticles.

Plasmonic sensors that can detect hydrogen are the target application for this type of plastic composite material that the researchers chose to focus on in their project. In doing so, they have pioneered an entirely new approach in the field of optical sensors based on plasmons, namely being able to 3D-print these sensors.

The sensor is designed so that the metal nanoparticles change colour when they come into contact with hydrogen, because they absorb the gas like a sponge. The color shift in turn alerts you immediately if the levels get too high.

Plasmonic plastics may now make it possible to exploit the versatile toolbox of polymer technology to design novel gas sensors, or applications in health and wearable technology as other examples. It may even inspire artists and fashion designers due to its tuneable colors. (Source: Chalmers)

Reference: *I. Darmadi* et al.: Bulk-Processed Plasmonic Plastic Nanocomposite Materials for Optical Hydrogen Detection, Acc. Chem. Res. 56, 1850 (2023); DOI: 10.1021/acs.accounts.3c00182

Detecting spoiled food with LEDs

Perovskite-modified LEDs reveal rot in fruit and veg before it is visible

Researchers have developed new LEDs that emit light simultaneously in two different wavelength ranges, for a simpler and more comprehensive way to monitor the freshness of fruit and vegetables. The team modified the LEDs with perovskite materials, causing them to emit in both the near-infrared range and the visible range, a significant development in the contact-free monitoring of food.

Perovskite crystals are able to capture and convert light. Being simple to produce and highly efficient, perovskites are already used in solar cells but are also being intensively researched for suitability in other technologies. Angshuman Nag and his team at the Indian Institute of Science Education and Research (IISER) in Pune, India, are now proposing a perovskite application in LED technology that could simplify the quality control of fresh fruit and vegetables.

Without light converters, LEDs would emit light in rather narrow light bands. To cover the whole range of white light produced by the sun, the diodes in 'phosphor-converted' (pc) LEDs are coated with luminescent substances. Nag, PhD student Sajid Saikia, first author of the paper, and their team have used a double emission coating to produce pc-LEDs that emit both white light and also a strong band in the near-infrared range (NIR).

To make the dual-emission pc-LED, they applied a double perovskite doped with bismuth and chromium. Part of the bismuth component emits warm white light and another part transfers energy to the chromium component, de-exciting it and causing an additional emission in the NIR range, the researchers found out.

NIR is already used in the food industry to examine freshness in fruit and vegetables. Nag explains their idea: "Food contains water, which absorbs the broad near-infrared emission at around 1000 nm. The more water that is present [due to rotting], the greater the absorption of near-infrared radiation, yielding darker contrast in an image taken under near-infrared radiation. This easy, non-invasive imaging process can estimate the water content in different parts of food, assessing its freshness."

Using these modified pc-LEDs to examine apples or strawberries, the team observed dark spots that were not visible in standard camera images. Illuminating the food with both white and NIR light revealed normal coloring that could be seen by the naked eye, as well as those parts which were starting to rot, but not yet visibly so. (Source: Wiley)

Reference: *S.Saikia, A. Ghosh, and A. Nag:* Broad Dual Emission by Codoping Cr^{3+} (d→d) and Bi^{3+} (s→p) in Cs_2-$Ag_{0.6}Na_{0.4}InCl_6$ Double Perovskite, Angew. Chem. Intl. Ed. 62(33), August 2023; DOI: 10.1002/anie.202307689

Ewit Roos leaves PhotonDelta

Consortium CEO becomes a general partner in the deep-tech venture capital firm PhotonVentures effective January 1, 2024

Roos joined PhotonDelta eight years ago and helped the organization develop into a recognized and well-funded integrated photonics industry accelerator with more than sixty corporate partners and a global reach. Photonic chips are critical in various applications, such as quantum computing, robotics, sustainable agriculture, and autonomous vehicles. Until Roos' replacement is found, the remaining executive board member Laurens Weers will manage the PhotonDelta foundation.

Roos is taking up his new position while the momentum of industrialization of integrated photonics as a key function in the semicon industry is entering a new and promising phase. Now that the Dutch infrastructure and ecosystem have been kickstarted, companies are starting to take advantage of it. The PhotonVentures fund, co-founded by PhotonDelta, takes this process further by investing in European and Dutch companies that will boost demand and benefit the Dutch integrated photonics industry.

"I may be leaving PhotonDelta, but my dedication remains with the integrated photonics ecosystem. While we have made great progress in recent years, it is clear that there is still a lot of work waiting for us. Suppliers need to manufacture in higher volumes to reach competitive prices, and they can only do so when there is sufficient demand. First adopters are typically smaller companies that do not yet generate the required level of demand. This is why I am grateful for the consistent support of the Dutch regional and national governments, helping many young companies to bridge the 'valley of death'. At PhotonVentures, I will be in the best position to support that goal," Roos said.

René Penning de Vries, chair of PhotonDelta's supervisory board said: "Ewit Roos has shown exceptional leadership and commitment during his tenure as CEO of PhotonDelta. His vision has played an important role in accelerating the PhotonDelta ecosystem from six companies to over sixty, laying the foundation for an integrated photonics industry in the Netherlands. We remain confident that Ewit, as a general partner in PhotonVentures, will continue contributing to the industry's growth. On behalf of the supervisory board, I want to thank Ewit for his efforts and wish him all the best in his future endeavors."

PhotonDelta CEO Ewit Roos (Source: PhotonDelta)

www.photondelta.com

James Wyant named Optica Honorary Member

Emeritus professor is recognized for his exceptional contributions to the global optics and photonics community

He has been a leader in the classroom, lab and boardroom for more than thirty years. His technical innovation and entrepreneurship changed the field of optical metrology and developed tools that enabled many disciplines of precision manufacturing. Now Optica has named James C. Wyant, emeritus professor and founding dean at the University of Arizona, Wyant College of Optical Sciences, USA, an Optica honorary member.

Wyant is recognized for his pioneering contributions to advancing the science and technology of quantitative interferometric metrology, his leadership as an educator and entrepreneur, and his visionary service to the global optics and photonics community.

"Jim has made extraordinary contributions to our society and field through his scientific and technical work, mentorship, leadership and philanthropy," said Michal Lipson, Optica's 2023 president.

His pioneering work in the field of adaptive optics played a vital role in the development of the first adaptive optical system, and his holographic techniques, which provided a means of testing aspheric surfaces, have been a standard procedure for decades. He is also well-known for his role in creating the optical testing technique used on the James Webb Space Telescope and most, if not all, of the world's giant telescopes.

Wyant earned his MS and PhD degrees from the University of Rochester, and his BS in Physics from the Case Institute of Technology (now Case Western Reserve University). After receiving his PhD, Wyant joined Itek in Burlington, Massachusetts, and worked at the interface of holography and rapidly developing computer technology. He later returned to academia with a faculty appointment at the Optical Sciences Center (OSC), University of Arizona. He went on to become the director of the OSC and the founding dean of the University's College of Optical Sciences. Wyant also co-founded WYKO and 4D Technology, and has been a board member for several other companies including Veeco Instruments, DMetrix, Optics 1 and ILX Lightwave.

James C. Wyant, professor emeritus and founding dean of the UA College of Optical Sciences (Source: U Arizona)

www.optica.org

A wrap-up for 2023

EPIC members bridge innovations in quantum, electric vehicles, healthcare

Photonics integrated circuits drive the heart of quantum advancements, as showcased at the EPIC Industrial Quantum Photonics Technology Meeting held at Toptica. (Source: EPIC)

During the past few months, EPIC has been actively bridging the gap between photonics technology and end-users in various markets such as quantum, electric vehicles, and healthcare. In parallel, we have led two delegations to Asia, the first to Taiwan and the second to Singapore, to foster connections between photonics integrated circuits and semiconductor technologies. This collaboration was also a central theme during our discussions in Munich during Semicon Europa.

October started with the EPIC Industrial Quantum Photonics Technology Meeting held at Toptica where more than sixty attendees explored how to establish quantum photonics technology as a pivotal and versatile cornerstone within the quantum technology landscape. Photonics empowers the development of highly sensitive quantum sensors, underpins quantum communications that rely on the properties of light, and holds the promise of superior performance in photonic quantum computing, shaping a bright and promising future.

Moving from Munich, we journeyed to Stuttgart and the cutting-edge Arena 2036 research campus of the University of Stuttgart. In collaboration with Precitec, we held a meeting here to explore how laser applications are advancing the efficiency of electric vehicle battery manufacture.

As we step into November, we have already visited Antwerp University Hospital to delve deeper into how photonics technology has emerged as a transformative force in cancer research and treatment. Its remarkable progress has paved the way for the development of powerful imaging systems that allow clinicians to visualize intricate structures within living tissues, enhancing diagnostic accuracy and therapeutic treatment.

The year 2023 has marked EPIC's 20th anniversary, and we extend our heartfelt gratitude to all our members who have placed their trust in EPIC and embraced collaborative innovation.

www.epic-assoc.com

Upcoming EPIC events:

- 10 January 2024, online event
  EPIC Online Marketing Meeting: Advanced Reporting, Events, and Conversions in GA4
- 15 January 2024, online event
  EPIC Online Technology Meeting on Graphene Technology and Applications
- 24 January 2024, Bordeaux, France
  EPIC RoundTable at OPTRO: Advanced Imaging and Sensing Technologies for Detection, Reconnaissance, and Identification
- 30 January 2024, San Francisco, CA, USA
  EPIC Members Networking Reception in San Francisco
- 30 January 2024, San Francisco, CA, USA
  Pilot Lines & Photonics Innovation Hubs Breakfast
- 31 January 2024, San Francisco, CA, USA
  EPIC Members Lunch in San Francisco
- 31 January 2024, San Francisco, CA, USA
  EPIC Executive 5 Miles Run in San Francisco
- 1 February 2024, San Francisco, CA, USA
  EPIC Members Run in San Francisco
- 19 February 2024, online event
  EPIC Online Technology Meeting on New Developments for Laser Welding
- 26 February 2024, online event
  EPIC Online Technology Meeting on Photonics for Automotive Lighting

For the list of all events, visit:

www.epic-assoc.com/epic-events

"Focus on sales by developing something unique"

Interview with Bjorn Andersen CEO at Shute Sensing Solutions

Antonio Castelo

Source all images: Shute Sensing

EPIC's technology manager Antonio Castelo met Bjorn Andersen from a Danish developer of novel polymer optical fiber sensor systems.

What is the background to your appointment as CEO at Shute Sensing Solutions?
Bjorn Andersen: Inspired by my grandfather who was a successful entrepreneur, I founded Noliac A/S in 1997, a hardware company developing and marketing piezoelectric sensors, actuators and transducers. In the first few years, the main challenge was to secure funding to get into black numbers.

In 2001, we acquired a substantial investment and over the next sixteen years Noliac expanded its product range and international sales – mainly to OEMs in the aerospace and defense, test and measurement, medical and industrial markets – and grew to a workforce of one hundred with manufacturing facilities in Denmark and the Czech Republic. I had no intention of selling the company, but in 2017 I was approached by CTS, a US multinational specializing in the design and manufacture of sensors, actuators, and electronic components. We went through a very thorough due diligence process, from which I learned a lot about negotiating with US companies, and I ended up selling Noliac in 2017.

Following the acquisition, I established my own technology fund, Øster Land Invest ApS, and began to search for a new challenge. I was not looking to get into photonics particularly, but in late 2017 I attended a matchmaking event for investors and startups at the Technical University of Denmark (DTU) and met the founders of Shute. We had some serious discussions over the next couple of weeks about me coming on board as CEO and investing in the company, and in February 2018 I joined Shute as an investor and as CEO.

▲ Bjørn Andersen, CEO, Shute Sensing Solutions (center), flanked to the left by CTO and co-founder Kristian Nielsen and to the right by CCO Kristian Rode.

What attracted you to Shute?
Andersen: Shute had been established in 2015 by Dr Kristian Nielsen and Prof Ole Bang, who were scientists working in the photonics department at DTU on projects related to polymer optic fibers. They had developed and patented a novel polymer optical fiber sensor system that enabled the real-time monitoring of strain, humidity and temperature at points along a hair-thin optical fiber – hence the name Shute. Even though I have a background in mechanical engineering, I immediately saw this unique polymer optical fiber sensing technology as an exciting platform with

ConcDry is Shute's first fully controlled commercial product, ready for commercial launch this year.

enormous potential to transform and enhance multiple businesses in areas such as construction, energy, biomedicine, defense, and aerospace.

How has the company developed?

Andersen: For the first couple of years, Shute operated in the incubator environment of DTU and one of my first decisions when I joined the company was to move Shute out of the DTU to larger and cheaper facilities more suitable for expanding the business. In 2018 we gained our first big customer, a German industrial company, which I am proud to say is still one of our customers today. 2018 and 2019 were great years: we grew a lot in both turnover and staff and just before the outbreak of Covid we had nine employees. Initially the pandemic was not too hard on us as we had good orders in the pipeline, but in 2020/21 we faced the challenges, like many others, of not being able to attend face-to-face trade fairs or visiting our customers' production facilities.

We decided to use this decline in activity to invest and set up an in-house production facility to enable our production to be completely independent from external partners. To this end, we invested in our own lasers, polishing machines, assembly and testing equipment, draw towers and IT infrastructure, and since 2020 all Shute optical fibers have been produced in-house. These developments have increased our ability to develop and scale up custom-made solutions within one to two weeks, and to deliver large quantities of custom-made sensors to more than forty different customers with around eighty percent of our orders for export.

What are Shute's main application areas?

Andersen: Firstly, we provide sensors as monitors for pressure and strain in industrial components such as rolling machine parts, extruders and pipes.

Secondly, capitalizing on the advantage of polymer over glass fiber for use in human bodies, our polymer fiber optic cables can be used as inner body communication wires in medical devices, transporting data to and from the med tech device and the human body – even for usage inside an MRI scanner.

Thirdly, the aerospace and space industries have shown interest in Shute sensors because of their light weight and ability to monitor in the core of composite materials. We have patented the world's first commercial plastic fiber sensor system, which can be placed inside composite elements to act as an internal strain monitor without compromising the strength of the structure.

Fourthly, as Shute sensors are light weight, anti-corrosive, flexible and durable, they are ideal for wind turbine purposes – both for monitoring strain in the wings and measuring stress in wind turbine concrete foundations. Our newest application is a non-electric vibration sensor for use in structural health monitoring applications, especially in limited or hard-to-reach places or where the environment needs to be free from electricity.

Finally, we have created the world's first commercial plastic fiber sensor system that can survive 100 % relative humidity and precisely measure humidity in concrete floors over time. This system, known as ConcDry, makes it easy for contractors to get precise knowledge on how a concrete floor is drying and to optimize the timing as to

ConcDry in its right element: a humidity and temperature sensor system made to monitor concrete drying, based on Shute's patented polymer optical fiber sensor technology.

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.

www.epic-assoc.com

when the structure is ready for flooring and for plaster walls to be installed. A unique feature of this system is that it has been designed for people who have no experience in photonics. In these cases, we tone down the tech part and focus on user experience – making the system easy to handle and making the interface simple to understand and access through a laptop or handheld device.

How do you see the future?
Andersen: Our aim is to develop, produce, and sell polymer optical fiber sensors and to solve sensing problems that cannot be solved with existing technology or are currently too expensive. Accordingly, we will continue to invest in developing new polymers, new fiber, and new sensing capabilities. We have proven that the technology works and that there is plenty of international interest from customers, and the next phase will be to secure the capital to scale up sensor production.

One of the reasons we are confident of success is that we have no direct competitors for our technology. While we have competitors that use other technologies to monitor some of the same parameters, Shute humidity technology is unique in terms of being able to monitor 100 % RH and having a very small footprint. In general, compared to other technologies, Shute can monitor many parameters on the same polymer fiber, making our technology more cost effective as one Shute sensor can do the same job as several of our competitors' sensors.

If you started again, what would you do differently?
Andersen: Looking back at my time with Noliac, after securing a sizable investment in 2001, we made the mistake of spending way too fast on setting up a sales office in the US, hiring people too fast and focusing too much on piezoelectric transformers and piezoelectric motors. These technologies never worked well for us, and with hindsight we should have concentrated totally on piezoelectric actuators, transducers, and sensors.

What is your advice for the next generation of entrepreneurs?
Andersen: Firstly, be realistic: developing a business always takes longer than you think and costs more money than anticipated. Secondly, try to find at least one experienced entrepreneur who can join the board or set up an advisory board. Thirdly, focus on sales by developing something unique that has very interesting sales potential and that can attract attention from potential buyers. Finally, obtain proof of business by getting orders to prove that someone believes in your technology.

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

Laseroptik honored with Trumpf Supplier Award

Laseroptik was honored with the Trumpf Supplier Award in the 'Best Innovator' category at the Trumpf Supplier Day. The laudatory speech highlighted in particular the award winner's commitment to the successful optimization of optical coatings, which Trumpf uses for optics in special high-performance laser systems. Their performance depends largely on the optical components used, which are coated at Laseroptik using complex physical processes.

Owner and managing director Dr Wolfgang Ebert accepted the award on behalf of his company from Jan Kistner, head of corporate purchasing at Trumpf, and laudator David Renner, who is responsible for the optics division in Trumpf's purchasing department in Ditzingen. Dr Wolfgang Ebert expressed his thanks for the many years of inspiring collaboration, which he considers emblematic of the award. David Renner emphasized: "I would like to highlight the always very constructive cooperation at all levels that has connected us for many years. The combination of technical excellence, fair dealings with each other and the pursuit of continuous improvement characterize the award winner and our joint partnership. Thank you for your ingenuity!"

Trumpf presents the supplier award to the best Trumpf suppliers every two years. Technical expertise, high quality, market-driven prices and high flexibility are still the most important requirements that Trumpf places on its suppliers. A jury in purchasing evaluates the suppliers according to these categories and selects the winners of the in-house supplier award. This year in the categories: best overall performance production material, best overall performance corporate indirect procurement (CIP), innovation and sustainability.

Sponsored content: Laseroptik

l–r: David Renner (Trumpf), Dr Wolfgang Ebert (Laseroptik), Jan Kistner (Trumpf)

The high-tech company Trumpf offers manufacturing solutions in the fields of machine tools and laser technology. The company is driving forward the digital networking of the manufacturing industry through consulting, platform and software offerings. Trumpf is one of the technology and market leaders in machine tools for flexible sheet metal processing and industrial lasers. In 2022/23, the company generated sales of 5.4 billion euros with around 18,400 employees worldwide.

Laseroptik is renowned for optical coatings and laser optics and employs more than forty coating machines with seven different coating methods. Founded in 1984 as a spin-off from Hanover University, the company produces an average of 180,000 coated optics per year, mainly for laser applications in industry, medicine, space and research.

www.laseroptik.com

A quarter-century of innovation

Toptica's pioneering journey in laser technology

Source all images: Toptica

Taking-off as a three-person startup in 1998, Toptica's vision at the time was to humbly add its tunable diode lasers to the field of scientific photonics and to make a living for around ten people within five years. Fast forward to today, and the company has achieved way more than that: it not only offers a plethora of different products but has become a global leader in photonics with nearly 550 employees worldwide and annual sales of 130 million euros.

More than twenty-five years ago, the founders of Toptica echoed a simple idea that would carry them into the center of the photonics industry: "The market for our cutting-edge research products is going to come. We just wait and be ready when it does!" It was a daring statement at the time, yet one that has been vindicated spectacularly.

In 1998, Dr Wilhelm Kaenders and his colleague, Dr Thomas Weber, founded TuiOptics as a technology spin-off of TuiLaser. In 2001, the company was renamed to Toptica Photonics and converted to a stock corporation. Kaenders was already enthusiastic about cold atomic physics as a doctoral student at the Institute of Quantum Optics in Hanover, inspired by Prof Hänsch's group at the LM University Munich and the Max Planck Institute in Garching. Starting Toptica as a company with scientific tunable diode lasers was the right decision at the time. Frequency 'division' then and frequency 'combing' today have triggered the fascination of ultimate precision with scientists. Transferring radio frequency thinking and control techniques into the optical domain allows us accuracy and precision to be pushed by multiple orders of magnitude. This ambition is still the driving force of the Toptica product range on its way into new markets.

▲ Laser rack systems for quantum technology research at the University of Saarland: six laser rack systems, two DFCs, and many Toptica lasers for atom-atom entanglement over 20 km of fiber.

A success story written in lasers

Over the years, Toptica's lasers became the hallmark for manipulating ultracold atoms in atom and molecular physics laboratories globally. Today, the com-

Company

Toptica Photonics

Toptica has been developing, producing, and marketing high-end lasers and laser systems for science, research, and industry for twenty-five years. The portfolio includes diode lasers, ultrafast fiber lasers, terahertz systems, and optical frequency combs. Worldwide, Toptica has 550 employees in six business units with a consolidated group revenue of 130 million euros.

www.toptica.com

pany has sold more than 10,000 tunable diode lasers and has grown into a globally recognized specialist in research lasers in general. The addition of fiber laser technology opened the laser technology box in 2004 even further, adding substantial industrial business to the mix. Toptica today boasts six subsidiaries in five different countries.

Dr Wilhelm Kaenders, founder and CTO, underscores the transition, saying, "We still share the language, the application know-how, and the passion with the scientists, but we also learned to understand and meet the industry's specific requirements." This dual understanding enables Toptica to reliably manufacture products in very high quantities.

Wilhelm Kaenders (l) and Thomas Weber in 2001 proudly presenting their latest laser system as joint presidents of newly founded laser system manufacturer Toptica.

The quantum revolution: a long, exciting journey

Quantum technology has seen unparalleled growth and significance over the last quarter-century, validated by receiving several Nobel Prizes in Physics. Toptica has not just been a spectator on this journey but an active participant and, being able to recruit field leaders into its growing team, often a trailblazer. The publication of the Quantum Manifesto in 2016 marked a significant milestone for quantum technologies and Toptica as one of its industry leaders.

As part of the European Union's Quantum Flagship Program, Toptica remains the only European company that has made initial contributions to all four pillars of quantum technology: communication, computing simulation, metrology, and sensing. This involvement shows the company's commitment to propelling the field into its promising future.

Facing forward: the next chapter

The rise of quantum technology and photonics as disciplines of global economic and security relevance marks the commencement of an international race. Governments, research institutions, and companies globally invest enormous financial and intellectual resources. "Toptica is proud to be part of this journey. We are poised to adapt and lead our laser technology to the needs at hand, as we have always done. With a continued average annual growth rate of around 15 %, we look forward to the next twenty-five years with optimism and an unquenchable thirst for innovation", Kaenders reports with pride. "Here's to the next twenty-five years that promise extraordinary growth, innovative products, and transformative solutions for both the economy and society. Thank you for being part of Toptica's remarkable journey. Let us continue to push the boundaries of what is possible in photonics and quantum technology."


L–r: Prof Adolf Giesen, Prof Helmut Hügel and Dr Wilhelm Kaenders talk on the occasion of the Leibinger Prize 2002 award ceremony.

Toptica Photonics AG

Lochhamer Schlag 19
82166 Graefelfing
Germany
phone: +49 89 85837-0
e-mail: info@toptica.com
www.toptica.com
toptica-photonics

Spectral imaging made easy

How Wageningen University & Research developed a fully standalone spectral imaging system for fresh produce analysis

Source: Wageningen University & Research

Based on hyperspectral cameras from the Finnish manufacturer Specim, researchers have developed a smart all-in-one spectral imaging laboratory system for standardized automated data acquisition and real-time spectral model deployment. A fully standalone system integrated with two different hyperspectral cameras working in the complementary spectral ranges has proven its capability for reliable fresh produce analysis.

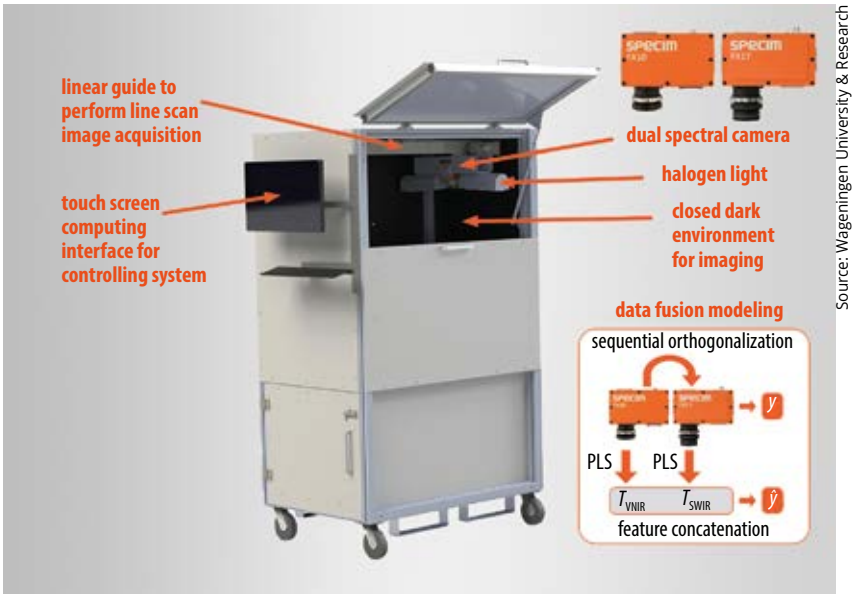
Hyperspectral imaging has been used for quite a while in scientific and industrial applications [1]. It has proven to be a powerful technology for advanced classification and material analysis in numerous use cases. Compared to conventional imaging systems, hyperspectral imaging extends beyond the visible spectrum, making it capable of detecting information that is invisible to the human eye.

Hyperspectral imaging offers unparalleled capabilities in numerous fields where precise characterization and identification are essential. While hyperspectral imaging has demonstrated significant advantages and potential in various industries and research fields, the complexity of data acquisition and analysis has hindered its widespread adoption – up until now [2].

To overcome this challenge, researchers wanted to develop a system that enables users without in-depth knowledge of hyperspectral imaging to benefit from this technology. Hyperspectral line-scan cameras from the Finnish manufacturer Specim are the key component of the project.

Numerous systems are available on the traditional image processing market, such as smart cameras, that enable users to carry out tasks without prior knowledge of machine vision. There is no such push-button type of system for hyperspectral imaging, so to change this situation there was a need to build an easy-to-use, one-touch system [3]. The aim of the research was to develop an intelligent all-in-one spectral imaging (ASI) laboratory system for standardized automated data acquisition and real-time spectral model deployment to make hyperspectral image acquisition easy.

▲ **Fig. 1** The all-in-one spectral imaging (ASI) laboratory system for standardized automated data acquisition and real-time spectral model deployment has proven its reliability by analyzing the properties of several fruits.



Source: Wageningen University & Research

Fig. 2 An illustration of the all-in-one spectral cabinet with two spectral cameras as FX10 and FX17 from Specim. The data modelling is inspired by complementary data fusion and performed with special data fusion methods developed by Dr Puneet Mishra.

Standardized hyperspectral imaging

Several hurdles had to be overcome in the past to realize practical implementations of spectral imaging for routine analysis. One of the primary challenges with spectral imaging is that the cameras that are available on the market usually require system integration and calibration modelling [3].

In addition, most of the hyperspectral sensors in the market are currently supplied as data acquisition tools. To conduct the measurements and develop the model, the user needs to design experimental setups where the sensor must be integrated. The best practice followed in research laboratories is usually to perform the data acquisition and data modeling in separate steps. Although this approach has shown potential, it cannot be considered a practical solution for routine use by non-experts[3].

To make hyperspectral imaging easier, especially for non-expert users, researchers developed a standardized spectral imaging system with embedded computing to have minimal influence on the measurement from unwanted sources. The goal was to avoid system reintegration and to reuse calibrated models to allow repeatable measurements [3].

Hyperspectral cameras as key components

The key decision for the successful realization of the system was the selection of suitable hyperspectral cameras. On this point, researchers opted for Specim FX10 and FX17 hyperspectral line-scan cameras. The physical size of these cameras was perfect for the desired compact design of the system. In terms of resolution and speed, they are also able to meet the specifications without any problems [3].

Complementing the Specim cameras, the researchers integrated a controlled, standardized illumination environment, a built-in computing system as well as embedded software for automated image acquisition and model deployment. This setup was the foundation to explore the spatial distribution of sample properties in real-time in the ASI system.

Combining VNIR and NIR cameras for more precise inspection

The researchers conducted some fruit property analysis experiments to show the capability of the ASI framework for a wide variety of fruits such as grapes, cherry, pear, and kiwi. The human eye and traditional machine vision cameras are sensitive to wavelengths between 380 and 760 nm. Being limited to that range, it can be difficult to detect the chemical parameters related to fruit maturity, such as moisture and soluble solids content. In contrast, the extended wavelength range of hyperspectral cameras makes it possible to predict these parameters.

The machine initially used a Specim FX10 hyperspectral camera that operates

Company

Specim

Specim is a globally leading supplier of hyperspectral imaging and a true pioneer and forerunner in this field. An international team of more than ninety professionals, with expertise in optics, electronics, software, and machine vision, serves the market with the broadest range of hyperspectral cameras, imaging spectrographs, systems, and accessories. Specim is a trusted partner for industrial OEMs, machine builders, and integrators.

www.specim.com

Institute

Wageningen University & Research

WUR is a collaboration between Wageningen University and the Wageningen Research foundation and explores the potential of nature to improve the quality of life. Over 7,200 employees, 13,200 students and over 150,000 participants in WUR's Life Long Learning from more than one hundred countries work everywhere around the world in the domain of healthy food and living environment for governments and the business community-at-large.

www.wur.nl

Fig. 3 Specim's FX10 and FX17 hyperspectral cameras are the key components for the fruit inspection system, covering a wavelength range from 400 to 1700 nm. (Source: Specim)

in the visible and near-infrared (VNIR) spectral range from 400 to 1000 nm. With only the FX10, it was already possible to check the sugar content and some other features of the fruits, but to collect more detailed information of higher quality that would be capable of reliably analyzing meat and other food, an additional InGaAs-based Specim FX17 near-infrared (NIR) hyperspectral camera that covers the wavelength range from 900 to 1700 nm was added. This brought further options to analyze food, but also other organic objects.

The Specim FX10 and Specim FX17 complement each other, especially when measuring in high-moisture samples such as fresh fruit where it has been found that, due to the low water absorption coefficients of water molecules in the 400 to 1000 nm spectral range, the penetration depth of the VNIR light is higher [5]. This allows more subsurface bulk information to be captured. In the 900 to 1700 nm range, the water absorption coefficient of water molecules is high, and allows a better analysis of surface moisture in samples.

The Specim FX17 camera is flexible regarding the recording speed as it offers the option of selecting and evaluating from 224 wavelength bands and only using those that supply relevant information for the current application at hand. By reducing the number of observed wavelengths, the standard recording speed of 670 lines per second when using all 224 wavelength bands can be increased to several thousands of lines per second when focusing on just a few wavelength bands. This property is called multiregion of interest (MROI). It is available on both the Specim FX10 and FX17 cameras and gives users very high flexibility in terms of speed without losing accuracy. In addition, MROI reduces the data quantity for easier processing and data storage. Using both cameras in one system allowed improved inspection precision and enabled quality examinations in the full wavelength range from 400 to 1700 nm [5].

Reliable fresh produce analysis with hyperspectral imaging

The all-in-one spectral imaging system has met the requirements to precisely analyze moisture and soluble solids content in a range of fresh fruits [3]. The system was benchmarked in performance against commercial point spectrometer systems that are widely used for NIR analysis. The ASI system achieved a similar performance to the long- established technology and there were only insignificant differences between the prediction of the ASI setup and the commercial spectrometers. In addition, hyperspectral imaging offers other advantages over point spectrometers.

A key benefit of the ASI development compared to point spectrometers is that it allows spatially distributed properties to be explored due to the rich spatial information captured by the cameras. In addition, the ASI setup enables the reuse of existing spectral data and models that were acquired before during laboratory experiments [3]. This opens up

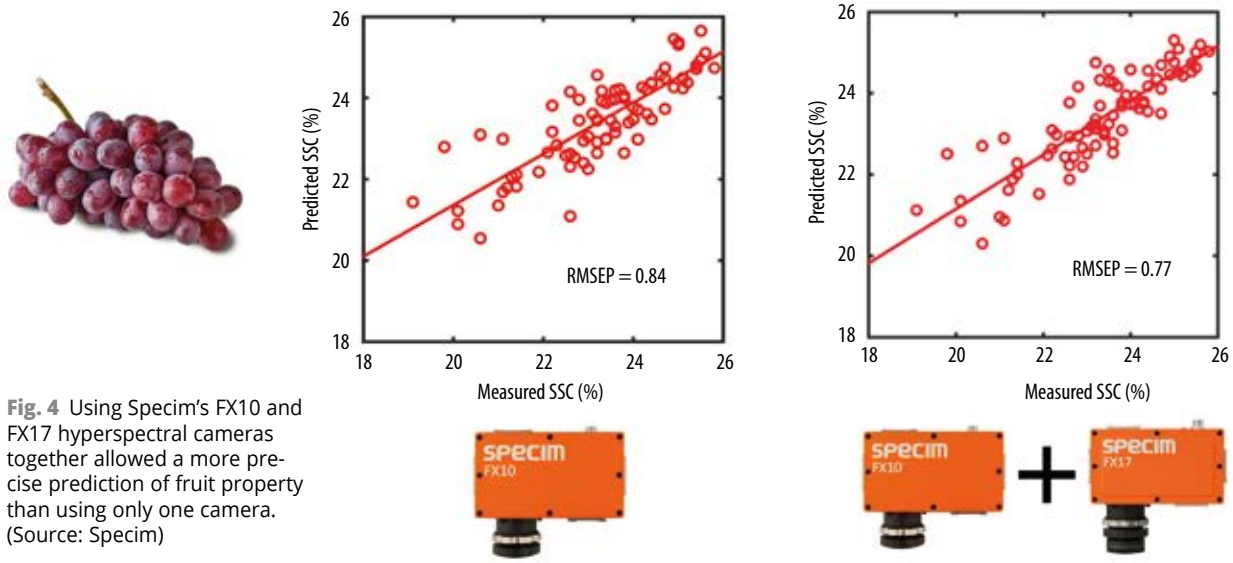


Fig. 4 Using Specim's FX10 and FX17 hyperspectral cameras together allowed a more precise prediction of fruit property than using only one camera. (Source: Specim)

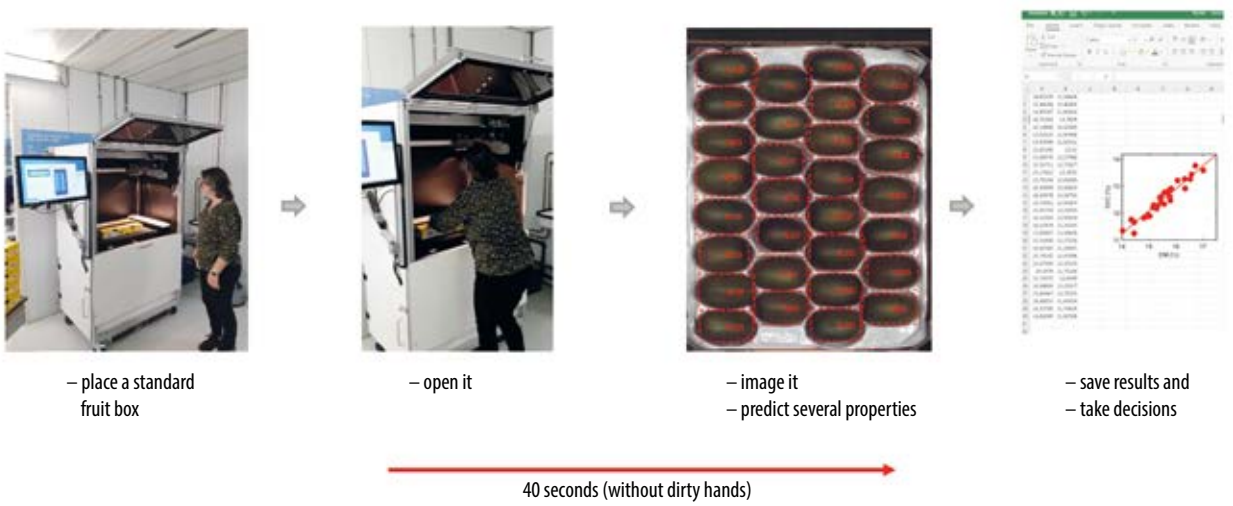


Fig. 5 Overview of the all-in-one spectral imaging (ASI) setup and workflow for kiwi fruit analysis. (Source: WUR)

new options for a wider usage of spectral sensing where models and data can be shared between different users of spectroscopy [3].

Furthermore, ASI is a fully mobile system that can be brought to the samples instead of bringing the samples to the lab. This is a huge advantage over traditional technologies in many use cases. Last but not least, it takes less than forty seconds to get the results. In the past, one might have to wait several days for the results of moisture content analysis [4].

Combined with its ease-of-use, this system gives experts and even users with only a little knowledge of spectral imaging the chance to access the potential of this technology [3, 4]. Researchers are already using the ASI system for experiments with all kinds of food products. The good portability of the device means that the possibilities of the system are far from exhausted.

Specim, Spectral Imaging Ltd.
Minna Törmälä
Global Marketing Manager
Elektroniikkatie 13
90590 Oulu
Finland
phone: +358 10 4244 400
fax: +358 10 4244 401
e-mail: info@specim.com
Web: www.specim.com

Wageningen Food & Biobased Research
Dr Puneet Mishra
Bornse Weilanden 9
6708 WG Wageningen
phone: +31 317 48 91 18
e-mail: puneet.mishra@wur.nl
Web: www.wur.nl

[1] *Y. Lu, W. Saeys, M. Kim, Y. Peng, and R. Lu:* Hyperspectral imaging technology for quality and safety evaluation of horticultural products: A review and celebration of the past 20-year progress, Postharvest Biology and Technology, **170** (2020) 111318. https://doi.org/https://doi.org/10.1016/j.postharvbio.2020.111318

[2] *M. Amigo, H. Babamoradi, and S. Elcoroaristizabal:* Hyperspectral image analysis. A tutorial, Analytica Chimica Acta, **896** (2015) 34-51. https://doi.org/https://doi.org/10.1016/j.aca.2015.09.030

[3] *P. Mishra, M. Sytsma, A. Chauhan, G. Polder, and E. Pekkeriet:* All-in-one: A spectral imaging laboratory system for standardised automated image acquisition and real-time spectral model deployment, Analytica Chimica Acta, **1190** (2022) 339235. https://doi.org/https://doi.org/10.1016/j.aca.2021.339235

[4] *P. Mishra, J. Verschoor, M. N. Vries, G. Polder, and M. P. Boer:* Portable near-infrared spectral imaging combining deep learning and chemometrics for dry matter and soluble solids prediction in intact kiwifruit, Infrared Physics & Technology, **131** (2023) 104677. https://doi.org/https://doi.org/10.1016/j.infrared.2023.104677

[5] *P. Mishra & J. Xu:* Multimodal close range hyperspectral imaging combined with multiblock sequential predictive modelling for fresh produce analysis, Journal of Near Infrared Spectroscopy, **31** (2023) 3, 141-149.

Laser processes are shaping e-mobility in Europe

Laser cutting, laser welding, and related technologies such as process monitoring are boosting battery manufacturing efficiency

Antonio Castelo

Source: Cailabs

Europe needs a battery industry. Internal combustion is a mastered technology on the old continent, but European companies need to improve their electric vehicle capabilities to reduce the gap to other markets. A collaborative approach is critical to succeeding in this objective, as is creating a European ecosystem that could work as a local supply base for the battery manufacturers and the automotive companies.

▲ Busbars welded by Cailabs

Photonics, and in particular lasers and sensors, are set to play a major role in the battery market in the coming years. The manufacturing of batteries for electric vehicles necessitates a shift from traditional factories to the establishment of gigafactories – large manufacturing facilities dedicated to the production of components and products related to electrification and decarbonization technology. Laser cutting and welding techniques are already integrated into battery production lines. While the laser cutting of battery foils finds application in various battery components, including separators and electrodes, laser welding systems have evolved to meet the requirements of minimal heat-affected zones, precise control of penetration depth and a high processing speed. Different solutions have been developed to improve the results in the welding of dissimilar metals and to reduce the number of pores and cracks. Process monitoring and metrology tools are also critical to control the processes and ensure the quality of the final product. And soon, AI is expected to support laser processes by evaluating the results obtained against different parameters to find the most efficient ones.

Innovative approaches to modify the characteristics of the laser beam offer a wide range of possible solutions for electromobility. But they also need to fit the strict requirements of the automotive industry, as described by Jan-Philipp Weberpals, a subject specialist on laser beam processes for car body construction and electromobility at Audi, "Not only the contacts at the heart of a battery module must be connected, but also its housing must be sealed using laser beam technology. The manufacturing challenges of these tasks become obvious during prototyping, coupled with a desire to use just one machine to do


Source: Trumpf

▲ Laser cutting of anode foil

both jobs. The materials involved are being constantly optimized, a situation that can be handled well with laser technology by adjusting the source and the wavelength, in particular for copper components."

Beam shaping in laser welding

Cailabs has identified three priority markets in which to develop the Canunda product range to improve laser processes: additive manufacturing and especially LPBF, micro-processing, and electric mobility – specifically the laser welding of complex materials such as copper and aluminum to produce electric vehicle components. After two years work on the 'Custodian' Horizon Europe Project, Cailabs made their first laser welds with a system integrated into a high-power head (16 kW), focusing on stainless steel. During discussions with their partner in the project, Precitec, they asked when Cailabs would be able to weld copper, marking the beginning of their journey into e-mobility.

It took Cailabs a year to develop a system more suited to copper welding and, since May 2022, it has been passing validation steps one by one. These include creating cords compliant with the standard and analyzing the process window in comparison to a dual-core laser at the Maupertuis Institute – the Cailabs head has a window 1.5 times larger. A second step was welding with x-ray analysis at the Institute für Strahlwerkzeuge (IFSW) at Stuttgart University. Welding was demonstrated here without visible pores at very low (5 m/min) and very high speeds (35 m/min). Live demonstrations of busbar welding were given at Laser World of Photonics, while welding hairpins through a wide-field scanner and welding cord on aluminum (three times faster than with oscillation) was carried out at Precitec (cf. p. 55).

Cailabs is currently carrying out trials with numerous partners, and further results will be available in the next few months. The company is putting a lot of energy into moving quickly in this market because the opportunity is right now while gigafactories are being constructed all over Europe. They are working to demonstrate the benefits of their solution as soon as possible. These include being compatible with all lasers and scanners to enable a globally less expensive solution; allowing a more robust process through a greater depth of field (×4 compared to dual core lasers) to reduce setup and process optimization time as well as scrap rates; offering an optimal and customized solution for each application to achieve the most efficient industry possible.

The progression of automotive manufacturing has precipitated a growing need to be able to weld aluminum materials. The lightweight nature and superior thermal conductivity of aluminum make it ideal for e-mobility applications. Nevertheless, welding aluminum presents distinct challenges, and especially with high-strength alloys, die-cast components, or when bridging gaps. Conventional welding methods fall short in simultaneously addressing all these issues. The challenges become particularly pronounced in scenarios such as welding battery enclosures at high feed rates and overcoming gaps between prismatic battery enclosures and their lids.

Civan Lasers created an emerging solution within the realm of aluminum welding that offers unprecedented capabilities in the real-time shaping and adjustment of the laser beam. Their dynamic beam laser allows manufacturers to quickly tailor the welding process to the application by controlling the beam shape, beam sequence, shape frequency, and focal depth at MHz speeds without any moving parts. As an example, this technology enabled the modulation of intensity distribution while utilizing laser power levels of up to 28 kW for welding. Such a capability enables precise control over the melt pool, allowing a dynamic beam laser to overcome the challenges inherent in high-strength aluminum welding.

Laser cutting of battery foils

The e-mobility sector is also demanding innovation in laser cutting processes during the manufacture of batteries, in particular for the battery cells. Whether cylindrical, pouch or prismatic, all battery cells need the foils to be cut. This has traditionally been done using mechanical processes such as slitting and stamping, but recent increases in laser power have made lasers more suitable for cutting, to a point where they are now becoming the process of choice. The industrial requirements are quite demanding and varied due to the complexity of the foil materials as well as the electrode designs, making it a challenge to identify the most appropriate laser

Source: Scanlab

◀ Remote laser welding enables new applications in battery manufacturing

technology. Requirements range from the slitting of thin bare metal foils to the profiling of coated materials where both bare foil and coated material need to be cut in a single process. The materials divide into anodes (copper foil coated with graphite) and cathodes (aluminum foil coated with active Li+ containing mediums such as NMC or LFP). As always, manufacturers require the highest possible processing speeds with the highest possible edge quality, which is proving challenging.

Cw lasers can be used for bare foil cutting, but in the vast majority of applications and particularly in notching, the laser needs to cut both the bare metal and areas of coated foil. Cw sources struggle to provide the cut quality here, and so ns pulsed fiber lasers have become the source of choice for these applications. The MOPA design of pulsed fiber lasers – like Trumpf's TruPulse nano – allow users to optimize pulse parameters such as the pulse duration (ns), pulse energy (mJ), peak power (kW) and pulse frequency (kHz). Nanosecond lasers are generally considered to be best in terms of both achievable quality and speed for anode foils. Cathode materials are significantly more challenging: they are thicker and have more complex chemistries that results in slower cutting speeds. The key issue with both MNC and LFP coated foils is the resulting cut quality, with burrs and droplets (pearls) adhering to the cut edge and causing potential problems. PS lasers – such as Trumpf's TruMicro sources – can deliver a better cut edge quality, but at the expense of both speed and cost.

Ongoing research and development is looking to further improve the cutting efficiency of all laser sources as well as improving the resulting edge quality to find the optimal solutions for the needs of the battery manufacturers.

Special scanners for e-mobility

When you consider the number of batteries that need to be produced, an improved cycle time is essential to sustain a positive business case. Scanlab offers on-the-fly welding for 1D linear stages to improve the cycle time of these applications. This alternative to static welding successfully overcomes several difficulties where the other method has failed. Some of the disadvantages of static welding are inconvenient laser-off times between seam groups and the need to account for angle changes and elliptical spot shape when using a larger scan area. Both drawbacks can be eliminated by implementing the on-the-fly capability for 1D/2D linear stages. On-the-fly mode advantages include the pre-recording of the axis' velocity, which permits increasing it until there is no laser-off time in the process. For a more complete solution, the combination of 3D scanners, single-mode laser sources, and linear stages offers a versatile setup for e-mobility applications.

Experts in process monitoring

Precitec has developed several systems based on chromatic confocal sensors to perform measurements on different components of the batteries. In this type of sensor, a polychromatic light source illuminates the surface of the object and is focused at different distances depending on the wavelength. Only the light of a very narrow part of the spectra reaches the surface under investigation and is reflected back into the optical system. By determining the wavelength of the focused light, it is possible to measure the distance very precisely at up to 70 kHz and in nanometer resolution. This information is used to analyze the surface and, in the case of battery manufacturing, detect impurities (for example, particles in the 10 – 50 µm range), measuring the thickness and edge superelevation or inspecting cutting burrs.

Chromatic confocal sensors offer several advantages: they are passive optical probes, compact and with no moving parts; it is possible to measure on any kind of material whether absorbent or colored, diffusive or reflective, rough or polished; they have an extremely high z-axis resolution and accuracy.

Primes has developed and produced industry-proven systems to characterize high-power laser beams for over thirty years, measuring crucial process parameters such as the laser power, TCP, beam profile, astigmatism, focus shift or beam jitter.

The demand for electrically powered mobility has continuously increased over recent years, with the steepest incline still ahead of us. While lasers have been well-established tools in automotive plants for decades, new challenges are emerging when it comes to electrically powered cars: up to a hundred times more welds per car, tighter process windows, exceptionally low pro-

cess error rates – and all that using lasers and optics that are much more prone to parasitic focus shift.

It has therefore become standard practice to monitor the relevant laser beam properties during production as frequently as possible. For some applications it is sufficient to measure just the laser power, while others are more sensitive and require additional checks of the beam profile and focus position. Primes offers a robust and versatile family of devices that integrates seamlessly into assembly lines – such as the FocusParameterMonitor (FPM) – and delivers precise results within seconds.

This allows for both preventive and predictive maintenance instead of producing high-cost scrap – which might even go undetected and present a severe safety risk to the finished car.

The rapid advent of artificial intelligence has revealed that reliable data on the laser beam itself is desperately required, but rarely available – simply because measurements used to be performed too infrequently in the production environment. Primes is dedicated to closing this data gap, allowing it to fuel holistic AI models with precise data and expert knowledge about the laser beam.

Such AI models will go perfectly hand-in-hand with even deeper integration of measuring devices into assembly lines. The Primes OnlineFocusTracker (OFT) technology is designed to be an integral part of every laser processing system. With direct access to the internal optical beam path, it can monitor the laser beam during processing in real time, enabling true closed-loop control of the laser process parameters.

The FocusParameterMonitor (FPM) monitors the relevant laser beam properties during production. (Source: Primes)

The Pulsate Network

Pulsate is a European network designed to boost and empower the adoption of laser-based manufacturing among the European Industry. European manufacturing companies, and particularly SMEs, have strong entry barriers to the technology: investment costs, complexity, system integration, awareness and adoption readiness. Pulsate aims to lower all these barriers to boost the adoption of laser-based manufacturing and to promote the development of SME-friendly equipment and solutions. For companies interested in developing laser processes for the e-mobility industry, Pulsate offers networking, matchmaking, technical and financial support, fostering the opportunities and capacity of technology developers, top research centers, manufacturers, and key support partners.

In conclusion, laser processes such as cutting, welding, and innovative beam shaping are playing a pivotal role in advancing electromobility in Europe. The technology is crucial to enhance battery manufacturing efficiency and to support the growth of the electric vehicle industry, with collaborative efforts and innovations driving progress in this dynamic field.

DOI: 10.1002/phvs.202300045

Author

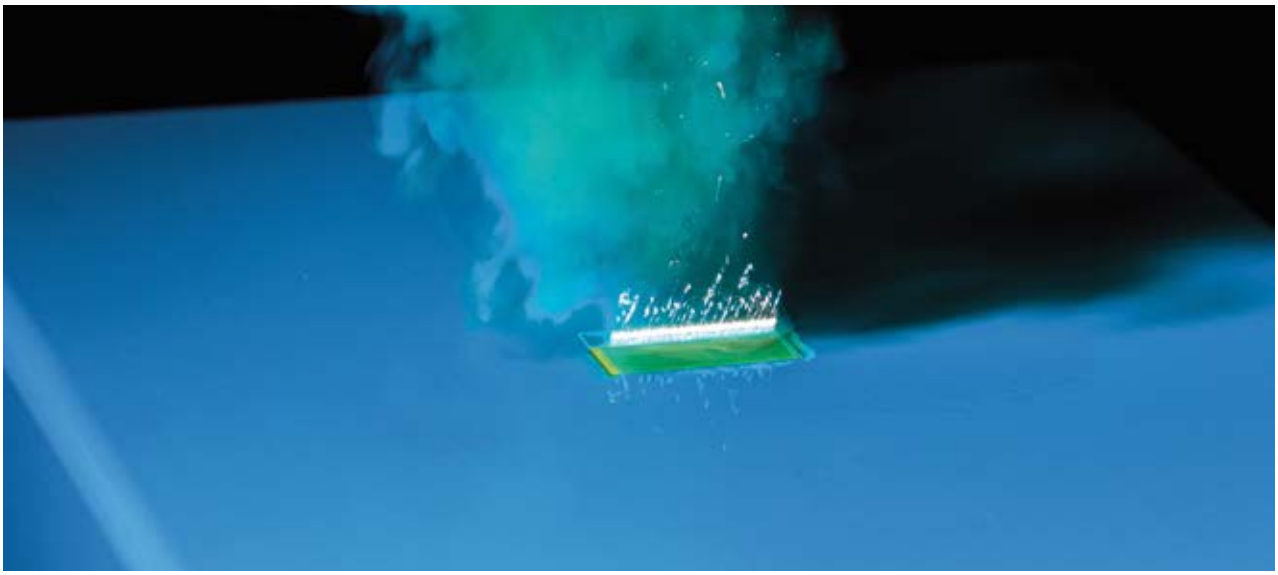
Antonio Castelo-Porta is a physicist specialized in optics and a program manager at the European Photonics Industry Consortium (EPIC). After obtaining a PhD in applied physics with a specialization in the laser processing of materials, he explored the industry as a sales engineer and sales manager for several added value distributors and manufacturers. At EPIC, Antonio is in charge of the 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

Applications for CO_2 lasers in the automotive industry

How CO_2 laser technology assists automotive producers in product development and manufacture

Louise May



Since the inception of the moving production line by Henry Ford in 1913, automotive manufacturers have continuously pursued process optimization to reduce costs and enhance profits by minimizing assembly times. In contemporary automotive production, automation is pervasive, and robots have become integral to manufacturing processes. To further improve efficiency and versatility, lasers have emerged as indispensable tools, supplanting conventional methods and offering numerous advantages in the automotive manufacturing landscape.

Automotive manufacturing utilizes a huge range of different materials, including plastics, metals, textiles, glass and rubber. High-end and luxury vehicles may feature state-of-the-art carbon fiber alongside traditional materials such as wood and leather. Processing such a diverse range of materials requires a versatile tool, and this is where the CO_2 laser comes in. Invented in 1964, the CO_2 laser is one of the oldest laser technologies, yet it remains a mainstay of modern manufacturing and finds a plethora of uses in the automotive industry today. CO_2 lasers are available with output powers ranging from a few tens of watts to several kilowatts, making them useful for a variety of different processes; low power levels are used primarily to mark and engrave, while higher powers can cut and weld with ease and precision. As a result, laser-processed components find their way into almost all areas of a typical vehicle, both the interior and exterior.

Processing plastics

CO_2 lasers find extensive use in processing plastic components, including interior panels, dashboard components, pillars, bumpers, spoilers, trims, number plates, and light housings. A broad spectrum of plastics is encountered, such as ABS, TPO, polypropylene, polycarbonate, HDPE, acrylic, and various composites and laminates. Plastics may be bare or painted, and may be combined with other materials, for example fabric-covered interior pillars, composite or veneered trim panels, and support structures filled with carbon or glass fibers for reinforcement. Lasers can be used to cut or drill holes for fixing points, lights, switches, parking sensors and other components, as well as to deburr or trim excess plastic left over from the injection molding process. Headlamp housings and lenses made from clear plastic often require laser trimming to remove tabs of excess plastic left after molding. Lamp parts are usually made from polycarbonate, chosen for its optical clarity, high impact/shatter

▲ A Luxinar CO_2 laser ablates a car battery coating (Source: Luxinar)

A Luxinar CO_2 laser source cuts airbag material (Source: Luxinar)

resistance, and its resistance to weather and UV rays. Although the laser process leaves this particular plastic with a rough finish, the laser-cut edges are not visible once the headlight is fully assembled. Many other plastics can be cut with a high-quality finish, leaving smooth edges that require no post-process cleaning or further modification.

Plastic cutting operations are typically performed with laser power anywhere from 125 W upwards, depending on the time available to complete the task. The relationship between laser power and process speed is linear for most plastics, meaning that laser power must be doubled in order to achieve a twofold increase in cutting speed. Handling time must also be taken into account when assessing the total cycle time for a set of operations, so that the laser power can be chosen accordingly. Of course, the handling requirements may be complex, and cutting operations frequently require either the laser beam or the part to move in three dimensions; this is where robotic technology comes into its own.

Robotic integration

Robots are indispensable in the era of highly automated automotive production. The integration of lasers into robotic systems presents unique challenges and can be approached in three ways:

- Mounting the laser directly on the robot arm with an articulated beam delivery system, enabling the robot to execute intricate cutting tasks while maintaining precise beam focus.
- Moving the workpiece in front of a stationary laser beam, a simpler approach suitable for smaller robots but the maximum size of the components is limited.
- Mounting an articulated arm on the laser, allowing the robot to position the arm for cutting tasks.

The first of these requires the laser to withstand the G-forces produced by the motion of the robot. The robot must be large and powerful enough to support and move the laser; alternatively, the laser must be sufficiently compact and lightweight to allow mounting directly on the robot arm. The second method often employs a galvanometer scanner to steer the laser beam as the part is offered up by the robot. Holes and small features are cut at high speed, often completing several cuts at each robot position. A typical application involves drilling small holes, typically around one millimeter in size, across the surface of an instrument panel; this allows a vacuum applied to the rear side to remove any air voids as the cover stock is adhered to the outer surface. Larger holes and features may be cut in a similar way, for the installation of switches and sensors for example.

Cutting textiles

Laser technology also extends to cutting and patterning the textiles used in car interiors, such as fabric upholstery and leather. The process speed depends on the type and thickness of the fabric, but a laser with more power will cut at proportionally higher speed. Most synthetic fabrics are cut cleanly, and the edges are simultaneously sealed so that the material does not fray during the subsequent

Source: Shutterstock / Sashkin

CO_2 lasers can drill rubber wiper blades for better water flow

Company

Luxinar

At Luxinar, we have a singular focus: developing laser technology to enhance our world.
The company has been at the forefront of laser technology for over 25 years and is a leading manufacturer of sealed CO_2 laser sources up to 1000 W and, more recently, ultrashort pulse laser sources. We have an installed base of over 25,000 lasers worldwide in a broad spectrum of industries, including automotive, electronics, packaging and textiles, used for applications such as ablating, cutting, drilling, marking, perforating, scribing and welding.

www.luxinar.com

Luxinar SR laser integrated with a robot for automotive production (Source: Robot Technology)

stitching and assembly of the car seats. Leather, both real and synthetic, can be cut for car upholstery in the same way. The fabric coverings that are often seen on the interior pillars of many consumer vehicles are frequently finished using lasers. Fabric is bonded to these plastic parts during the molding process, requiring the excess to be removed from the edges prior to fitting in the vehicle. Again, this is a 5-axis robotic process with the cutting head following the contours of the part and trimming the fabric with precision. CO_2 lasers with moderate power, such as Luxinar's SR and OEM series, are typically used for these applications.

Safety systems

Fabrics are not only for decoration and comfort; technical textiles are utilized in a vehicle's safety systems, namely for the seat belts and airbags. Modern vehicles are typically fitted with multiple airbags as standard to protect both driver and passengers. Airbag materials are usually made from densely woven nylon or polyester fibers, and are often silicone-coated to obtain the desired air permeability. Airbags may be flat-woven where the bag is made up of several fabric pieces stitched together, or one-piece-woven (OPW) where the structure of the airbag is fully formed on the loom. Both types require trimming, for which a CO_2 laser is the ideal tool. The laser process is efficient and reliable, minimizing waste by cutting with consistently high quality. The non-contact nature of the process means that handling of the fabric is minimized and the silicone coating is therefore less likely to incur any damage that could compromise the integrity of the airbag.

It is testament to the versatility of the CO_2 laser that the same technology can be used to score lines in the material of the car dashboard and door skins, selectively weakening the structure so that a flap breaks open to release the airbag in the event of a collision. This laser scoring is implemented on the reverse side of the interior panels so that there is no aesthetic impact visible to the occupants of the vehicle, and must be performed to extremely tight tolerances.

Surface modification

CO_2 lasers are also employed in automotive manufacturing for surface modification and paint removal from selected areas of plastic or composite components. This ablation process is crucial when attaching components to painted or lacquered surfaces where the laser precisely removes the top paint layer or roughens the surface for improved adhesion.

Here, the laser is used in conjunction with a galvanometer scanner to pass the laser beam in a raster or cross-hatched pattern over the required area at high speed. The laser delivers just enough energy to ablate the surface without damaging the bulk of the material. Precise geometries can be realized with ease, ablation depth and surface texture can be controlled, and ablation patterns can be changed as required with a minimum of effort. In some cases laser technology may replace a process previously done by hand, resulting in considerable savings in time and improvements in quality and consistency.

Conclusion

Laser-based manufacturing extends beyond luxury cars; it is prevalent in everyday vehicles. CO_2 lasers impact various components: marking windows with security details, engraving tires with product information, drilling rubber door seals and wiper blades for better water flow, cleaning brake discs, and selectively removing enamel from copper hairpins in hybrid or electric motors. CO_2 lasers also cut or trim plastic parts such as number plates, instrument panels, door skins, lamp covers, interior pillars, filter housings and air intake ducts, among others.

CO_2 laser technology has become indispensable in automotive manufacturing, enhancing production processes and product quality, and today's producers are constantly finding new ways to use this well-established and versatile technology to ensure their continued relevance in the ever-evolving automotive landscape.

DOI: 10.1002/phvs.202300039

Author

Louise May is a senior applications engineer at Luxinar where she is responsible for testing and qualifying industrial processes in the lab. She has 14 years' experience in laser applications, preceded by five years in CO_2 laser R&D. Louise obtained a BSc in applied physics from the University of Hull in 1994, followed by a doctorate in the optical characterization of semiconductors in 1998.

Dr Louise May, Luxinar Ltd, Meadow Road, Bridgehead Business Park, Kingston Upon Hull, HU13 0DG, UK; phone: +44 1482 650088, e-mail: louise.may@luxinar.com, Web: www.luxinar.com, https://www.linkedin.com/company/luxinar, https://www.youtube.com/@luxinar_lasers, https://twitter.com/luxinarlasers

Switching from opaque to transparent

Managing near infrared light using visibly opaque materials

Donald Tibbitt

Source: Adobe Stock / metamorworks

Fig. 1 Multiple smart car functionalities rely on photonics

Near infrared (NIR) light is becoming pervasive within products to improve perception, functionality, and safety. NIR is used in applications ranging from lidar and automotive ADAS to machine vision systems, night vision cameras, IR remotes, touch screens, and various medical and therapeutic uses.

NIR illumination and detection electronics often incorporate a protective cover or lens that appears black or visibly opaque. The black cover on the end of a TV remote or a dome around a night vision security camera are examples of visibly opaque but NIR transmitting materials. They obscure electronics and reduce heat from the solar visual spectrum while efficiently transmitting the NIR portion of light. They also expand design options and minimize the appearance of welds created by NIR lasers in part joining operations.

NIR light, traditionally classified as starting at 780 nm, has several advantages over visual light, such as no glare, lower diffraction under problematic atmospheric conditions, and increased transmission through many materials compared to visible light. Another advantage is that NIR wavelengths were largely presumed to be invisible to human sight as human eye sensitivity dramatically decreases at wavelengths longer than 700 nm.

More recent studies indicate that some human eyes can detect a visible

Company

Epolin

Since 1983, Epolin has produced the highest quality materials to meet laser protective eyewear manufacturer needs, with Epolight dyes and Luminate thermoplastic pellets. Epolin develops and manufactures near-infrared absorbing dyes and thermoplastic compounds. Our materials provide premium performance for laser and welding eyewear, light filters, touchscreens, night vision products, sensors, lidar, and security inks.
Epolin is a subsidiary of the Chroma Color Corporation, and manufactures and ships products from our headquarters in Newark, New Jersey, USA. Epolin regional distributors include AAKO BV (Europe), SN Consultant (Japan), and Sun & Bright Industrial Ltd (China).

www.epolin.com

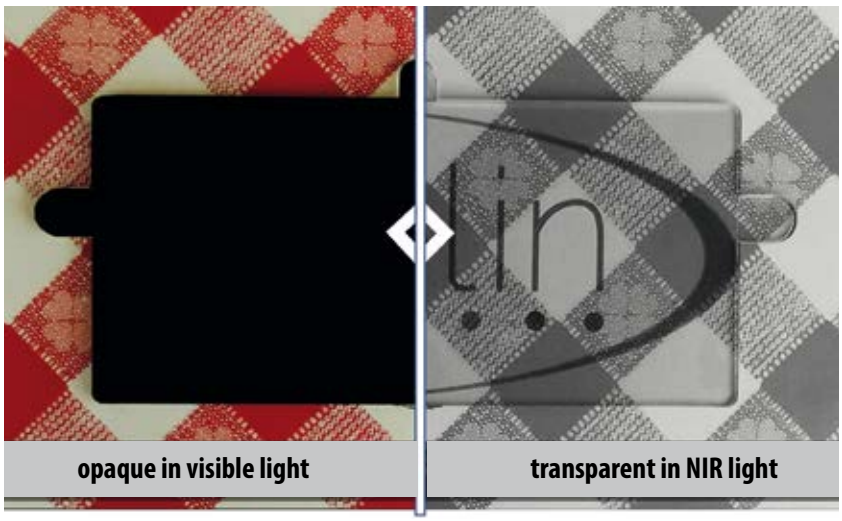


Fig. 2 Materials can exhibit different behaviors depending on wavelength

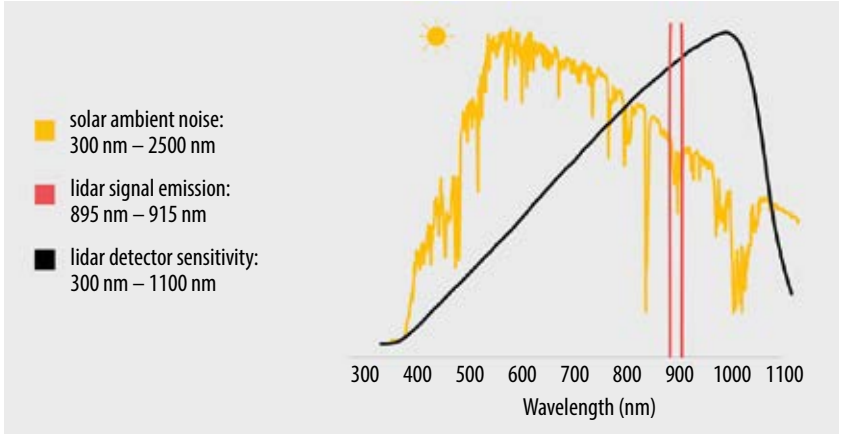


Fig. 3 The lidar filtering challenge, resulting from ambient light and detector sensitivity

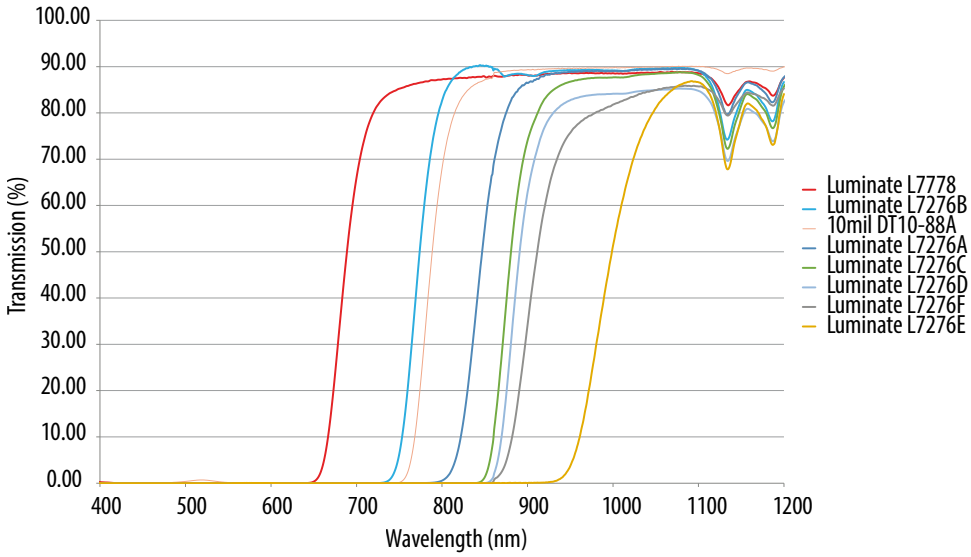


Fig. 4 Transmission spectra of Luminate formulated thermoplastic pellet grades

light response from the NIR light above 780 nm. One study demonstrated that the human eye may respond to radiation up as far as 1,064 nm depending on the light intensity, duration, angle, location of the image on the retina, as well as other factors. As NIR light applications have expanded, international standards have been established to limit infrared exposure to the eye. IEC-62471 covers LEDs, while lasers are covered by IEC-60825.2.

Sensors, like human eyes, are also susceptible to environmental factors that can reduce performance. Fortunately, visibly opaque materials can be utilized to pass desired signals while rejecting noise or interference.

Lidar-functional visible opaque applications

Lidar is often used as a highly capable environmental mapping technology, enabling higher levels of vehicle autonomy. Lidar units produce a narrow band of 905 ± 10 nm NIR light that reflects off illuminated objects and returns to the detector in the unit. If the detector receives a clean return signal, it produces a highly accurate positional map of the environment based on those reflections.

A typical silicon-based lidar detector chip is highly sensitive around the narrow lidar signal range, but is also sensitive to shorter NIR and visible wavelengths. Ambient sunlight reaching the earth's surface contains a wide range of UV, visible, and NIR light which, combined with interference from other NIR sources like LEDs or other lasers, can saturate the lidar detector, thereby reducing overall system performance.

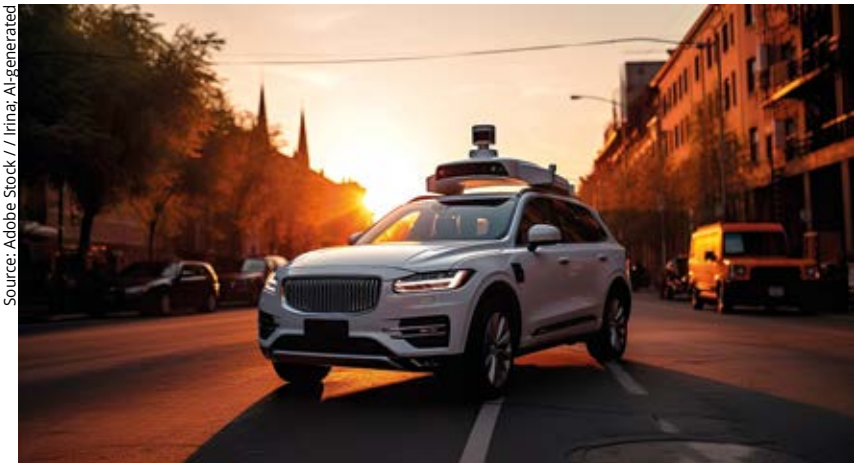
Using visible opaque materials formulated with specific NIR absorbers effectively filters both visual and NIR noise that lies outside of the targeted lidar signal band. Such light management techniques can dramatically improve lidar resolution and range.

Interior ADAS visible opaque applications

Beyond exterior applications, in-vehicle ADAS applications including driver alertness and occupant sensing applications increasingly rely upon NIR light management (Fig. 1). Such applications use NIR LEDs to illuminate objects via directed or flood lighting of the cabin. Some occupants may perceive such emissions once their eyes have adjusted to low visible light conditions while driving at night. Visible opaque formulations tailored around specific illumination spectra can mitigate potential occupant distraction. As facial and gesture recognition systems evolve, Epolin can customize light management solutions, whether they are based on LED or laser technology.

Product options

These visibly opaque, NIR transmitting functional materials (comparis on Fig. 4) may be sourced as an Epolight dye blend



Source: Adobe Stock / / Irina: AI-generated

Fig. 5 Lidar systems need to be protected from interference to ensure full functionality at all times.

in powder form for compounding or as ready-to-mold Luminate compounded thermoplastic pellets. Ink or thin film supply forms are also available.

L7778: An economic solution to obscure device electronics like IR remotes.

L7276B: Produces a deep, aesthetically appealing black that can be formulated into various shades of grey. Suitable for NIR laser welding and joining operations.

L7276A: Used to reduce solar and NIR interference and improve 905 nm lidar signal fidelity. Reduces red glow from 850 nm illumination in security camera applications. High transmission above 880 nm.

L7276F: Mitigates the red glow from 940 nm LEDs for applications requiring covert illumination concealment.

L7276E: Begins to transmit above 950 nm with good transmission over 1,050 nm.

Epolin's technical team can provide timely, optimized, product recommendations for your specific application. Should a novel approach be required, the company's R&D group has the capacities to develop new materials targeted to a customer's unique specifications. Epolin's 'concierge chemistry' approach to product development and light management expertise allows the company to address a wide range of challenging opportunities.

DOI: 10.1002/phvs.202300041

Author

Donald Tibbitt is an organic chemist with over twenty years of experience in synthesizing, formulating, and compounding UV, visible, and infrared dyes. After holding positions at Dupont and AstraZeneca, he joined Epolin where he serves as technical marketing director. Epolin is a global leader in optimizing near-infrared and visible light transmittance in plastic parts, films, adhesives, and coatings.

Donald Tibbitt, Epolin LLC, 358-364 Adams Street, Newark, New Jersey 07105, U.S.A.; phone: +1 973 465 9495, e-mails: dtibbitt@epolin.com, epolin@epolin.com, Web: www.epolin.com

See the light

Photonics enhances vehicle safety and comfort

Florian Friedl & Luigi Ghezzi

Source: Fotoschlick /Adobe Stock

Blinding light in the rear mirror

Many features in today's modern cars are designed to support drivers on their journeys all over the world. Working in the background and invisible to most, some of these hidden components provide us with increased comfort and safety no matter what the driving conditions are like.

EU regulations are becoming stricter with new 2022 regulations for advanced safety systems aiming to improve the safety of both occupants and vulnerable road users [1]. Ultimately, technology will play a key role in achieving the EU's long-term goal of moving close to zero fatalities and serious injuries by 2050.

Hamamatsu Photonics, an expert in optoelectronic technology, develops high-quality optical sensors for the automotive industry. With over thirty-five years of experience in this industry, it has grown to understand the specific challenges, and developed customization capabilities to cater to customers' requirements, ensuring reliability by testing in its manufacturing facilities as well as the highest quality through its AECQ qualification.

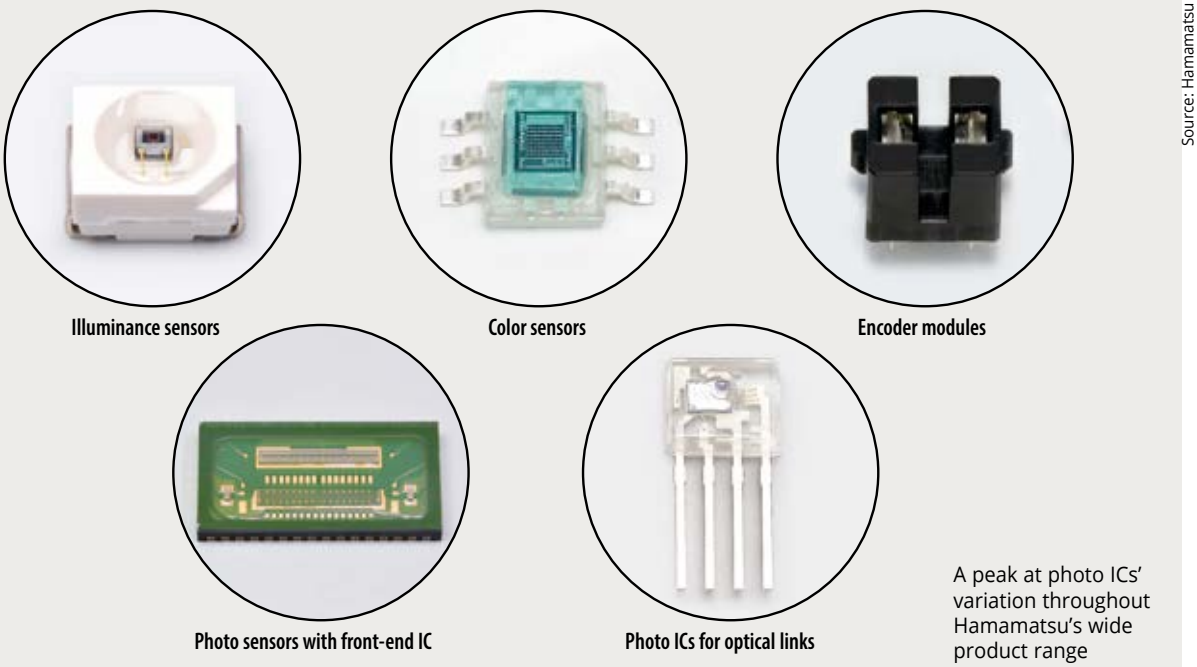
Hamamatsu has grown its portfolio with diverse advanced technologies to assist in safe, reliable, green, and comfortable car driving. Within the automotive devices range, photo ICs (integrated circuits) are a key component that come in many shapes and forms but are essential for many light-sensing automotive applications.

A photo IC is an intelligent optical sensor with diverse functions that integrates a photodiode with a signal processing IC in the same package. Hamamatsu designs all types to match the working environment and the application needs. These compact and lightweight devices can be built or adapted to function as illuminance sensors, color sensors, encoder modules, photo sensors with front-end ICs, and photo ICs for optical links.

Illuminance sensors are ideal to detect the ambient light level. They are built with excellent linearity and a large dynamic range of five orders of magnitude in order to detect low light levels in the dark as well as to work properly in bright daylight. Smart headlights respond to the ambient light level to automatically turn on or off. An illuminance sensor mounted near the dashboard monitors the brightness outside the car and turns on the lights when the brightness drops below a certain light level.

Auto antiglare rearview mirrors also have an illuminance sensor that automatically adjusts the mirror reflectance when they detect intense light (high-beam headlights) from a rear-approaching car at night so that the driver is not dazzled by the headlight glare.

Also providing comfort, color sensors provide information on brightness or color functions for displays, dashboards, interior lighting, or dimming of the head-up display. Interior illumination according to certain situations



Source: Hamamatsu

A peak at photo ICs' variation throughout Hamamatsu's wide product range

or moods is one of the big topics for car manufacturers today: scientific studies show that light influences the mood and the condition of the driver.

Adjustment of the brightness or color can help the driver to remain attentive while driving, while special filters are used to achieve sensitivity close to the human eye. RGB sensors improve the categorization of the measured light in order to distinguish the different times of the day and weather conditions, or between natural and artificial light sources. Encoder modules can also be found in electric power-assisted steering motors, electric brakes, and traction motors to send accurate speed and direction signals to the car's control systems.

Optical data transmission

The large number of sensors in today's vehicles generate a large amount of data that is sent to the central unit board. Once processed, the data is transferred to the vehicle's network, which can be split into safety networks (cameras, mm-wave radar, lidar, etc.), control networks (engines, brakes, etc.), and information networks (car navigation, video, audio, etc.).

At the same time, the industry is shifting towards electric vehicles with more batteries and electric components inside the motors. This means that modern cars need to communicate even more information in a very fast time and without electromagnetic impacts.

The ideal solution to meet the needs of these modern vehicles is an optical network that uses plastic optical fibers with photo ICs for optical links. Hamamatsu Photonics already supplies manufacturers with fiber optical transceivers (FOT), and there are plans to use optical networks for ADAS*3 networks, including for automatic braking. Work is also in progress to develop FOT for optical networks that run at 1 Gbps or even 10 Gbps and faster.

A look at automotive lidar

One of the most promising developments in recent years has been the use of light detection and ranging (lidar) systems, an optical method to measure distances and speed. It measures distance by emitting laser light to a target and detecting its reflection with a photosensor. It is increasingly important in today's safety measures as it helps us detect obstacles and avoid collisions. Photo sensors with front-end ICs assist by optically measuring the distance from the car in front and monitoring the gap between the vehicles. Complete accuracy and fast reaction times are essential for this, even at high speeds and in unforeseen situations.

Unlike the related radar system, lidar sensors identify the environment by means of light only, which is detected by a photosensor. But not all lidar is the same, and not all photosensors are equal. Which technology is the most suitable is not always clear to the manufacturer and depends on the specific application.

Main lidar approaches

Currently, there are two technological approaches to lidar: time of flight (also called TOF) and frequency-modulated continuous-wave (FMCW). While TOF lidars are recognized as the norm, FMCW systems are increasingly growing in popularity for reasons such as the promise of overcoming some of the problems of the time-of-flight approach.

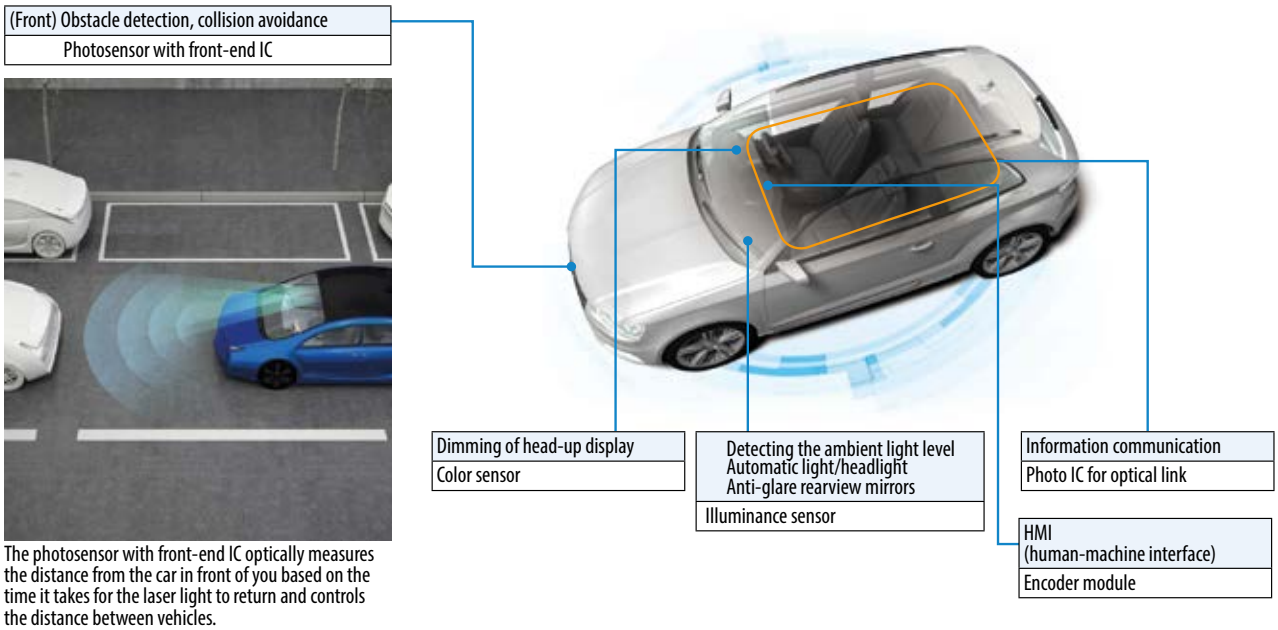
The basic principle of TOF lidar is simple: a light source emits a concentrated beam of light that is reflected by an obstacle – such as a pedestrian or a

Company

Hamamatsu Photonics Deutschland

Hamamatsu Photonics is a Japanese manufacturer of optoelectronic detectors, light sources and systems. The company was founded in 1953 in Hamamatsu City, where it is still located for research and production today.
Hamamatsu Photonics is one of the world's leading innovators in photonics; it develops and produces components across the entire range of light-based technologies and is a leading high-tech supplier for a wide range of industries such as chemical analysis, medical, automotive, security, X-ray and sensor technology.
The Systems division produces a wide range of image processing systems used in life sciences, digital pathology, semiconductor manufacturing, process control and basic research.

www.hamamatsu.com



The photosensor with front-end IC optically measures the distance from the car in front of you based on the time it takes for the laser light to return and controls the distance between vehicles.

The photosensor with front-end IC optically measures the distance from the car in front of you based on the time it takes for the laser light to return and controls the distance between vehicles.

car – and bounces it back to a photosensor. The sensor calculates the object's distance, based on the time the reflected light needs to hit the sensor. A factor to take into consideration is the distance: the greater the distance from the object to be detected, the lower the measurement accuracy. However, this principle is not equal for all types of photosensors – depending on the application, manufacturers can in fact choose from three types: silicon PIN photodiodes (PIN PD), silicon avalanche photodiodes (APD) and multipixel photon counters (MPPC), also known as silicon photon multipliers (SiPMs) or SPADs (single photon avalanche diodes).

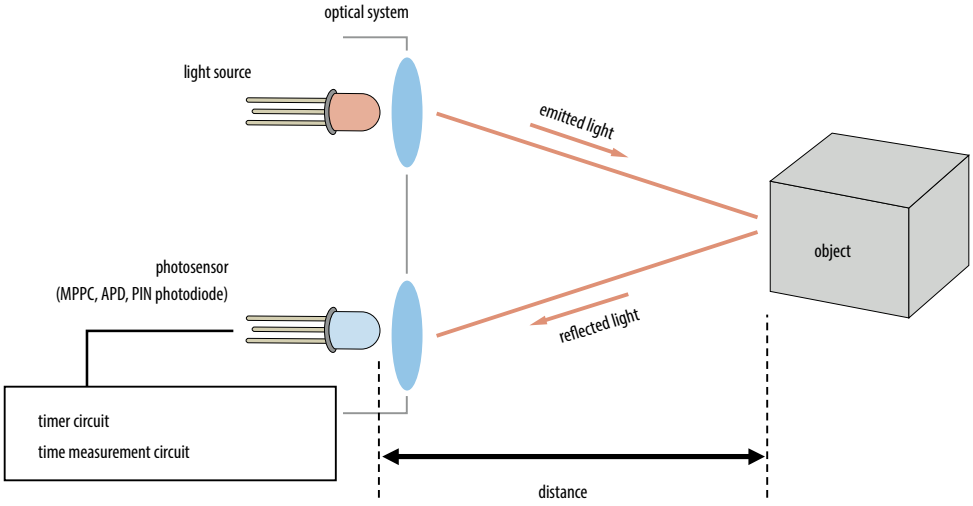
Some types of photosensor will work better than others, depending on the amount of light (number of photons) and the distance. For example, when there is a high number of photons at a short distance and high reflectivity from the object, we can only use the PIN PD (the APD and MPPC would be saturated). However, when the light decreases, meaning the object is moving further away from the light source and the detector, we should use a detector with a higher gain. At this range, the best solution is an APD. In yet another scenario, if we decrease the light but have a longer distance of 100 m for example, a single photon detector with a very high gain should be used: the MPPC.

Yet sensor technologies are not the only consideration. A different sensor geometry and function will be needed depending on the lidar scanning system, whether the traditional system or Flash (flooded light array type), and the exact use case application such as long-range for a highway pilot or a short-range cocoon for parking. This poses one of the main challenges to sensor providers: the need for customization.

For example, there has been a recent increase in the need for 2D MPPCs or SPAD detectors, which are already similar to image sensors but with much higher sensitivity. This customization could be as simple as changing the gap size between the detector elements in an array, or as complex as designing a whole new ASIC. It could also include complete optical assemblies that combine a light source such as a pulsed laser diode with sensors and bandpass filters. Hamamatsu Photonics has the capability and experience to produce such custom chips, starting with the manufacturing of semiconductors up to the special packaging that is necessary to meet the demanding automotive standards.

Greener driving

Tackling environmental challenges is also at the forefront of automotive

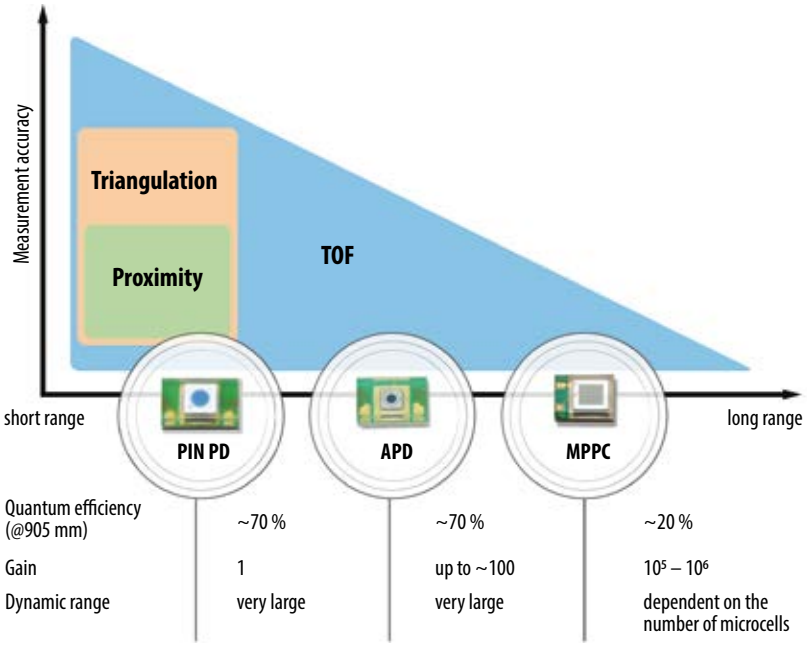


Lidar for automobiles mainly uses the direct TOF method. This method calculates the distance by calculating the length of time for a light pulse to travel from its light source, be reflected off an object, and return to the sensor.

industry concerns. Photo ICs for optical links can be useful to help monitor and control the current, voltage, temperature, and functionality of each individual battery cell in order to ensure the best reliability and performance of the battery pack. Multimedia information like the video and audio data we enjoy in a car is sent via a wire harness or optical fiber cable between various devices such as a display, in-car camera, audio player, and loudspeakers. Light emitter and receiver photo ICs are used for such information exchange through optical fiber links.

DOI: 10.1002/phvs.202300044

[1] Vehicle Safety and automated/connected vehicles (https://single-market-economy.ec.europa.eu/sectors/automotive-industry/vehicle-safety-and-automatedconnected-vehicles_en)



Each different type of photosensor supports a specific lidar system

Authors

Florian Friedl is the group leader for automotive business at Hamamatsu Photonics Deutschland. After completing his apprenticeship in IT engineering at Siemens and his studies of physical engineering in Munich, he worked for an automotive OEM before he joined Hamamatsu Photonics in 2012. Together with his team, he is responsible for the automotive business in Germany and Eastern Europe.
Florian has successfully managed several innovative automotive projects from R&D to SOP through to mass production. One of his current points of focus is the automotive lidar market where he has built up his expertise in a range of different sensor technologies.

Luigi Ghezzi is a technical marketing engineer at Hamamatsu Photonics Europe, where he focuses on detectors ranging from ultraviolet, visible to near and short infrared.
After graduating in physics at Federico II of Naples in 2010, specializing in solid-state physics, optics and optoelectronics, Ghezzi began his career in the automotive sector where he expanded his optical skills in industrial processes and the use of silicon-based sensors in the automotive and industrial sectors. At Hamamatsu Photonics Europe, Ghezzi is focused on the Si and InGaAs PD&APD and image sensor product families.

Florian Friedl, Hamamatsu Photonics Deutschland GmbH / Luigi Ghezzi, Hamamatsu Photonics Europe GmbH, Arzbergerstr. 10, 82211 Herrsching a. Ammersee, Germany; phone +49 8152 3750; e-mail: ffriedl@hamamatsu.de, Web: https://automotive.hamamatsu.com, HamamatsuPhotonics HamamatsuCorporation HamamatsuPhoton hamamatsu

SMaC sets new standards in coating and surface finishing

Coating of brake discs with the opportunity for simultaneous machining

Martin Grolms & Viktor Glushych

Source: Fh. ILT / Volker Lannert

The Fraunhofer Institute for Laser Technology ILT has developed SMaC, a coating process that combines extreme high-speed laser material deposition (EHLA) and mechanical post-machining in a single process. Thanks to SMaC, high-strength coating materials can be applied quickly and efficiently, and simultaneously finished by machining.

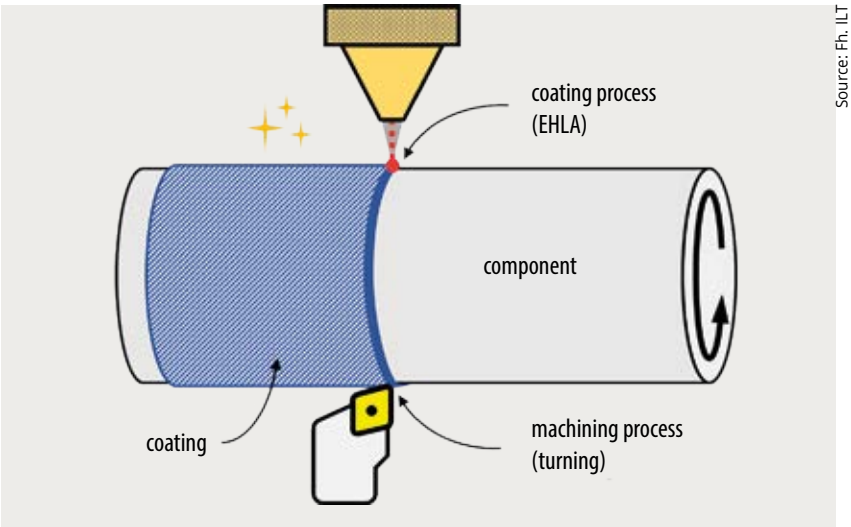
Metallic coatings and the associated coating processes are something like hidden champions: they are hardly noticed, yet they are essential technology. They help to protect components from all kinds of damage and wear. Coatings improve the physical or chemical properties of component surfaces or impart certain functions to them.

However, conventional coatings and their processes often have shortcomings in functionality, resource efficiency or environmental compatibility. Hard chrome plating, for example, requires the use of highly toxic chemicals, and the coatings contain microcracks that can lead to sub-surface corrosion. In thermal spraying, not only do the coatings not have a material bond to the part, but this process also consumes material and gas inefficiently. Laser metal deposition (LMD) is often unsuitable for mass production, in part because of slow process speeds in the range of a few meters per minute. Losses in strength result when the coating material mixes with the substrate, as well as through microstructural changes of the component in the heat-affected zone [1]. In addition, the surfaces produced require extensive post-processing due to their high unevenness – the thinner the coating required, the more expensive the post-processing is.

Since there is a very high demand for efficient and effective coating solutions, especially for corrosion and wear protection, Fraunhofer ILT has specifically addressed these disadvantages by developing EHLA as a variant of LMD.

Extreme high speed laser material deposition – EHLA

The basic idea of EHLA sounds simple at first: instead of conveying the metallic powder particles in a solid aggregate state into a melt pool on the component surface, the particles are melted before-



Source: Fh. ILT

Schematic representation of simultaneous machining and coating (SMaC)

hand in the laser beam. In this way, the process speed is increased by a factor of 10 to 100, which enables area coating rates of up to 20 m^2/h [2].

The key factor to achieving these rates is the precise adjustment of the process zone where the laser beam, the powder jet and the base material interact. The filler material can then be completely melted and, at the same time, an ultra-thin melt pool can be generated on the surface of the component, which ensures a material-to-material bond between coating and substrate. Based on initial work on the new process variant in 2010 which led to a patent application and grant, Dr Thomas Schopphoven began systematic research on the fundamentals of EHLA in 2012.

The results showed that EHLA has some distinct advantages over other processes: EHLA coatings exhibit a fusion-metallurgical bond to the substrate that is characteristic of laser metal deposition while maintaining low coating thicknesses between 25 µm and 400 µm per layer. "High-quality, crack-free and dense coatings can be produced with EHLA from a wide range of materials," comments Schopphoven, head of the laser material deposition department at Fraunhofer ILT.

The reduced heat input prevents distortion, while the microstructure of the base material remains almost unchanged, as do its mechanical properties. The applied coatings have a high purity since the applied material does not mix with the base material to a large extent and lower coating thicknesses can be used in many cases. The improved surface finishes and a low requirement for post-processing make the process both particularly resource-efficient and economically superior, and its high level of automation makes it ideal for series production.

Six months after the prototype system was set up at Fraunhofer ILT, the process was implemented in 2015 at an industrial partner for the first time. The REACH regulation that was passed in 2006 fueled demand for a reduction in the use of harmful chemicals. Since the beginning of 2018, hard chrome plating with chromium (VI) has only been permitted in the European Union with explicit authorization from the European Chemicals Agency (ECHA). Chromium (VI) is highly toxic, carcinogenic and mutagenic. A comprehensive ban on chromium (VI) is foreseeable in the near future, both in Europe and internationally. In this context, EHLA is considered a particularly economical and ecological alternative for very many applications [3].

EHLA is now widely used in everyday production – more than 100 machines are in operation worldwide. In addition

Source: Fh. ILT

The SMaC process: coating with EHLA and time-parallel mechanical machining. The coating is several hundred degrees hot immediately after being deposited and therefore has only a fraction of its regular hardness.

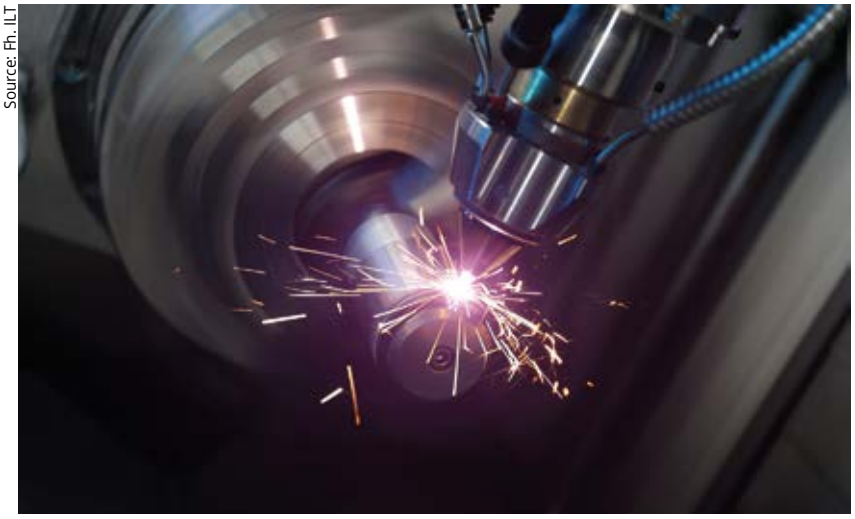
Company

Fraunhofer Institute for Laser Technology ILT

With over 480 employees and more than forty spin-offs, the Fraunhofer Institute for Laser Technology ILT in Aachen is one of the leading contract research and development institutes in its field. For more than thirty-five years, the Fraunhofer ILT experts have been developing and optimizing laser beam sources and laser processes for production and metrology, energy and mobility, medical and environmental technology, and now for quantum technology as well.

www.ilt.fraunhofer.de

Source: Fh. ILT



EHLA produces thinner layers and offers a coating rate many times higher compared to conventional LMD. The precise process uses far fewer resources than thermal spraying and completely eliminates the use of toxic chemicals.

to the enormous application potential that the process offers in surface technology, the innovation can also be used to open up new and, in some cases, very large markets with applications where no technical solutions have existed to date, or where previous process chains promise great potential for economic improvement.

Application: passenger car brake discs

A particularly prominent application is the passenger car brake disc [4]. Such discs are usually made of gray cast iron. The material is comparatively soft and ductile, but has good thermal conductivity and heat storage capacity. The material has advantageous damping properties for use as a brake disc, excellent compressive strength, and it is inexpensive.

It has been known for some time that tire and brake abrasion release significant amounts of particulate matter into the environment. Medical studies show that brake dust is harmful to health and significantly increases the risk of respiratory diseases. To address this, Thomas Schopphoven and his team conducted extensive tests with EHLA-coated brake discs back in 2012. Their idea was to reduce emissions of particulate matter and to increase service life [5].

Other coating processes have considerable problems in this context, for example classic LMD: in addition to shape deviations caused by thermal expansion, too much carbon dissolves from the brake disc due to the high heat input caused by the slow process speed. This results in brittle phases, pores, bonding defects and cracks in the coating or the bonding zone. Since EHLA works at high speeds and generates only limited thermal penetration depth, it avoids these issues; the gray cast iron is effectively protected by the EHLA coating and abrasion is reduced [6].

Now the topic is gaining influence in the industry: the reason for this is the new Euro 7 emissions standard which also takes emissions from brakes and tires into account for the first time. According to current proposals, the rules for passenger cars and light commercial vehicles will apply from July 2025 and for heavy commercial vehicles from July 2027.

Whether internal combustion or electric driven, the new guideline level for passenger cars per vehicle and kilometer is to be less than seven milligrams for PM 10 (up to a maximum of ten micrometers) and smaller particles. Thanks to research conducted at Fraunhofer ILT, the EHLA coating process is now considered the leading technology to comply with the required limits.

Simultaneous machining and coating: combining two high-performance processes

In the vast majority of cases, coatings require post-machining by turning or grinding, which leads to various challenges in productivity and dimensional accuracy, especially in the case of high-hardness coatings for wear protection applications.

Fraunhofer ILT developed a novel combination process to address these challenges that pairs EHLA with the turning process. The clever thing about it is that the rotation and feed rates of the EHLA and turning processes are congruent over a wide range of parameters, which means that both processes can be run in parallel. Fraunhofer researchers Max Gero Zimmermann and Viktor Glushych, as well as Matthias Brucki, a former group leader for LMD process development at Fraunhofer ILT, put the idea into action by running the two manufacturing processes simultaneously.

"This significantly increases productivity compared to the conventional process chain," explains Glushych, head of the Coating LMD and Heat Treatment group at Fraunhofer ILT. "We also use the heat generated in the coating process, which creates advantages in the machinability of high-strength coating materials."

The cooperation with J. G. Weisser Söhne has proven to be particularly valuable: together with the custom machine manufacturer from Southern Germany, Fraunhofer ILT implemented the concept in a manufacturing plant. "The result is a kind of hybrid system, a machining center that combines the two different processes," Zimmermann describes. "The new machine turns and mills on the one hand and additionally coats with extreme high-speed laser material deposition on the other – all in one setup."

The Fraunhofer ILT team has been testing the new machine tool since 2021: they are focusing their process and application development on industrially relevant applications. Brucki, Glushych and Zimmermann have filed a patent application for the innovative solution that allows different additive and subtractive tools to be combined in one process. The three researchers have given the first implementation of the combination process the name SMaC for 'simultaneous machining and coating'.

Symbiosis used intelligently

SMaC is not only faster, it also solves a fundamental problem of high-strength protective coatings: the harder the coating, the better the wear protection, but the more costly the mechanical post-processing to the point of being uneconomical. However, immediately after the EHLA process the coating has only a fraction of its regular hardness and strength because it is still several hundred degrees hot. Thanks to the simultaneous coating and mechanical

machining, the tool wears considerably less in the case of high-strength materials. The technology is even suitable for materials that cannot be machined conventionally by turning due to their high hardness.

"In addition, we specifically compensate for thermally-induced tensile stresses by applying compressive stresses on the tool side," adds Glushych. This makes it possible to prevent cold cracks from forming, especially in high-strength, brittle materials. In this way, the combination process enables the economical production of particularly wear-resistant protective coatings that could otherwise only be produced without defects at enormous expense, for example by preheating the component to several hundred degrees, controlled cooling and subsequent machining.

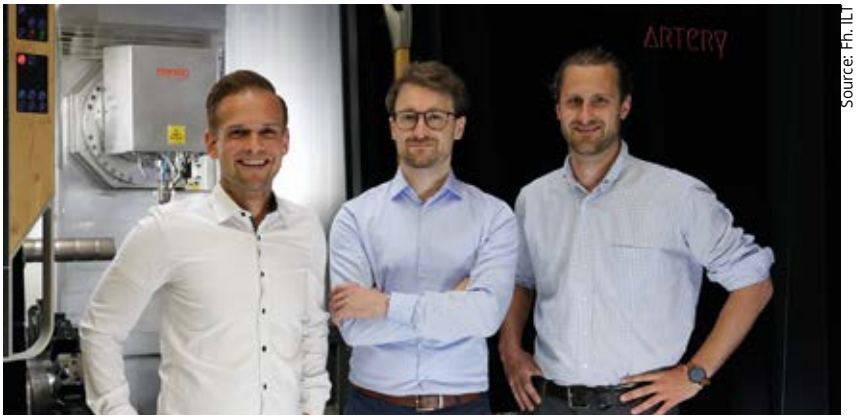
"SMaC is efficient – it saves energy, time and resources," Matthias Brucki summarizes the advantages. "In addition to offering technical advantages, simultaneous machining can reduce the manufacturing times of the process chain down to sixty percent. If the component is also simultaneously pre-machined, the production times are further reduced and the investment costs lowered since additional machines are not required."

In principle, the process is suitable for all applications, including mass production, where components were previously coated and machined one after the other. It can be used to produce coatings for corrosion and wear protection, coatings with hard and soft magnetic properties or to produce highly durable and long-lasting plain bearings as well as other functional surfaces.

Easy scaling and automation

Applications can be found in the energy industry and the entire mobility sector wherever highly loaded, rotationally symmetrical components are used. In the chemical industry, for example, surfaces have to withstand more aggressive media, and high-strength coatings effectively protect against wear in mining or molding tools. The combination process is ready to take on challenging applications, such as the mass production of coated brake discs that comply with the Euro 7 standard.

The process could also be used to transfer a number of new high-performance materials or innovative material combinations to series production. The team is currently exploring the market potential and looking for industrial partners for follow-up projects. The Fraunhofer researchers assume that SMaC can establish itself in numerous markets where corresponding coatings are used. The food industry, plastics industry, paper industry, aerospace, metal or plant engineering are further potential areas of application.



Source: Fh. ILT

The inventors of the process for simultaneous coating and machining (from left): Matthias Brucki, Viktor Glushych, and Max Gero Zimmermann, in front of the hybrid machine from J. G. Weisser Söhne that combines subtractive and additive manufacturing.

DOI: 10.1002/phvs.202300042

[1] *T. Schopphoven:* Experimentelle und modelltheoretische Untersuchungen zum Extremen Hochgeschwindigkeits-Laserauftragschweißen (Doctoral dissertation, RWTH Aachen University, 2019)

[2] *C. Zhong, G. Backes, L.M. Johann* et al.: Development of a novel green coating process with laser. Sci Rep **12** (2022) 6314. DOI: 10.1038/s41598-022-10351-4

[3] *A. Müller, H. Nicolai:* Survey on technical and economic feasibility of the available alternatives for chromium trioxide on the market in hard/functional and decorative chrome plating. baua: Report (2020). DOI:10.21934/baua:report20200331

[4] *T. Schopphoven* et al.: Laserbeschichtung von Bremsscheiben mit angepasster Fertigbearbeitung. VDI-Z BD, 161 (2019) NR. 7/8. DOI: 10.37544/0042-1766-2019-07-08-48

[5] *A.Sutschet, K. Bause, A. Bischofberger* et al.: Feinstaubemissionen trockenlaufender Friktionssysteme in Fahrzeugen. Forsch Ingenieurwes. (2023) DOI: 10.1007/s10010-023-00664-9

[6] *H.Gurk, M. Brucki, R. Mayer:* Frequenz- und Modalanalyse laserbeschichteter Bremsscheiben. In: Mayer, R. (eds) Berichte aus dem Fahrzeugsystemdesign 2021. Wissenschaftliche Reihe Fahrzeugsystemdesign (2021). Springer Vieweg, Wiesbaden. DOI: 10.1007/978-3-658-34821-2_3

Authors

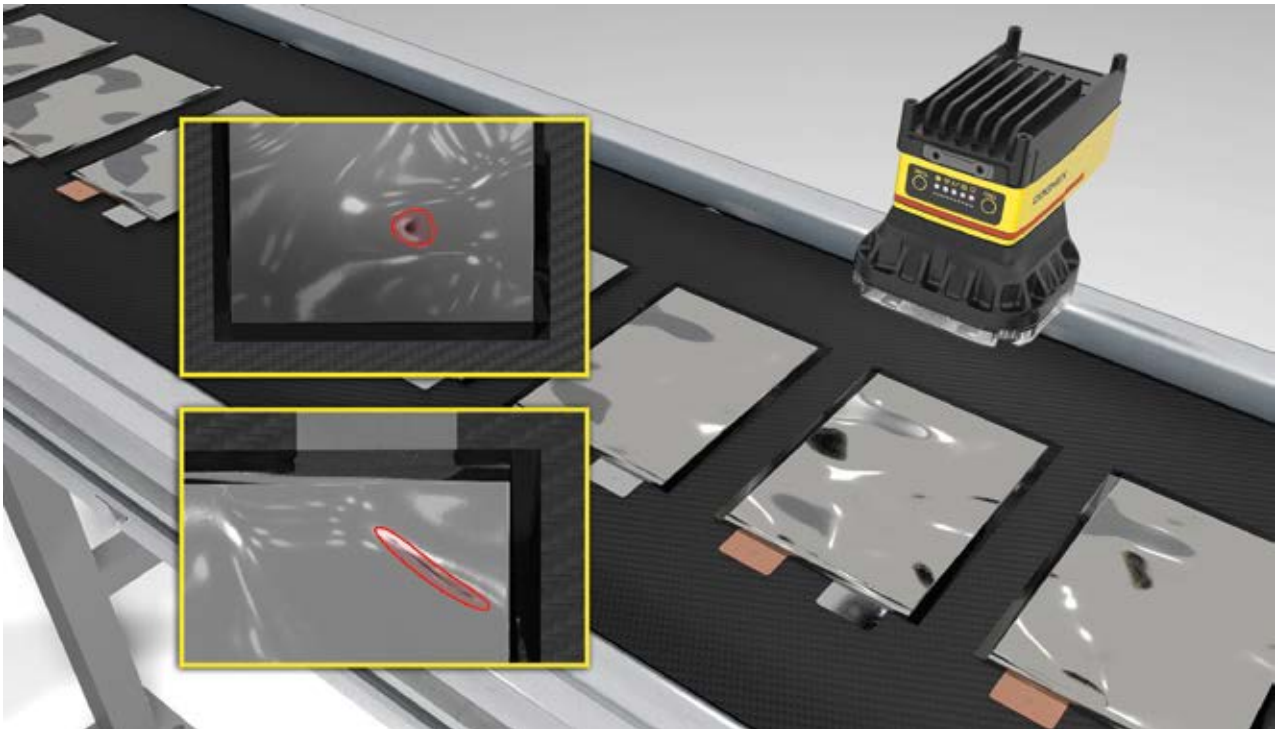
Martin Grolms has nearly twenty years of experience in press relations as well as writing technical articles for newspapers and the trade press. He studied mechanical engineering and communication science at the RWTH Aachen University in Germany. Martin works as an editor and journalist in the fields of laser technology, innovation, mobility and energy.

Viktor Glushych is a group manager and Researcher at Fraunhofer Institute for Laser Technology ILT in the laser material deposition department. He is an expert on extreme high-speed laser material deposition (EHLA), a novel productive and resource-efficient technology for coating, repair and additive manufacturing of metal components.

Martin Grolms, Viktor Glushych, Fraunhofer-Institut für Lasertechnik ILT, Steinbachstr. 15, 52074 Aachen, Germany; phone +49 241 8906-353 / -152; e-mails: martin.grolms@ilt.fraunhofer.de, viktor.glushych@ilt.fraunhofer.de, Web: www.ilt.fraunhofer.de

More efficient production of electric vehicles

Industrial machine vision systems based on artificial intelligence use innovative technology to provide effective quality control



Source all images: Cognex

An enormous number of production steps are required before a car completes its first miles on the road. From the blinker glass, which costs mere cents, to the drive assembly that represents a significant portion of the overall price, every single component must be absolutely flawless and correctly installed in order to meet customer requirements and avoid complaints.

While many quality assurance procedures apply to all vehicles, electric or conventional, electric vehicles (EVs) require special processes for quality inspection, especially for the production of their batteries. Machine vision systems based on artificial intelligence provide economical solutions for this, as the following examples show.

Pouch surface inspection

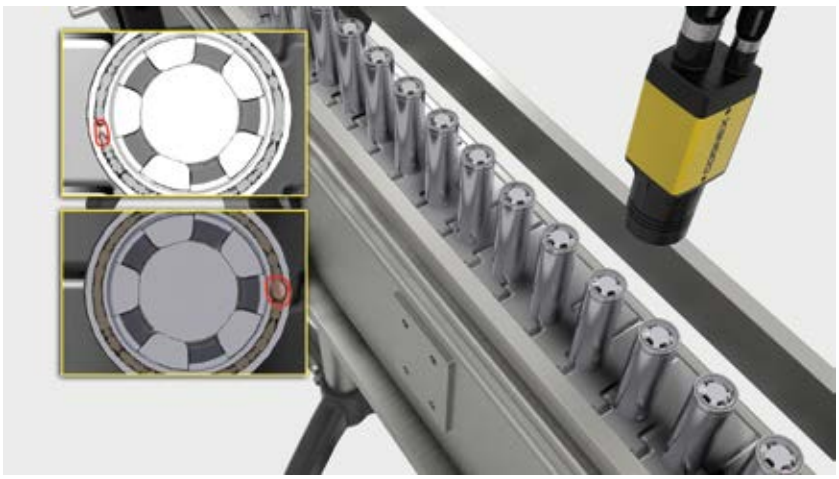
The essential core of an EV is its battery. If the battery construction is not perfect, its efficiency is reduced and, to make matters worse, uneven load distribution between the cells leads to more difficult battery management. Both shorten the lifetime of the battery pack and will result in the owner not being satisfied with the performance of their vehicle.

Most batteries used in EVs are comprised of pouch battery cells. Their shape changes during the degassing phase of production and becomes somewhat more irregular. Later in the manufacturing process, pouches are compressed to smooth their surfaces as only smooth, wrinkle-free, and straightened pouches can achieve their full performance.

Cell battery manufacturers use automated inspection systems during production to detect surface defects. However, the complex surface structure of the pouches, whose choppy, distracting background can hide wrinkles, bubbles and other defects, can be problematic from a machine vision perspective. The appearance of cell pouches can also vary greatly, making it too complicated and time-consuming to search in detail for all defects and to reliably identify them.

▲ Cognex's VisionPro Deep Learning software uses deep learning-based machine vision algorithms to identify defects such as bubbles and wrinkles on pouch battery cells (insets, red marks).

Deep learning tools such as VisionPro Deep Learning from Cognex offer an efficient solution to this challenge. This software uses deep learning-based machine vision algorithms to identify defects such as bubbles and wrinkles by learning from annotated images. The model first learns the usual appearance of a pouch surface including any



Deep learning defect detection and classification tools from Cognex enable the reliable assessment of battery cell cap welds.

natural variations that are not defects. Any features that deviate from the normal appearance of the model are classified as abnormal, and over time the algorithms 'learn' what is normal and what is abnormal. In this way, VisionPro Deep Learning reliably and consistently captures all anomalies without the need for extensive defect libraries.

Cap welding inspection

The manufacture of batteries presents another problem in that faults are difficult to rectify once cells have been joined together to form modules and packages. The housing is sealed with a cap after the electrodes and separators are packed together in the housing of a cylindrical or prismatic cell. A low-temperature welding method is required, typically laser welding, to prevent damage to the sensitive electrical parts inside the housing. Such welds must be extremely precise to ensure a secure seal. Any leakage of electrolyte due to a faulty weld will reduce the efficiency of the cell and could lead to short circuits in the battery.

Reliable inspection of cap welds is therefore important for the functionality and service life of the entire battery. From a machine vision point of view, this task presents a challenge: these welds can have a range of defects with varying appearances, but there can be specific and possibly even large deviations from a 'normal' looking weld that do not affect performance. It is almost impossible to distinguish harmless differences in appearance from functionally problematic deviations using a conventional machine vision system because their appearances overlap.

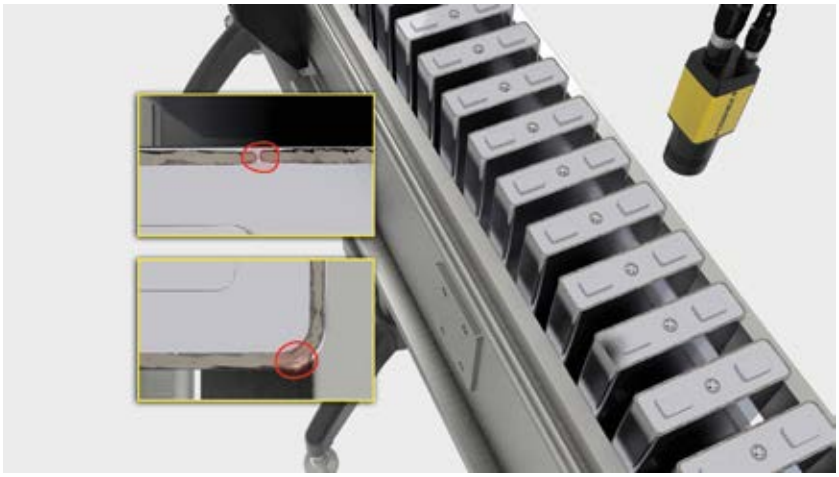
Cognex deep learning defect detection and classification tools provide a solution. They are trained using a wide variety of weld variations and learn to accurately classify and distinguish between the different defect types, despite variations in the objects and welds.

Evaluation of housing welds

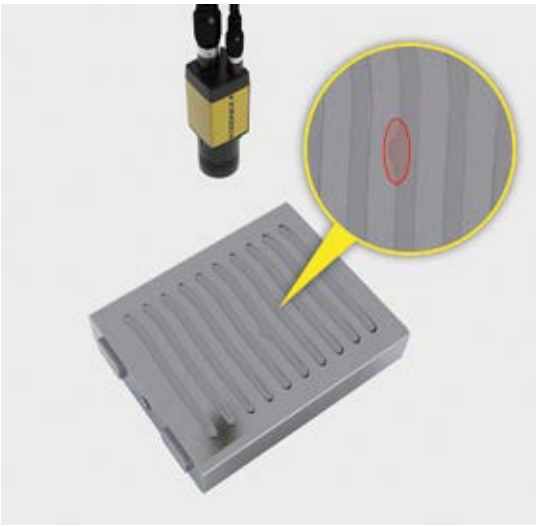
Another application example of deep learning solutions in battery manufacturing for EVs is the evaluation of the housing welds of prismatic battery cells. A rectangular housing for these components is welded around an electrode plate before the upper housing section is subsequently welded on. This cover must allow for some expansion and contraction of the cells as they heat up and cool down during use. This room for expansion is particularly important since prismatic cells are arranged tightly in a space-saving manner. The weld seams on both lateral and upper housing sections must be checked for defects before battery cells are installed.

The correct assessment of these welds is essential for the functionality and service life of the entire battery. As with cap welds, the challenge for automated quality control is that welds can vary significantly in appearance. In addition, a distinction must be made between actual, performance-reducing defects of various degrees and deviations that do not affect performance. This is also true for other battery welds, e.g. when welding shut the hole required to fill the battery with a liquid electrolyte that conducts the electrons.

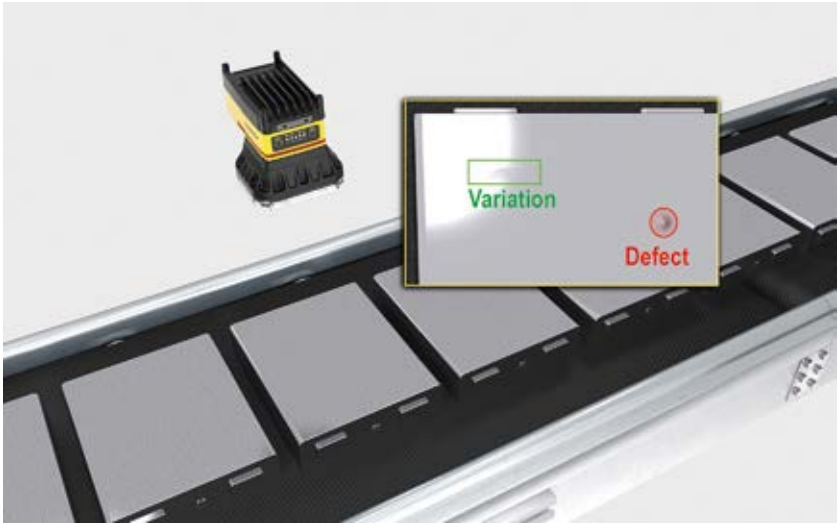
In such cases, a combination of 2D and 3D machine vision systems with deep learning technology can detect many more possible defect types than just one technology could. Cognex's deep learning defect detection and classification tools are trained on a wide



A combination of 2D and 3D machine vision systems with deep learning technology enables accurate classification to safely distinguish functional defects from purely cosmetic ones.



Cognex In-Sight D900 Series smart cameras have embedded deep-learning inspection capabilities that allow the reliable differentiation of true coating defects from unacceptable defects and acceptable deviations.



Deep learning-based machine vision exhibits significant advantages over rule-based machine vision when inspecting thermally conductive material for unpredictable defects.

variety of good and defective weld variations to enable accurate classification and to safely distinguish functional defects from purely cosmetic ones.

Testing of the heat conducting material

Batteries can generate a lot of heat that must be dissipated to prevent damage or premature power loss. The thermally conductive material used for this purpose often also performs the equally important function of electrical insulation, and must be correctly applied with close contact between the substrates to perform its tasks flawlessly.

Possible defects here can include air bubbles, poor adhesion, or inclusions for example, which can result in a reduction in both thermal conductivity and electrical insulation. Once the next step of battery assembly has taken place, the heat conducting material is permanently covered and is no longer accessible for further inspection. Errors at this stage can then lead to problems that are difficult to diagnose later.

A strength of traditional rule-based machine vision is its ability to accurately identify expected problems. In contrast, a much broader range of installation problems that cannot be predicted beforehand can occur when using thermally conductive materials. For this reason, deep learning-based machine vision from Cognex is a more efficient solution for this application. This technology even goes a step further: should a battery later fail, the type of failure can be linked to an image of the thermal material taken during testing and added to the training set. In this way, the deep learning model can be further refined to recognize these new faults for future inspections.

Battery surface inspection

At the end of manufacturing, batteries are provided with a permanent coating that protects the cells. However, this protective material can also have defects such as bubbles and inclusions, scratches, or inadequate application.

Verifying whether these coatings have minor defects that do not affect function or whether seemingly minor scratches result in unsafe or unusable battery cells is almost impossible to do with confidence using conventional machine vision algorithms. This can be remedied by more sophisticated machine vision systems such as intelligent cameras from Cognex's In-Sight D900 series that have embedded deep learning inspection functions.

This system is trained using a set of images of both good and defective surfaces so that the Cognex deep learning defect detection tool learns to recognize surfaces and assign them within the acceptable range of deviations, as well as mark those with unacceptable defects. It even takes natural deviations in the image such as reflections into account.

Experience in all industrial sectors

The above examples show only a small selection of applications from the production of EVs where machine vision in combination with deep learning can contribute to efficient and safe production processes. Other applications in this industrial sector can be found for the so-called stacking of individual electrode sheets where the correct, µ-accurate alignment to each other is checked, for assembly inspection, for the reliable differentiation between real defects and acceptable deviations, and for many other tasks.

Cognex machine vision systems, with and without deep learning functionality, are also used in a variety of other industries to inspect materials for quality and consistency, to guide, to align and identify components, to monitor assembly processes, and many other tasks. Cognex's broad portfolio includes a suitable solution for almost any vision task.

*

Text: Peter Stiefenhöfer, PS Marcom Services, Olching, Germany, www.psmarcom.de

Company

Cognex Corporation

Cognex is a leading global provider of machine vision products and solutions that improve efficiency and quality in high-growth-potential businesses across attractive industrial end markets. Cognex solutions blend physical products and software to capture and analyze visual information, allowing for the automation of manufacturing and distribution tasks for customers worldwide.

www.cognex.com

Shining a light on innovation

Breakthrough automotive lighting technologies that improve safety and usability

Sylvia Weise, Manuel Walch, and Hermann Senninger

Source all images: AMS Osram

The automotive industry has undergone a revolution in lighting as LED technology has enabled new design opportunities, more brightness, and new imaginative effects. More of everything is possible, with the added advantages of greater resolution, enhanced control, and – at the cutting edge of design – ultrathin and 2.5D-formable units that enable the impression of 'light out of nowhere'.

It is estimated that there are more than 1.47 billion cars on the road in 2023, according to Hedges Company. With all of this traffic, safety for the driver, passengers and people outside of the car remains a key factor of automotive innovation. In fact, the European automobile manufacturers' association (ACEA), a globally recognized association encompassing the top fourteen European automotive manufacturers, strives to progress to zero-emission and zero-fatality transport, and identifies more than 150 EU regulations and 30 directives of which the overwhelming majority are focused on safety. AMS Osram therefore focuses a significant portion of its automotive and mobility R&D on features that are designed to enhance safety in the industry.

Lighting is critical to automotive and mobility safety. Enhanced exterior lighting offers increased brightness and intensity, thereby enhancing visibility for both drivers and pedestrians. The rapid response enabled by electronic controls enables adaptive lighting functions that can dynamically adjust the headlamp beam pattern in response to varying driving conditions. These advancements also deliver an extended lifespan and improved efficiency.

LED lighting gives designers new opportunities to engineer the interior ambiance of the vehicle. It not only make controls easier to see, but the small emitter sizes allow lighting to be embedded in door cappings, console edges, and other locations. The available spectrum of colors enables drivers and passengers to adjust the cabin lighting to their own preference.

▲ Dynamic lighting effects in the car interior with Osire

In addition to improved safety, LEDs also make distinctive designs possible as they can be arranged in different shapes and sizes, enabling automakers to create unique signature lighting elements throughout the vehicle. This has become a crucial aspect of brand identity because

Eviyos enables fully adaptive, dynamic headlight operation

many vehicles are now recognized by their distinctive LED lighting patterns. The styling demands and functional lighting requirements differ for inside and outside the vehicle. In response, LED vendors are positioning families of devices that have different properties to achieve the desired effects.

The next step ambient lighting

For many generations, ambient lighting within vehicles has produced little in the way of ambience. For the driver, the illumination has been functional, focused on lighting up the instruments and controls to make them easier to read and use the vehicle safely. Passengers have courtesy lights, although the controls are often difficult to use. With the new creative opportunities now opening thanks to LED technology, ambience is firmly on the agenda as designers seek to differentiate their vehicles from others in the market by how the car makes the occupants feel.

A lot of components can be involved in this and setting up the system and calibrating the LEDs can be time-consuming. The bill of materials for some elements can be large, adding to the cost of the vehicle, and space also needs to be found for the circuitry. The extra equipment also contributes to the overall vehicle weight.

A new approach is now changing the landscape, enabling simpler architecture with fewer parts and lower weight. Bringing together IC design and fabrication capabilities with optical design skills, AMS Osram has created the Osire family of high-performance RGB LEDs. These devices contain an integrated digital core that enables low-latency communication over a standard serial bus interface with any microcontroller. The design team also developed a new open system protocol that lets the designer's choice of microcontroller transmit instructions to each LED to individually modulate the brightness and color. This makes it easier to realize novel dynamic lighting effects in the car interior, such as changes of color and brightness combined with pulsing, breathing, or moving lights. The effects created can be purely decorative or may have a functional purpose such as alerting the driver to a reduction in the outside temperature that may affect driving conditions.

In addition to the LED emitters, the co-packaged IC integrates three LED drivers, a temperature sensor and on-chip memory. This extensive integration enables dynamic interior lighting to be implemented with a relatively simple architecture that comprises few components and minimal wiring, and provides savings in overall system cost.

Each intelligent RGB LED is characterized at the factory, and its optical performance data are stored in the Osire on-chip memory. All measured data of every single LED is collected while running at 10 and 50 mA. This makes it easier for automotive manufacturers to perform end-of-line calibration of interior lighting systems, and to achieve very high optical uniformity and consistency across arrays of hundreds of LEDs. Up to a thousand LEDs can be connected in a daisy chain, controlled via one microcontroller.

The Osire LEDs have been designed for colored ambient lighting in automotive applications. They are individually addressable LED chips, providing maximum flexibility in color, driver selection, and interconnection for interior ambient lighting. They are available in several low-profile package styles that are ideal for coupling into lightguides, including sidelooker packages specifically designed to save space in automotive interior applications. The packages are also compatible with IMSE (in-mold structural electronics) processing.

Company

ams OSRAM

The ams OSRAM group is a global leader in intelligent sensors and emitters. By adding intelligence to light and passion to innovation, we enrich people's lives. With over 110 years of combined history, our core is defined by imagination, deep engineering expertise and the ability to provide global industrial capacity in sensor and light technologies. We create exciting innovations that enable our customers in the automotive, industrial, medical, and consumer markets to maintain their competitive edge and to drive innovation that meaningfully improves the quality of life in terms of health, safety and convenience, while reducing our impact on the environment. Our 21,000 employees worldwide focus on innovation across sensing, illumination and visualization to make journeys safer, medical diagnosis more accurate and daily moments in communication a richer experience. Our work creates technology for breakthrough applications, which is reflected in over 15,000 patents granted and applied.

www.ams-osram.com

Demonstrator of a rear light with Aliyos technology

Increased safety for forward lighting

When it comes to headlamps, increasing the brightness is typically seen as safer. There is no question that lighting the way more clearly and further ahead of the vehicle helps the driver to assess road conditions, as well as giving more time to prepare for turns and to react to events and any obstacles. However, drivers of other vehicles in front and, especially, in the oncoming direction can be dazzled, which is uncomfortable and a threat to safety. Many of the lighting manufacturers have been developing adaptive driving beam (ADB) technology that can reduce glare for other road users while at the same time further enhancing the view forward for the driver. Using technology such as monolithic µ-LED chip arrays to produce light beams of several thousand pixels, ADB matrix lighting and projection with individual pixel control automatically adjusts the beam intensity and direction. In combination with an intelligent camera scanning the scene in front of the vehicle, the LEDs on the top of the array can be switched off to avoid glare for other road users while still maximizing the driver's view of the road.

ADB lights are now making a further leap forward by using the latest monolithic µ-LED chip array technology to deliver significantly higher resolution. AMS Osram's Eviyos 2.0 intelligent forward lighting contains up to 25,600 individually controllable light pixels, with extremely close spacing of just 40 microns. The monolithic array method ensures excellent color and brightness consistency, while the streamlined package design facilitates seamless integration of the light source into sleek headlamp assemblies.

Eviyos 2.0 enables the projection of safety-relevant symbols to assist the driver and other road users. For instance, the car can project warnings related to road conditions, like reduced grip on icy surfaces, by utilizing data from the vehicle's temperature and motion sensors. It also makes it possible for the headlamps to guide the driver past obstacles that might be partially or fully obscured if driving with normal headlamps. Dynamic control of individual LEDs also enables the headlight to project accurately along curves, extending the driver's view of the road ahead.

Light out of nowhere

One of the key strengths of LEDs in automotive lighting is the small size of the light units, made possible by exchanging the bulky filament bulbs for smaller LEDs in chip-scale packages. With these, the lamp units can be smaller and shallower and can take advantage of addressability and RGB mixing to consolidate functions such as combination lamps and turn signals.

The stage is now set to make another transformation with the arrival of LED-on-foil technology that enables ultra-thin profile light units. Form has had to follow function in automotive lighting design for years, but with Aliyos LED technology a new era of freedom in automotive design is about to dawn. From now on, form and function no longer follow one another, but instead follow a common goal: best-in-class customer-centric designed automotive lighting solutions.

AMS Osram Aliyos LED foils make this possible by placing mini-LEDs on a flexible, transparent substrate. The ultra-thin construction (<1 mm) and the 2.5D bendability enables lights of extremely low profile to be produced in almost any required shape. The mini-LEDs are connected with metal traces that are practically invisible and can be arranged in individually addressable segments to perform standard lighting functions such as a stop lights or turn indicators. The addressable segments can also provide programmable animation effects that can include symbols, words, images or abstract patterns for decoration, information, or warnings. Aliyos technology can help to meet legal requirements, such as UN Regulation No. 148 which applies to the brightness of rear lights, stop lights, and turn indicators.

The light units have a minimalist appearance when turned off because they are transparent. One of the company's demonstration designs shows how these almost invisible lights can be applied to curved body panels, creating the effect of 'light from nowhere' when turned on. The unique transparency, thinness and flexibility opens up many other new design options to car manufacturers.

Another demonstration design uses the transparent nature of the Aliyos foil substrate to produce new 3D effects in rear lights. This is achieved by arranging three Aliyos LED foils in a transparent array, with one positioned behind the other, creating a captivating sense of depth.

Conclusion

With almost 1.5 billion cars on roads across the world, 360-degree safety is increasingly important. LED technology has changed automotive lighting and brought opportunities to combine safety, flexibility, and previously unachievable styles, while also delivering greater reliability. Lamps are now capable of lasting the lifetime of the vehicle. The LEDs' efficiency advantage also lets brighter lights draw very low electrical power, which can be directly linked to a greater driving range as electric vehicles come to the fore.

LED-lighting technology continues to move forward. Those companies that can augment their lighting expertise by adding in-house chip design skills are best positioned to achieve the high levels of integration that deliver the greatest advancements in future generations of interior and exterior lighting.

DOI: 10.1002/phvs.202300043

Authors

Sylvia Weise is an expert in the LED industry. She currently works as a senior product marketing manager. Having started in the company in 2008 in customer quality management, her experience in dynamic forward lighting makes an important contribution to the company's success.

Manuel Walch is a product marketing professional for automotive dynamic signaling. His current focus is on Aliyos and the respective applications possible with this new LED-on-foil technology. He joined AMS Osram in 2020 and has gained more than ten years experience within the automotive industry.

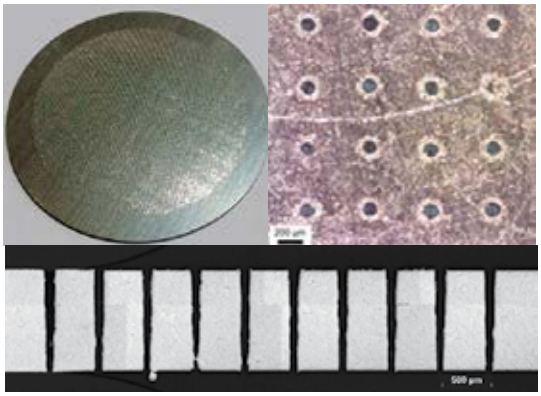
Hermann Senninger is a senior product marketing manager at AMS Osram, working at the moment on intelligent RGB solutions. Bringing light and electronics together is his passion. He has more than thirty years' experience in the automotive industry. He has been with AMS Osram since 2015.

Sylvia Weise, Manuel Walch, Hermann Senninger, ams OSRAM AG, Tobelbader Str. 30, 8141 Premstaetten, Austria; phone: +43 3136 500-0, e-mails: sylvia.weise@ams-osram.com, manuel.walch@ams-osram.com, hermann.senninger@ams-osram.com, https://ams-osram.com, ams-osram

Full article in PhotonicsViews issue 1/2024

Laser-based manufacturing of hydrogen components

High-speed laser drilling for scaling up fuel cells and hydrogen electrolyzers



Macro and micro image of the laser drilled hole along with cross-sectional image (Source: PI)

Scaling up clean hydrogen production using renewable energy is essential for decarbonizing a range of sectors, including transportation, chemicals, and steel, where reducing emissions and achieving net-zero targets have proven to be challenging. Advances in laser-based manufacturing, particularly ultrahigh-speed laser drilling, are crucial for economically producing and scaling up hydrogen components, including high-temperature hydrogen electrolyzers (HTHE).

Recently, The Manufacturing Technology Centre (MTC), in collaboration with Physik Instrumente (PI), has been focusing on high-speed laser drilling of hydrogen electrolyzer components using high-energy microsecond pulse lasers. By harnessing the high-pulse energy and precision of the PI CNC motion stage, the team has achieved a drilling rate of more than 600 holes per second. One of the main research challenges in this undertaking was synchronizing the laser pulse with the CNC axis movement to achieve hole drilling positional accuracy of less than 5 microns. The figure depicts the laser-drilled sample.

PI (Physik Instrumente) Ltd

Dr Cliff Jolliffe
Strategic Marketing Manager
Industrial Automation
Trent House, University Way
Cranfield Technology Park
Cranfield, Bedford, MK43 0AN
United Kingdom
phone: +44 1234 756 360
e-mail: c.jolliffe@pi.ws
Web: www.pi.ws

Manufacturing Technology Centre Ltd

Dr Mitchell Leering
Advanced Research Engineer in
Laser Processing
Ansty Park
Coventry CV7 9JU
United Kingdom
phone: +44 2476 701600
e-mail: mitchell.leering@the-mtc.org
Web: www.the-mtc.org

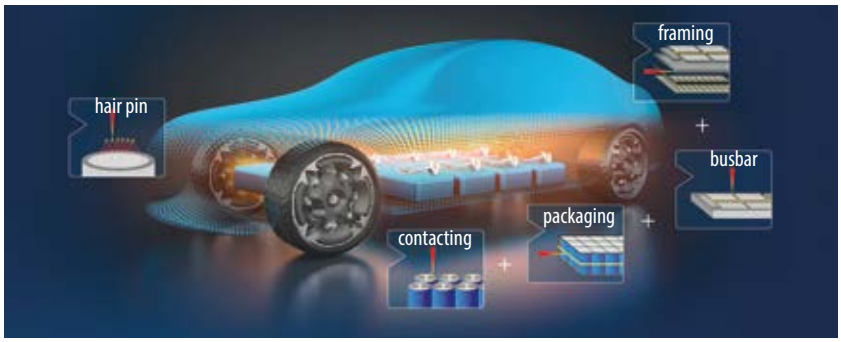
Full articles now online and in PhotonicsViews issue 1/2024

Addressing challenges in electric vehicle production

Advancements in beam shaping technology for enhanced laser welding of copper

Electric vehicles (EVs) promise a sustainable mobility, aligning with stringent emissions standards and attracting government incentives globally. However, the journey towards e-mobility is not without hurdles. To truly accelerate the adoption of EVs, we must tackle the challenges of cost reduction, increased driving range (autonomy), and enhanced safety.

To confront these challenges head-on, laser beam shaping based on multiplane light conversion (MPLC) technology has been developed. This technology significantly enhances the copper laser welding process within electric vehicle manufacturing. The MPLC-based systems have been developed to provide process improvements of two parts: hairpins and busbars. These are both made of copper, which is challenging due to its high reflectivity and conductivity. Another challenge are the especially high quality welding standards for e-mobility (very few pores and spatters).



Different parts of the EV which require laser welding (Source: Precitec)

The system which has been tested for busbar welding at the Maupertuis Institute and for hairpin welding by Precitec, that also provided the collimation optics, helps through a substantial expansion of the process window and an extension of the depth of field. The artricle delves into the development process and take a deeper look into the advantages of this innovative technology.

Cailabs
Gwenn Pallier
1 rue Nicolas Joseph Cugnot
35000 Rennes, France
phone: +33 6 66 62 87 02
e-mail: gwenn@cailabs.com
Web: www.cailabs.com

https://doi.org/
10.1002/phvs.202300048

Optical neurons to interconnect sensors and artificial brains in autonomous vehicles

Fiber optics connectivity based on long-wavelength VCSEL and fully integrated and adaptive electronics

With the ever-increasing need for faster data communication in cars, electrical interconnects are beginning to show bandwidth and electromagnetic compatibility limitations. The new IEEE 802.3cz ethernet physical layer has been developed specifically to meet these needs, based on a long-wavelength multimode VCSEL and mature bend-insensitive multimode fibers. A major innovation is taking place that will make possible automotive-grade multigigabit optical transceivers.

Connectivity of sensors (e.g., camera, radar, and lidar) with artificial intelligence (AI) central units is key for sensor fusion used in advance driver assistance systems (ADAS) and autonomous vehicles (AV).

With the ever-increasing need for faster and more reliable data transfer, traditional electrical interconnects are beginning to show limitations, urging the industry to explore alternative solutions. Optical interconnections are very well positioned for several reasons: highly demanded data rates, superior Electromagnetic Compatibility (EMC) performance, and future-proven data rate density scalability.

Automotive, however, requires operation under more stringent environmental conditions, reliability requirements, cost constraints, and high production volume, compared with data center optical links. This has led to a new set of specifications for the optical links, which are covered in this article.

Source: KDPOF

KDPOF
Rubén Pérez-Aranda
co-founder & CTO
Ronda de poniente 14, 2CD
28760, Tres Cantos, Madrid, Spain
phone: +34 918 043 387
e-mail: rubenpda@kdpof.com
Web: www.kdpof.com

TRUMPF Photonic Components
Joseph Pankert
management consultant
Lise-Meitner-Str. 13
89081 Ulm, Germany
phone: +49 171 3361262
e-mail: joseph.pankert@trumpf.com
Web: www.trumpf.com

https://doi.org/
10.1002/phvs.202300047

The quantum revolution in vehicle sensor technology

How quantum dots are empowering vehicle safety and automation features

Vehicle safety technology has come a long way. In the 19th century, drivers in England were required by law to be led by someone waving a red flag or lantern to warn pedestrians and horse-drawn carriages that an automobile was approaching. Today, things are a little more advanced.

From time-of-flight (ToF) sensors to in-cab driver monitoring, breakthroughs in photonics have helped to revolutionize technology that improves road safety – and as the materials that power this technology advance, it will only become more effective.

In fact, photonics systems have reached the point where something that once seemed the stuff of science fiction – self-driving cars – may not be too far out of reach. But for this technology to reach consumer markets, car manufacturers will need to incorporate the latest in sensing and imaging technology.

Quantum dots (QDs) – nanoscale semiconductor materials responsive to short-wave infrared light – are the answer. Already facilitating breakthroughs in sensing systems, these tiny technological marvels could be key to enhancing existing vehicle safety features and to making truly autonomous roadways a reality.

A sample of quantum dot ink in a small vial. (Source: Quantum Science)

https://doi.org/10.1002/phvs.202300038

Quantum Science Ltd

Dr Hao Pang
Office S03, Techspace One,
Sci-Tech Daresbury
Keckwick Lane
Daresbury
Warrington, WA4 4AB,
United Kingdom
phone: +44 1925 807 980
e-mail: hao.pang@qscis.com
Web: www.quantumscis.com

Epitaxial regrowth

How GaAs is the key to unlocking new semiconductor laser markets

How can design engineers use epitaxial regrowth to enhance semiconductor laser performance and unlock new markets? First, we need to take a closer look at the relatively mature, epitaxial regrowth process for indium phosphide lasers, commonly used in 5G, datacomms, telecoms and co-located optics applications. Then we can consider gallium arsenide, a less mature material system, which suits a multitude of emerging industrial, biomedical imaging, datacomms, and sensing laser applications.

Epitaxial regrowth better meets the need for greater heat dissipation, reduced optical loss, and the ever-increasing demand for photonics integration. It also brings the next-generation device performance necessary for semiconductor lasers of the future. Current InP device manufacturing technology involves multiple epitaxy (additive) and fabrication steps (lithography and subtractive etching) to form the semiconductor laser. This method contrasts with the more basic ridge-laser structures, where one epitaxy step is followed by subtractive etching to form a waveguide, with passivation and isolation to produce electrical contacts.

Source: III-V Epi

https://doi.org/10.1002/phvs.202300040

III-V Epi Ltd

Prof Richard Hogg
chief technical officer
No 11 The Square
University Avenue
Glasgow
Lanarkshire
G12 8QQ
United Kingdom
phone: +44 141 266 0115
e-mail: richard@iii-vepi.com
Web: www.iii-vepi.com

Source: CIOE

Source: Messe München

January 27 – February 01, 2024
SPIE Photonics West
San Francisco, CA, USA
https://spie.org/pw

February 21 – 22, 2024
TOP Conference 2024
London, UK
https://topconference.com

February 21 – 23, 2024
PHOTOPTICS
Rome, Italy
https://photoptics.scitevents.org

March 06 – 08, 2024
Asia Photonics Show (APE)
Singapore
www.asiaphotonicsexpo.com

March 13 – 14, 2024
W3+ Fair
Wetzlar, Germany
https://w3-fair.com

March 20 – 22, 2024
LASER World of PHOTONICS CHINA
Shanghai, China
www.world-of-photonics-china.com.cn

April 07 – 11, 2024
SPIE Photonics Europe
Strasbourg, France
https://spie.org/conferences-and-exhibitions/photonics-europe

April 17 – 19, 2024
AKL'24
Aachen, Germany
www.lasercongress.org

April 23 – 26, 2024
Control
Stuttgart, Germany
www.control-messe.de

April 22 – 26, 2024
Hannover Messe
Hanover, Germany
www.hannovermesse.de

May 05 – 10, 2024
CLEO
Charlotte, NC, USA
www.cleoconference.org

May 14 – 16, 2024
Optatec
Frankfurt, Germany
www.optatec-messe.de

May 14 – 16, 2024
Rapid.Tech 3D
Erfurt, Germany
www.rapidtech-3d.de

June 04 – 06, 2024
SLT 2024
Stuttgart, Germany
www.slt.uni-stuttgart.de

Read event previews and reviews on www.wileyindustrynews.com/en/events

"This is one of the prime industry events in the calendar"

Review: ECOC Exhibition, 2 – 4 October 2023, Glasgow, United Kingdom

From over 300 exhibitors showcasing the latest technologies to the huge selection of Market Focus sessions, and Product Focus presentations and EPIC's Techwatch sessions, there was plenty to see across the three days.

Source: Nexus Media Events

Innovation – and recognition of that innovation – was found across the ECOC Exhibition halls as companies hosted partners and customers on their booths and the Market and Product focus sessions continued to draw crowds. The spotlight was focused on the winners of the ECOC Industry Award when Michael Lebby of Lightwave Logic presented the deserving companies with their trophies.

The awards went to Coherent's 200G four-level pulse amplitude modulation (PAM4) distributed-feedback laser and Mach-Zehnder modulator, combined monolithically into a photonic integrated circuit; to RAM photonics for Medusa; Marvell for their Nova PAM4 electro-optics digital signal processor platform; Lightwave Logic as Hybrid PIC/Optical Integration Platform Award winner; and in other categories to Huawei, China Mobile, Ciena, Keysight, and Infinera.

The Open XR forum that took place in Product Focus was a major attraction, featuring the latest transceiver specifications, including thermal mechanical form factor and electro-optical characteristics. The symposium also highlighted multivendor use cases.

It was a successful inauguration for the Demo Focus too as attendees got a close-up look at the workings of optical network technology.

When talking to the attendees and exhibitors at ECOC Exhibition, there was a common conclusion. "This is one of the prime industry events in the calendar. It is a key opportunity for us to come and present our view on where things are going, our product lines and to meet with our customers and pick up on the important trends and things on the horizon we need to be aware of," said Thomas Liljeberg, senior director photonic integration at Intel.

ECOC Exhibition will be back next year in Frankfurt, Germany, on 23 – 25 September.

www.ecocexhibition.com

Exceeding expectations

Review: Quantum Effects, 10 – 11 October 2023, Stuttgart, Germany

The Quantum Effects fair with the associated QBN Quantum Industry Summit had a successful premiere: 70 exhibitors and 2,132 participants attended the two-day event at Messe Stuttgart; over a fifth of guests came from abroad. "We were very satisfied with the première of Quantum Effects," said Roland Bleinroth, president of Messe Stuttgart, and drew some extremely positive conclusions. "We reached precisely the right target group. Together with our partners we managed to network innovative ideas with those people who will use them. We were delighted with the broad support from politicians. This clearly illustrates the importance of the topic for Baden-Wuerttemberg and its economy."

Source: Messe Stuttgart

Baden-Wuerttemberg's Minister-President Winfried Kretschmann (center left) with Prof Joachim Ankerhold (left), Dr Katrin Kobe, and Dr Volkmar Denner

In his welcoming address on the afternoon of the first day of the exhibition, Baden-Wuerttemberg's Minister President Winfried Kretschmann described what characterizes the 'quantum state of Baden-Württemberg'. "For example, we have the necessary infrastructure with the IBM quantum computer in Ehningen together with the corresponding partnerships and networks. With the most powerful commercial quantum computer in Europe we can try out things without any great financial risk."

Hosting partner Bosch Quantum Sensing presented the latest quantum sensor prototypes in a smartphone format. "Our participation in Quantum Effects was a great success! We were pleased with the large number of visitors on our stand and the great interest that was shown in our topics and exhibits. As the hosting partner, we were also delighted with the general response to the entire exhibition and the truly inspiring, first-class talk programme. We are also naturally looking forward to Quantum Effects 2024," said CEO Dr Katrin Kobe.

The global Quantum Business Network (QBN), congress partner for Quantum Effects, concurrently staged the QBN Quantum Industry Summit, the international business and technology conference, for the first time in Stuttgart.

"It was fantastic to bring the growing international quantum industry together to discuss the latest developments and most urgent challenges of the expanding quantum industry. The QBN Summit attracted world market leaders, quantum experts, politicians and end users, thereby making an important contribution towards the promotion of international cooperation and strengthening of Europe's sovereignty in the global quantum sector," said Johannes Verst, CEO of QBN.

The next Quantum Effects will be held at Messe Stuttgart on 8 – 9 October 2024 – concurrent with Vision and Hy-Fcell.

www.messe-stuttgart.de

EMVA celebrated Machine Vision Forum as success

Review: European Machine Vision Forum, 12 – 13 October 2023, Wageningen, The Netherlands

The European Machine Vision Forum offers a unique platform in Europe for machine vision researchers and industry representatives to exchange ideas and discuss possible collaboration. More than one hundred participants gathered at the 6th European Machine Vision Forum 2023 in Wageningen on October 12 and 13.

The three keynotes at the event each highlighted a scientific image processing sub-discipline. Amongst them, the presentation by Christophe Cudel, professor at the Université de Haute Alsace, on light field cameras for visual navigation showed the maturity and suitability of light field cameras, despite all the technological challenges. The keynote by Alfred Bruckstein, professor at the Technion – Israel Institute of Technology, on 'random dot videos' illustrated how powerful the human visual system is and how this can trigger technical implementation using machine vision technology.

The presentation by Albert Theuwissen, CEO and founder of Harvest Imaging, on 'stacked image sensors' demonstrated very clearly how image sensors, and probably soon also machine vision applications, benefit from the technical progress of the semiconductor industry.

Machine Learning has been a frequently addressed technology at the European Machine Vision Forum this year. Particularly in unstructured environments, such as in agriculture or industrial production, machine learning methods help to deal with variability. However, the presentations on machine learning also made very clear what prerequisites must be in place for its use. First and foremost, this includes suitable training data, which can now also be generated with the help of artificial intelligence, but which requires corresponding (human) expertise. All these contributions were particularly relevant to this year's focus topic 'Real-world Machine Vision Challenges – Coping with Variability and Uncontrolled Environments'.

Source: EMVA

This year's host, Wageningen University & Research, provided a deep insight into the wide range of machine vision developments in agriculture, such as in large-scale plant growth monitoring and state-of-the-art 3D crop detection, or the hands-on demonstration of quality inspection of fruits.

The location and date of the 7th European Machine Vision Forum will be announced soon.

www.emva.org

Setting course for a more productive, sustainable industrial future

Review: Formnext, 11 – 15 November 2023, Frankfurt, Germany

Formnext again demonstrated the relevance of additive manufacturing processes. In its ninth year, the trade fair welcomed 32,851 specialists and managers (50 % international), representing a further increase of 11 % on the numbers recorded for the previous year.

With 859 exhibitors (59 % of which were international), it proved to be another record year for Formnext. The exhibitors, varied events, and special shows demonstrated the wide range of possibilities offered by additive manufacturing for numerous user industries, including medical technology, automotive and mechanical engineering, architecture, and aerospace. Visitors were able to discover innovative solutions that they could use to make their own production more efficient and sustainable.

The latest next-level developments in industrial 3D printing were also on display. Exhibitors presented robotic 3D Printing systems for plastics, for instance, which can even be used to print entire boats. Meanwhile in metals, companies such as AMCM, Eplus3D, InssTek and others demonstrated that highly complex components weighing several tons, such as rocket engines, can be manufactured in one piece using precision AM.

In nanotechnology, exhibitors such as BMF and Nano Dimension presented new solutions that can be used, for the 3D printing of electronic components and much more, and will make numerous new applications and products possible in the future. The high level of innovation was also demonstrated by established players and young start-ups alike, including Bosch, D3-AM, Reinforce 3D and Venox Systems, who presented their latest additive manufacturing technologies.

The supporting events at Formnext 2023 were very diverse, aimed at a wide range of user industries from automotive and construction through to mechanical engineering. The new service provider marketplace put the spotlight on the special role of service providers in expanding the AM user base. The new multistage concept was well received and showcased AM applications, technologies, and innovations while providing a platform for discussions on industry-relevant topics such as sustainability, cybersecurity, and investments. Content from the stage program will continue to be available on demand even after the event on 'Formnext streAM'. Contacts made during the event can be followed up online and discussions continued until the end of November.

Source: Mesago / Mathias Kutt

3D printing live demo at Formnext 2023

Next year, Formnext is scheduled to take place from 19 – 22 November 2024 in Frankfurt am Main.

https://formnext.mesago.com

Preview: SPIE Photonics West 2024

27 January – 1 February 2024, San Francisco, CA, United States

Registration has opened for SPIE Photonics West 2024, which will run from 27 January to 1 February at the Moscone Center in San Francisco. The largest annual conference and exhibition in optics and photonics, the week will include more than 4,500 technical presentations as well as showcasing over 1,200 companies in three focused exhibitions. Photonics West brings together researchers, innovators, engineers, and business leaders from across the globe for research sharing, collaboration forming, and innovation-inspiring exchanges.

SPIE Photonics West has four major application areas emphasizing the latest technologies and discoveries that utilize optics and photonics. BiOS highlights new research in biophotonics, biomedical optics, and imaging for diagnostics and therapeutics; LASE focuses on the laser industry and its diverse applications; OPTO covers optoelectronics, photonic materials, and optical devices; and, now in its third year, Quantum West features quantum 2.0 technologies from quantum sensing and information systems to quantum enabled materials and devices and quantum biology. This year, Quantum West will also include a Quantum West Business Summit highlighting the work of moving quantum technologies to market.

Featuring more than 1,200 companies with product launches, live demonstrations, and cutting-edge technologies on display, the accompanying exhibitions during Photonics West provide terrific platforms for the diverse and healthy photonics industry.

New this time, the Quantum West Expo, 30 – 31 January, will showcase worldwide providers of the latest quantum technologies. The BiOS Expo, featuring new and transformative technologies in biomedical optics and healthcare applications, runs 27 – 28 January, while the Photonics West Exhibition, 30 January – 1 February, encompasses the latest from laser manufacturers and suppliers as well as other innovative optics and photonics devices, components, systems, and services.

https://spie.org/pw

Preview: Asia Photonics Expo (APE) 2024

6 – 8 March 2024, Singapore

APE focuses on the latest cutting-edge innovative technologies and the emerging application markets in Asia, aiming to promote the in-depth communication and business collaboration between the photonics upstream and downstream professionals.

Organized by Informa Markets, Asia Photonics Expo (APE) will be held at Sands Expo and Convention Center. APE is the one-stop photonics exhibition for industry players for technical communication, networking, and product sourcing. It will cover the entire optoelectronic ecosystem to showcase the latest products and technologies in optical communication, precision optics, laser, infrared, sensor, and display fields.

With an exhibition area of 15,000 square meters, APE is expected to attract 400+ enterprises, and over 5,000 visitors to attend the show. During the exhibition, APE will also hold a variety of concurrent events, such as academic conferences and industry forums for future trends, cutting-edge technology, site tours to research institutes, R&D centers, and local companies.

www.asiaphotonicsexpo.com

W3+ Fair Wetzlar

13 – 14 March 2024, Wetzlar, Germany

The successful networking fair and conference will celebrate its 10th birthday in 2024. For some, it is an important contact exchange – for others, the gateway to a promising high-tech region. The W3+ Fair is now the meeting place for the Central Hessian optics industry – a marketplace for cutting-edge technologies, knowledge and talent.

The focus is on user sectors such as automotive, aerospace, medtech, life science, consumer electronics, and machine and plant construction.

To date in November 2023, the exhibition space is very well booked; only a few stand spaces are still available. With Carl Zeiss SMT, Oculus Optikgeräte, Opto-Tech Optikmaschinen, Janitza, Harmonic Drive, Helmut Hund, Hensoldt, Werth Messtechnik, Brückmann Elektronik, Christ Feinmechanik, and many others, the region itself is strongly represented. The joint Thuringian stand will build a bridge from the new W3+ Fair in Jena to the headquarters in Wetzlar. Numerous new exhibitors promise interesting new contacts, including Zeeko, Eclipse, MPA Technologie, Kowa Optimed, Wache, Codixx, IKO Nippon, Asprova, Swarotec, GVB, Glogar Umwelttechnik, Oqema, Electronics For Engineers and Eli Eric.

The list of competence partners of the W3+ Fair Wetzlar is long, above all the gold partners EPIC and Wetzlar Network – the co-initiator of the W3+ Fair. New on board are the European Technology Platform Photonics 21, the Association for Sensors and Measurement AMA, and the European Enterprise Network EEN.

Participants will receive up-to-date knowledge and inspiration on current trend topics at the free high-tech conference en-tech.talks. There will be thematic blocks and an EPIC TechWatch.

https://w3-fair.com

Components and accessories

Cooling systems

KKT chillers
Industriestraße 3 • 95359 Kasendorf
T +49 9228 9977 0
F +49 9228 9977 149
E info@kkt-chillers.com
W www.kkt-chillers.com

technotrans systems GmbH
Gottlieb-Daimler-Str. 3-9
76532 Baden-Baden
Tel.: +49 7221 9711-0 Fax.: -111
www.technotrans.de
info@technotrans.de

Extraction systems, AIR PuriFication

Fuchs Umwelttechnik P+V GmbH
Gassenäcker 35-39
89195 Steinberg
Tel.: +49 (0) 7346 / 9614-0
Fax: +49 (0) 7346 / 8422
E-Mail: info@fuchs-umwelttechnik.com
www.fuchs-umwelttechnik.com

TEKA Absaug- und Entsorgungstechnologie GmbH
Millenkamp 9
48653 Coesfeld
Tel.: +49 2541 84 84 1-0
info@teka.eu | www.teka.eu
Social Media: www.teka.eu/socialmedia

Laser beam sources: Solid-state lasers

Diode lasers, for material processing

Laserline GmbH
56218 Mülheim-Kärlich
Tel. 02630/964-0, Fax 02630/964-1018
www.laserline.com, info@laserline.com

Fiber lasers up to 100 W

PHOTON ENERGY GMBH
Bräunleinsberg 10, 91242 Ottensoos
Tel. +49(0)9123-99034-0, Fax. –22
info@photon-energy.de, www.photon-energy.de

Nd:YAG lasers, diode-pumped

PHOTON ENERGY GMBH
Bräunleinsberg 10, 91242 Ottensoos
Tel. +49(0)9123-99034-0, Fax. –22
info@photon-energy.de, www.photon-energy.de

Nd:YAG lasers, pulsed

PHOTON ENERGY GMBH
Bräunleinsberg 10, 91242 Ottensoos
Tel. +49(0)9123-99034-0, Fax –22
info@photon-energy.de, www.photon-energy.de

Nd:YAG lasers, up to 500 W

PHOTON ENERGY GMBH
Bräunleinsberg 10, 91242 Ottensoos
Tel. +49(0)9123-99034-0, Fax. –22
info@photon-energy.de, www.photon-energy.de

Short-pulse lasers

PHOTON ENERGY GMBH
Bräunleinsberg 10, 91242 Ottensoos
Tel. +49(0)9123-99034-0, Fax –22
info@photon-energy.de, www.photon-energy.de

Laser optics and components

Beam splitters

Optics Balzers AG
Balzers, Liechtenstein
Phone +423 388 92 00
info.mbo@materion.com
www.materion.com/balzersoptics

Filters, optical

Optics Balzers AG
Balzers, Liechtenstein
Phone +423 388 92 00
info.mbo@materion.com
www.materion.com/balzersoptics

Free-form optics

Trionplas Technologies GmbH
Permoserstr. 15
D-04318 Leipzig
Tel. +49(0)3412352234
info@trionplas.de
www.trionplas.de

LOGO?

Galvanometer Scanning Systems

SCANLAB GmbH
Siemensstr. 2 a
82178 Puchheim
Tel. +49 (0) 89 800 746-0
Fax +49 (0) 89 800 746-199
info@scanlab.de
www.scanlab.de

Microoptics

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

Mirror coatings

Optics Balzers AG
Balzers, Liechtenstein
Phone +423 388 92 00
info.mbo@materion.com
www.materion.com/balzersoptics

Mirrors

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

Mirros, UV

Optics Balzers AG
Balzers, Liechtenstein
Phone +423 388 92 00
info.mbo@materion.com
www.materion.com/balzersoptics

Optical Components

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

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

Windows, optical

B&M Optik GmbH
Am Fleckenberg 20, 65549 Limburg
+49 (0) 6431 9860 – 0
info@bm-optik.de / www.bm-optik.de

Material processing systems

Laser welding

Evosys Laser GmbH
Erlangen, Tel. +49 9131-4088-0
www.evosys-laser.com
sales@evosys-laser.com

LPKF WeldingQuipment GmbH
Tel. +49-911-669859-0, Fax: -77
www.lpkf-laserwelding.de

Marking systems

PHOTON ENERGY GMBH
Bräunleinsberg 10, 91242 Ottensoos
Tel. +49(0)9123-99034-0, Fax. –22
info@photon-energy.de, www.photon-energy.de

Optical components

3D Anti-Glare-Spray

Helling GmbH, 25436 Heidgraben
3D-Laserscanning-Entspiegelungsspray
Tel.: 04122/922-0, Fax: 922-201
info@helling.de

Optical metrology

Acceleration sensors

POLYTEC GmbH
76337 Waldbronn
www.polytec.de
info@polytec.de

Dimensional gauging

POLYTEC GmbH
76337 Waldbronn
www.polytec.de
info@polytec.de

Film thickness measurements

POLYTEC GmbH
76337 Waldbronn
www.polytec.de
info@polytec.de

Interferometric measurements

POLYTEC GmbH
76337 Waldbronn
www.polytec.de
info@polytec.de

Surface quality measurements

POLYTEC GmbH
76337 Waldbronn
www.polytec.de
info@polytec.de

Transmission/reflection measurement of thin films

ESSENT OPTICS
Spectrophotometers for Coaters

EssentOptics Europe UAB
Mokslininkų g. 2A
Vilnius LT-08412, Lithuania
Tel. +370 616 19961
E-mail: office@essentoptics.com
www.essentoptics.com

Velocity measurement

POLYTEC GmbH
76337 Waldbronn
www.polytec.de
info@polytec.de

Vibration measurement

POLYTEC GmbH
76337 Waldbronn
www.polytec.de
info@polytec.de

Services

Application development/ Application laboratories

Fraunhofer-Institut für Lasertechnik
Steinbachstraße 15, 52074 Aachen
Tel: 0241/8906-0, Fax: 0241/8906-121
www.ilt.fraunhofer.de

Optical development and engineering companies

Fraunhofer-Institut für Lasertechnik
Steinbachstraße 15, 52074 Aachen
Tel: 0241/8906-0 Fax: 0241/8906-121
www.ilt.fraunhofer.de

System consulting

Fraunhofer-Institut für Lasertechnik
Steinbachstraße 15, 52074 Aachen
Tel: 0241/8906-0, Fax: 0241/8906-121
www.ilt.fraunhofer.de

PhotonicsViews

OPTICS • PHOTONICS • LASER TECHNOLOGY

PhotonicsViews is published with five international issues per year.

Don't miss any issue

subscribe at an annual fee of 454 Euros per year*).

Or apply for a qualified subscription and receive individual issues **for free.**

*) including national/intl. shipping

I wish to receive all print issues of the chosen publication as a regular subscriber for 454.00 Euro per year

☐ PhotonicsViews

I wish to receive chosen issues free of charge as a qualified subscriber

☐ PhotonicsViews

Your principal job function

- ☐ Corporate Management
- ☐ Design & Development Engineering
- ☐ Engineering Management
- ☐ Manufacturing Production Engineering
- ☐ Marketing/Sales
- ☐ Purchasing/Procurement
- ☐ Quality Control
- ☐ Research and Development
- ☐ Technical Service
- ☐ Other: _____

What industry do you work for?

- ☐ Aerospace
- ☐ Automotive
- ☐ Chemical
- ☐ Consulting
- ☐ Electronics
- ☐ General Manufacturing
- ☐ Government/Organization
- ☐ Industrial R&D
- ☐ Medical Equipment
- ☐ Military/Defense
- ☐ Optics/Precision Engineering
- ☐ Printing
- ☐ Scientific R&D
- ☐ Semiconductor
- ☐ Other: _____

Please submit this form via telefax to +49 6123 9238 244 or send a scan as e-mail to WileyGIT@vuservice.de

☐ I agree to receive further electronic information from Wiley.

www.photonicsviews.com

Your Contact Details / Billing Address:

Title/First Name/Last Name

Company/Organization

Address

Country/City/Zip-Code

E-Mail

Phone/Fax

Date/Signature

WILEY

Company Index

published in media partnership with

publishing medium of

PhotonicsViews
OPTICS • PHOTONICS • LASER TECHNOLOGY

Wiley-VCH GmbH
Boschstraße 12, 69469 Weinheim, Germany
ISSN 2626-1294

Editorial:
Dr. Oliver Dreissigacker (od; responsible), Sybille Lepper (sl), Stephanie Nickl (sn)
Phone: +49 (0)6201 606-181 / -105

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 Löfken

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@vuservice.de
Our service is available for you from Monday to Friday 8 am – 5 pm (CEST)

Advertising:
Änne 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

Valid advertising price list: 01 October 2023

Banking account:
JP Morgan AG, Frankfurt, Germany
Account number: 6161517443
BLZ: 50110800
BIC: CHASDEFX
IBAN: DE55501108006161517443

Production and Layout:
Marita Beyer, Anja Hauck

Commercial Manager: Jörg Wüllner
Publishing Director: Steffen Ebert

Printed in Germany by westermann DRUCK I pva

Per media partnership or publishing co-operation, members of the European Photonics Industry Consortium EPIC, Photonics Germany – through OptecNet Deutschland e.V. and SPECTARIS Deutscher Industrieverband für Optik, Photonik, Analysen- und Medizintechnik e.V. – and European Optical Society (EOS) with its national optical societies, especially the Deutsche Gesellschaft für angewandte Optik DGaO, receive PhotonicsViews with currently six issues per year.

Fraunhofer ILT

Fraunhofer Institute for Laser Technology ILT

REGISTER NOW!

Laser applications of tomorrow!

AKL'24 – International Laser Technology Congress April 17–19, 2024

www.lasercongress.org

SUPPORTING ORGANIZATIONS

EPIC EUROPEAN PHOTONICS INDUSTRY CONSORTIUM

PHOTONICS GERMANY

optecnet Innovationsnetze Optische Technologien

SPECTARIS German Hightech Industry Association

VDI Technologiezentrum

VDA Verband der Automobilindustrie

VDMA

PhotonicsViews OPTICS • PHOTONICS • LASER TECHNOLOGY

MAIN MEDIA PARTNER

LASER PHOTONICS PROFESSIONAL

MEDIA PARTNER