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4

PhotonicsViews

OPTICS • PHOTONICS • LASER TECHNOLOGY

Biophotonics
THz-Raman –
A New Analytical Tool

Trends in Manufacturing
More Flexibility and Sharp Edges

Focus:

Automotive Applications

published in media partnership with EPIC European Photonics Industry Consortium

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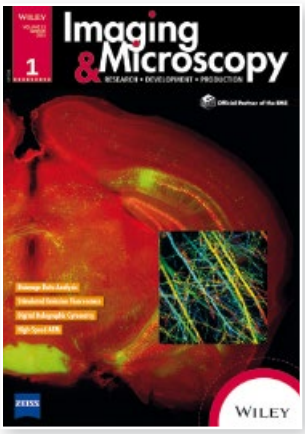

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We are established media partner of the: European Microscopy Society (EMS), European Light Microscopy Initiative (ELMI), Royal Microscopical Society (RMS), EMBL International Centre for Advanced Training (EICAT) and Focus on Microscopy (FOM).

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www.imaging-git.com

Imaging & Microscopy
RESEARCH • DEVELOPMENT • PRODUCTION

Autonomous Driving Inspires Photonics to Thrive

The technology is now at the tipping point

Photonics has become indispensable in our everyday life, especially in the automotive industry. Automotive has been one of the most foreseeable application fields of photonic technologies that is destined to lead a new wave of technology progress. It is easy to see the key application scenarios: laser cutting and welding on the car chassis, on-board cameras for environment detection, 3D sensing for advanced driver-assistance systems (ADAS), infrared applications in night vision, head up displays (HUD), etc. Another healthy boost for ADAS or autonomous driving may be expected from China's recently released "New Infrastructure" strategy.

Now that level 4 and level 5 unmanned vehicles are being tested on public roads, we can expect autonomous driving to become widely available in the next two years or so. To provide vision for these smart cars, on-board cameras, lidar, and head-up displays, are considered to be an essential combination to realize autonomous driving in the future.

On-board cameras featuring 3D imaging require the new technology of wafer-level optics to develop faster. Thanks to the globally rising awareness of safe driving, ADAS is acting as a prime factor to boost the demand for sensors, especially the automotive lidar, which is an optimum solution for precise detection. As a result, the demand for VCSELs, which are a core component, is expected to increase very rapidly with a CAGR of 185 % between 2018 and 2024 in lidar, sensing, in-cabin monitoring or driver monitoring, and gesture recognition applications.

The China International Optoelectronic Exposition CIOE, known as a sourcing platform covering the entire photonics ecosystem, will highlight key groundbreaking technologies including on-board cameras, lidar, millimeter-wave radar, IR night vision systems, Internet of Vehicles under 5G, as well as laser equipment for manufacturing. It brings optimum automotive solutions together in one place for automotive and electronics manufacturers, tier 1 / tier 2 suppliers, etc. The Imaging and Lidar for Automotive Forum 2020 will be held concurrently, with the collaboration of Yole Développement, to offer you an overview of key automotive vision technologies.

Enjoy this issue of PhotonicsViews

Eric Yang

Eric Yang
Director, Chinese Optical Society
Deputy General Manager, CIOE

CIOE
中国国际光电博览会
CHINA INTERNATIONAL
OPTOELECTRONIC
EXPO

COS
THE CHINESE OPTICAL SOCIETY

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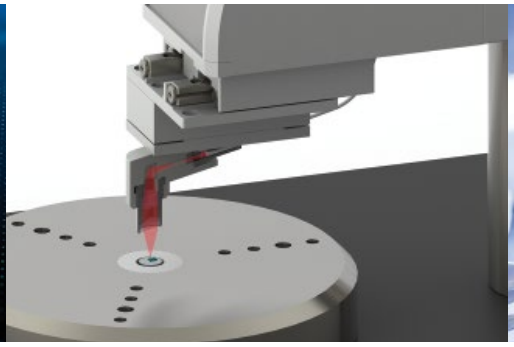

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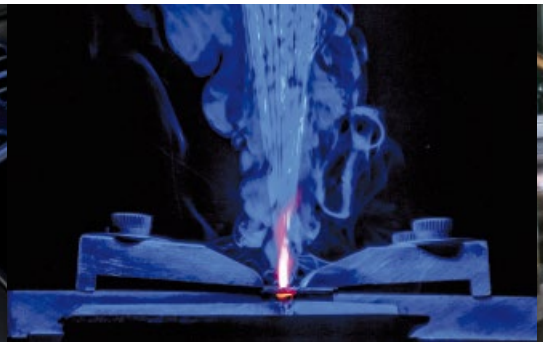
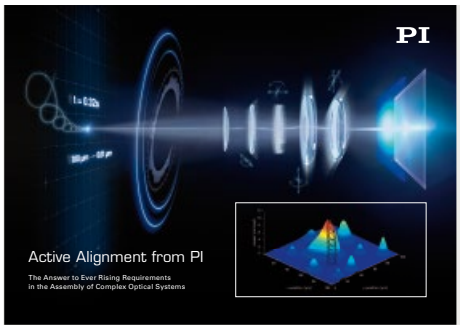


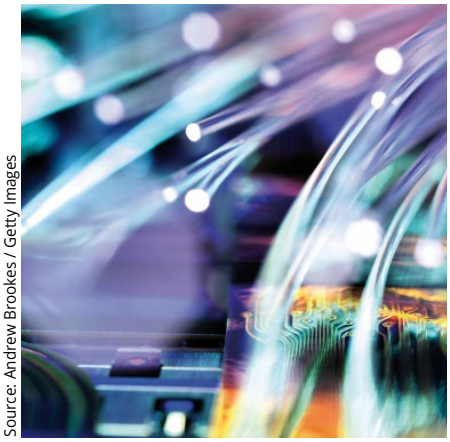


Cover:

The assembly of complex optical systems requires highest accuracy. Active Alignment helps to reduce cycle times by two orders of magnitude. Learn more on: www.pi.ws/active-alignment

Revamping Optical Fibers to Transmit Even More Data

Across the globe, telecommunications companies have installed over 2.5 billion miles of optical fibers – enough to reach from Earth to Neptune. This massive network rapidly transmits nearly all data, voice and video communications around the world. However, as telecom demands grow, scientists are trying to improve the data transmission capabilities of optical fibers, according to an article in Chemical & Engineering News (C&EN), the weekly news magazine of the American Chemical Society.



Source: Andrew Brookes / Getty Images

Words, images and sounds travel through the internet to tablets, computers and cell phones via fiber optic cables. These cables, which span oceans and continents, are made almost entirely of hair-thin silica glass strands. Silica is good at transmitting light – which encodes data – over long distances with little loss of signal. But it does not perform well with highly intense light, which can carry even more data to meet the growing demands of internet and cellular service providers. Therefore, researchers are exploring other materials to make optical fibers, senior correspondent Mitch Jacoby writes.

In 2017, scientists undertook a comprehensive study to evaluate materials that could be suitable for fiber optics, including oxides of strontium, aluminum, barium and phosphorous. Although the team did not find a single material or combination that was ideal, their results could guide future efforts. In other work, fibers made of fluoride glass recently hit the market. Fluoride fibers can transmit light over a wider range of wavelengths, but they are more expensive than silica and can be brittle. Other researchers are developing polymer-based fibers that are inexpensive and flexible. Although no alternative is ready to replace silica yet, ever-increasing telecom industry demands will call upon scientists to keep improving these materials, Jacoby writes.

https://cen.acs.org

Wiley Acquires Bio-Rad Assets

John Wiley and Sons, a global leader in research and education, acquired Bio-Rad Laboratories' informatics products including the company's spectroscopy software and spectral databases. The acquisition adds expertise, content, and powerful software to Wiley's Science Solutions segment. Terms of the agreement were not disclosed.

Source: Bio-Rad

"Laboratory-generated data is at the heart of all research. We welcome these new spectroscopy products and services that will help enhance the Wiley Science Solutions portfolio," said Judy Verses, executive vice president, Wiley Research. "These software and spectral libraries are invaluable interpretation tools for researchers who are making an impact in laboratories ranging from environmental to pharmaceutical, and from aerospace to toxicology."

As one of the largest providers of spectral libraries in mass spectrometry and a long-standing partner of Wiley, Bio-Rad's Sadtler spectra databases in IR, Raman, UV-Vis and NMR allows Wiley to expand its offering in the spectroscopy market. With the acquisition of Bio-Rad's KnowItAll desktop spectroscopy data system (SDS), server SDS, web-server SDS and ChemWindow chemical structure drawing software, Wiley is poised to enhance its support in vital areas of research data interpretation.

Wiley Science Solutions has been a trusted partner in publishing empirical, experimental, and validated data for laboratory solutions, aiming to improve the quality of chemical analysis and identification through spectral libraries and providing researchers with high-quality data collections.

sciencesolutions.wiley.com
www.bio-rad.com

Wasatch Photonics Integrates KnowItAll

As part of the rapid expansion of the Wasatch Photonics Raman spectroscopy product line, the company has announced a strategic partnership with Wiley Science Solutions and its KnowItAll Raman spectral identification partner program. The partnership will allow Wasatch Photonics customers direct access to KnowItAll's Raman identification software capabilities through the company's Enlighten spectroscopy operating software, leveraging integration with compact, modular Raman spectroscopy solutions. KnowItAll offers the world's largest Raman spectral database, powered by spectral search algorithms optimized for speed and performance. This comprehensive library covers a wide range of compounds including organics and inorganics, with specialty libraries covering drugs, fragrances, polymers, nutraceuticals, and more.

As a Wiley KnowItAll Raman spectral identification partner, Wasatch Photonics will provide its Raman spectroscopy customers a one-year subscription to KnowItAll Raman Identification Pro, accessible through the Wasatch Photonics Enlighten software. Users will benefit from the comprehensive, high-quality database of reference Raman spectra and patented spectral analysis solutions available only through KnowItAll, together with the ability to rapidly acquire Raman spectra in a single software application, thereby enhancing the user experience.

"Wasatch Photonics is known for delivering high-quality Raman spectra in innovative, easy-to-use instrumentation, and the power of KnowItAll's spectral identification software and extensive libraries is clear," says Dr. David Creasey, Wasatch Photonics CEO.

The integration of KnowItAll's toolsets with Wasatch Photonics' Enlighten spectral acquisition software eliminates the need for multiple software packages and increases overall lab efficiency.

https://wasatchphotonics.com
sciencesolutions.wiley.com

"A Revolutionary Photonics Assembly Platform Partnership"

Dick Moerman, managing director of PI Benelux (left), and Pierre van Lamsweerden, managing director of Tegema (Source: PI)

System integrator Tegema and Physik Instrumente (PI) have started a co-operation to develop automated systems for assembly and packaging technology in the photonics industry.

"Many customers request a much higher level of automation, for example when handling photonic chips or applying and curing adhesives," says Scott Jordan, head of the photonics market segment at PI, and adds: "Tegema is an experienced system integrator that has yearlong experience with such questions."

Arno Thoer, director project solutions at Tegema: "The assembly and packaging technology contributes to a considerable part to the total costs of photonic components. The already proven systems from PI form the heart of our platform concepts for the further automation of this process step. We want to contribute to speeding up this process considerably, minimizing the associated costs and thus helping the photonics industry to make a further breakthrough."

www.tegema.nl · www.pi.ws

Fisba Opens Sales Office in Shanghai

The Swiss optics manufacturer is reinforcing its market presence in the Asian region and is opening a sales office in the World Square Building in Shanghai, China. With its newly established office in the Chinese business metropolis, the company will be able to provide even more effective support to customers in China and Asia and react more flexibly to their needs.

The sales office in Shanghai, China (Source: Fisba)

Fisba has been active in the Chinese market in co-operation with distributors for more than ten years. Opening the sales office is a further milestone for the company as part of its long-term development strategy. With the official inauguration of the sales office, expansion on the Chinese and Asian markets in the field of optical components and systems is being driven forward even further.

According to general manager Jiangiu Zuo, who heads the team in Shanghai, opening the branch office is a decisive step in continuing to expand Fisba's leading position in the field of optical components: "Opening the sales office in Shanghai demonstrates Fisba's commitment to responding even more effectively to its customer needs."

Markus Hersche, CEO of Fisba adds: "We are well prepared for our planned expansion. It is our goal to intensify existing customer relationships with highly qualified sales staff and to actively work on new business areas such as life sciences."

www.fisba.com

Motion Control Specialist Turns 50

Chief officer communication & strategy Steve Botos, co-founder and partner Stephen J. Botos, and president Mark Botos (Source: Aerotech)

High-performance motion control and positioning systems manufacturer Aerotech is celebrating its 50th company anniversary this year. The company's history is directly related to the founder Stephen J. Botos (82).

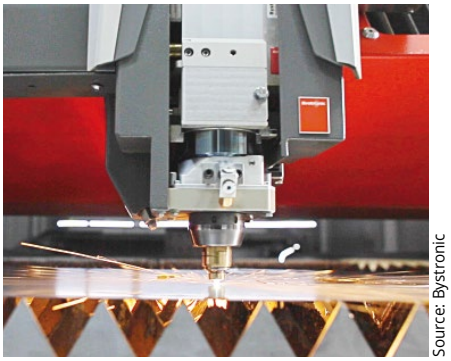
It all started in 1956 with the Hungarian uprising. Stephen, an 18 year old trained toolmaker at this time, had to leave his Hungarian home for fear of his security. On a foggy night, he hid in a hay cart and crossed the Austrian border undiscovered. Via detours, he came to the US with a few dollars in his pocket. He started his career at Goerz Optical Co. in Pittsburgh as a designer. He and two of his engineering colleagues teamed up and founded Aerotech Inc. in 1970.

From its early beginnings in a Pittsburgh garage to today, Aerotech has worked out a solid niche in the field of high-precision motion control. The company has now grown to around 500 employees worldwide but has remained a family-run company.

www.aerotech.com

A Partnership That Generates Innovations

A new strategic partnership with IPG Photonics is strengthening Bystronic's innovative capacity: Together, these two companies are developing the next generation of fiber lasers. In addition, Bystronic benefits from attractive procurement terms and can set itself apart by offering exclusive customer services.



Source: Bystronic

Laser cutting machines are Bystronic's most important sales pillar. For more than thirty years, the heart of these systems, the laser source, was developed in-house – initially for CO_2 technology and since 2005 for fiber lasers. Three years ago, Bystronic discontinued the in-house development, instead procuring its laser sources from the market leader IPG Photonics, a pioneer and world leader in this highly competitive market. with revenue of over 1.3 billion US dollars.

Being a part of the Swiss industrial holding company Conzzeta since 1994, Bystronic is one of IPG's most important customers in the field of materials processing. What started as a simple supplier-customer relationship has evolved into a strategic partnership. Two years ago, Bystronic brought a 12 kilowatts system to the market, and this October, with 15 kilowatts, the next power level will be launched.

www.bystronic.com
www.ipgphotonics.com

Self-Driving Volvos Powered by Silicon Valley LiDAR Technology

Volvo Cars is aiming to set new safety and technology standards by partnering with tech firm Luminar to provide their sophisticated lidar and perception technology for their next generation cars. The partnership will deliver Volvo's first fully self-driving technology for highways and paves the way for future active safety developments.

Roofline integration of Luminar's lidar sensors (Source: Volvo)

Volvo Cars' next generation SPA 2 modular vehicle architecture will be available as hardware-ready for autonomous driving from production start in 2022, with the Luminar lidar seamlessly integrated into the roof.

Volvo and Luminar are also exploring lidar's role in improving future advanced driver assistance systems ADAS, with the potential for equipping all future SPA2-based cars with a lidar sensor as standard.

Luminar's technology is based on its high performance lidar sensors, which emit millions of pulses of laser light to accurately detect where objects are by scanning the environment in 3D, creating a temporary, real-time map without requiring internet connectivity. Lidar is key in creating cars that can navigate safely in autonomous mode, providing them with the reliable vision and perception that cameras and radar alone cannot provide.

For Luminar, partnering with the Swedish auto maker represents the company's first delivery of its technology into series production.

www.luminartech.com

Zeiss Spin-Off for Autonomous Driving

Zeiss spun off the start-up Scantinel Photonics and integrated it into its venture portfolio. Scantinel is involved in the development of second generation light detection and ranging sensors (lidar). The technology for optical distance and speed measurement is used in autonomous vehicle technologies.

The company relies on frequency-modulated continuous-wave technology FMCW for the development of new lidar sensors. The distances and speeds of detected objects can be measured even more accurately with these frequency-modulated lidar sensors.

The manufacture of the new optical sensors is based on photonic integration, in which special optical components for processing light pulses, similar to electronic circuits, are applied to a silicon chip. Zeiss competencies in semiconductor technology, process development, photonic circuits and data processing will play an important role.

There are already various collaborations with high-tech partners, including Bridger Photonics, also a Zeiss venture and pioneer in FMCW lidar technology, and the European research center Imec, one of the world's leading institutes in the field of silicon electronics. (Source: inspect)

www.scantinel.com
www.zeiss.com

Jenoptik Supplies Laser Systems to Xinquan

Chinese automotive supplier and long-term Jenoptik customer Jiangsu Xinquan Automotive Trim Co., located near Shanghai, has ordered an additional airbag laser perforation system from Jenoptik, after a recent delivery of an identical system just a few weeks earlier.

Jenoptik President & CEO Stefan Traeger: "We are particularly pleased that Xinquan placed the order only a few days after resuming their daily business after a multi-week shutdown. As manufacturing activity in China actively increases, Chinese car models will continue to be equipped with lasered airbag solutions from Jenoptik in the future."

Votan A Scan is the latest member of the product family that enables more efficient processing of safety system related materials in the automotive market. Using a fast-moving laser beam on a stationary component, the machine fires sensor-controlled pulses to precisely cut predetermined breaking points in airbag covers. This results in simplified instrument panel integration, improved esthetics and increased safety. Additionally, the technology can be adapted for processing sensitive materials such as leather, foam foils, as well as single- and multilayer materials used for vehicle interiors.

www.jenoptik.com

Ultra-Compact Infrared LED Enables Gesture Control in Cars

Automotive interior design is currently undergoing a fundamental change. Displays are getting larger, the number of manual controls is decreasing, and customizable lighting solutions are creating a feel-good atmosphere. Advanced driver assistance systems (ADAS) and technologies previously designed for mobile devices such as facial recognition, eye tracking or gesture control are increasingly making their way into the automotive sector. These technologies are based on infrared light. The smaller and more powerful the required components, the easier they are to integrate into complex designs. Osram's Oslon Piccolo now offers an extremely compact infrared LED (Ired) that packs enormous power in a small package.

Source: Osram

Thanks to gesture recognition, completely new ways of using displays have also been created. For example, when navigating to a destination, the vehicle displays a map with the corresponding route. At the edges of the image, different menu items for operating the display are often shown in a standardized way, which in turn takes away space from displaying the map. With the help of gesture recognition, menu items are only shown when the driver moves his hand towards the display, allowing the route to appear full screen.

The automotive-qualified component (AEC-Q102) is available in two wavelengths: 850 and 940 nm.

www.osram.com/os

Capturing the Spectral Fingerprint – START Prize 2020 for TU Graz Physicist

Electronic fingerprint spectroscopy (ELFIS), is the name of the new measuring method that Birgitta Schultze-Bernhardt wants to develop further in the framework of the START program of the Austrian Science Fund (FWF). The aim is to study light-induced chemical reactions, for example those triggered in atmospheric trace gases by the sun's UV light. Understanding photochemical processes in the atmosphere can be the basis for successful measures against climate change.

The core of ELFIS is the combination of two frequency combs, a tool that was invented by Theodor Hänsch who was Schultze-Bernhardt's doctoral supervisor and long-time collaborator at the MPI of Quantum Optics.

Dual-comb spectroscopy is currently growing into one of the most popular laser measurement techniques because it can be used to measure the vibrations and rotations of molecules in the infrared spectral range.

Birgitta Schultze-Bernhardt (Source: FWF / Hoffmann)

A visible (green) spectrometer is currently being developed that can detect trace gases such as nitrogen dioxide. One in the near UV spectral range could be realistic within a year, making it a technique with a broad spectral range.

www.tugraz.at

iPronics Selected „Spinoffs to Watch"

A spinoff from the Universitat Politècnica de València, iPronics Programmable Photonics, has been selected as one of 32 spinoff companies to watch in the first edition of the Spinoff Prize, sponsored by Nature magazine and the German multinational Merck.

The company intends to make the computational power of photonics commercially affordable. Its processors share a common hardware platform that is reconfigurable by software. This cost-effective solution enables the same hardware to be applied to limitless commercial applications. According to the company, current technologies based on electronic transistors are approaching the limits of their fundamental capabilities and programmable photonics is key to address the voracious appetite for bandwidth, flexibility and processing speed required by many emerging applications. Among these, 5G communications, data center interconnection, cloud computing, artificial intelligence, biosensors, autonomous driving, quantum computing and IoT stand in front.

www.ipronics.com

Hans van den Vlekkert Wins EPIC Award

Hans van den Vlekkert (left), José Pozo (Source: EPIC)

The jury for the EPIC Industry Award for the best CEO unanimously gave the award to Hans van den Vlekkert.

In the course of nearly twenty years, Hans has founded a series of successful photonics-related enterprises in Enschede, Eastern Netherlands. He recently stepped down as CEO of Lionix International in order to take on a new role as vice president of strategic business development. "So his influence on our industry will continue," said EPIC CTO Jose Pozo.

www.epic-assoc.com

Optogenetics Honored by The Shaw Prize 2020

The Shaw Prize in Life Science and Medicine 2020 has been awarded in equal shares to Gero Miesenböck, Waynflete Professor of Physiology and director of the Centre for Neural Circuits and Behaviour, University of Oxford, UK, Peter Hegemann, Hertie Professor for Neuroscience and head of the department of biophysics, Humboldt University of Berlin, Germany, and Georg Nagel, professor for molecular plant-physiology, University of Würzburg, Germany, for the development of optogenetics, a technology that has revolutionized neuroscience. It uses a combination of techniques from optics and genetics to control the activities of individual neurons in living tissue.

Neuroscientists had long sought methods to control the activity of individual nerve cells in order to observe the networks in which they communicate and define the processes that they control. Local direct activation of nerve cells by chemical or physical means has been used for over a century to detect and control voltage changes on cells in a network. The dream had been to control voltage changes indirectly by using light, allowing a less invasive and more precise means of controlling and observing the function of neural networks in an intact organism.

The first key breakthrough came in 2002 with the development of an optogenetic tool devised by Miesenböck and colleagues, based on early work published in 1991 by Peter Hegemann who teamed up with Georg Nagel for two papers published in 2002 and 2003 on the two light-responsive channel proteins, ChR1 and ChR2.

Source: The Shaw Prize Foundation

Gero Miesenböck (top), Peter Hegemann (right), Georg Nagel

www.shawprize.org

Guido Bonati Fisba's New CTO, Head of R&D

In this position, together with his team, he is responsible for decisions on quotations, product development and technical projects. He structures the services required of R&D with the resources, ideas and potential and deploys efficient teams to successfully handle customer projects.

Guido Bonati was awarded a PhD in mechanical engineering, specializing in laser technology and design, at RWTH Aachen University in North Rhine-Westphalia, Germany. He has worked in management positions all over the world for various companies in the optical industry, including in the fields of laser technology and optics, for over 25 years.

Source: Fisba

Guido Bonati

In his new position at Fisba, he can rely on his experience and in-depth knowledge of development, production and business development.

Guido Bonati succeeds Christian Zellweger, who has taken up a new challenge within the company as its COO.

www.fisba.com

Bühler's Executive Board Member Dieter Vögtli Passed Away

Bühler's executive board member Dieter Vögtli passed away June 5 after a short illness. He headed the global service and sales (SAS) organization of the company and was previously responsible for Bühler's business in Asia. "We lose a great entrepreneur, a powerful leader, and a very close friend," says Stefan Scheiber, CEO at Bühler Group.

Source: Bühler

Dieter Vögtli

Vögtli, a mechanical engineer who graduated from ETH Zurich, started his career as a global power plant commissioning engineer at the Swiss-based Brown Boveri Co. He joined Bühler in 2004, first as country head China, and from 2009 onwards also as head of Bühler Group Asia Pacific. With his entrepreneurial attitude and deep market understanding, combined with a strong empathy for customers and employees, he was fundamental to the success and growth over the past 16 years, especially in Asia. Vögtli has also served as a member of the Bühler Group executive board. After handing over his responsibilities to his successor in Asia, he relocated with his family back to Switzerland in 2018.

Samuel Schär has taken over the responsibilities as head of the global SAS organization, in addition to his current function as CEO of the Advanced Materials business. This internal succession solution had been in preparation some time and, in 2013, he had already been promoted to Bühler's executive board.

www.buhlergroup.com

Nanoscribe: Lars Tritschler to be CFO

On 1 April 2020, Lars Tritschler joined Nanoscribe's executive board as chief financial officer, responsible for organization, finances, purchasing, human resources and legal affairs. The management of Nanoscribe is now represented by three members with the following core functions: the two co-founders, Martin Hermatschweiler as CEO and Dr. Michael Thiel as CSO are now joined by Tritschler as CFO.

"I am very pleased that with Lars Tritschler we now have an experienced business economist and manager as CFO on our management board. He has already proven his management strengths many times, for example in the establishment of our three new locations in Shanghai, Boston and Karlsruhe, and this within an exceptionally short timeframe," explains Hermatschweiler about the new addition to the management board.

Source: Nanoscribe

Lars Tritschler

After completing his studies in economics at the University of Hohenheim, Tritschler (41) started his professional career at Bosch. He then moved to Polytec, where his last position was director of finance for the composites business unit. His international assignments took him to France, Mexico and the USA.

"I see myself as a trigger driving the development of organizations towards agile teams and profitable units. I am therefore looking forward to shaping the strategic and proactive positioning of Nanoscribe," states Tritschler.

www.nanoscribe.de

New General Manager at Coherent Mainz

Coherent announces that Dr. Markus Klein has been appointed to the position of General Manager for the diode laser facility located in Mainz, Germany.

"With his long experience in the opto-semiconductor industry, as well as his managerial experience, Dr. Klein will lead the reorganization and the transformation of the site, formerly known as Dilas Diodenlaser GmbH, into a fully-integrated Coherent business unit", comments Juergen Jandeleit, Coherent VP of diode components. "In addition to the transformation agenda, close collaboration with Coherent facilities and enhancing global service to customers is a major focus for Dr. Klein."

Source: Coherent

Dr. Markus Klein

Klein will be leading the facility in Mainz, which is developing and manufacturing high-power diode-lasers in a wide range of powers and wavelengths, including OEM components and integrated laser systems. The markets and applications served are laser pumping, medical, material processing, semiconductor inspection, printing, defense, and scientific.

www.coherent.com

China Branches Under One Roof

SPI Lasers, the UK-based designer and manufacturer of fiber lasers, has announced that, in order to enhance its customer service offering throughout China, it has combined its business operations with its parent company Trumpf to distribute its fiber lasers throughout China, starting by relocating its Shanghai office to the Trumpf facility in Taicang.

Commenting on the decision to bring the two businesses closer together, Mark Greenwood, CEO for SPI Lasers stated: "This is fantastic news for our customers, it means they benefit from an enhanced level of sales and service support throughout the country. We've always been committed to supplying quality products backed by the highest levels of after-sales support, the decision to bring us closer to our parent company ensures we remain true to that commitment."

Source: SPI Lasers

Zack Huang

Continuity for customers is guaranteed by the transition of former general manager of SPI, Zack Huang, moving over to run both the local Trumpf and SPI businesses, ensuring both continue to provide market leading products, service and support throughout China.

The two brands were on public display together for the first time at the Laser World of Photonics exhibition in Shanghai, July 2020.

www.spilasers.cn

Laser 2000: New Managing Director

On June 1st, Andreas Boerner stepped up to further extend the success curve of the photonics specialist. The new managing director has more than ten years of direct professional experience in the development and sales of laser systems, which gives him insights into a wide range of applications from semicon to fusion research. From this time, he now brings international experience in market development for industrial and scientific applications, driven by building close relationships with key users and an openness to innovative approaches.

Born in Munich, Boerner holds a master's degree in photonics and is therefore welcomed by the advisory board as the ideal candidate to further advance the successful development of the company. He is looking forward to the new challenges: "When supporting customers of all backgrounds, understanding the application requirements on a detailed technical level is key to identify the most feasible solution".

Source: Laser 2000

Andreas Boerner (right), Ronald Bartel (left)

With Boerner taking up his new position, interim managing director Ronald Bartel, from Laser 2000 investor Gimv – who took over after the departure of Dr. Katrin Kobe in December 2019 – will return as planned to the advisory board of which he is the chairman.

www.laser2000.de

Antonio Raspa – EPIC's Innovation Manager

EPIC keeps growing and now has over 560 members impacting the photonics industry. In May, EPIC hired Antonio Raspa as innovation manager to lead the highly skilled technical team.

Antonio earned his masters degree in electrical engineering in 1988 at the Polytechnic Institute of Milan, specializing in quantum electronics.

Before joining EPIC, he worked at Quanta System as R&D manager, developing solid-state laser sources and custom-tailored photonic systems for industrial and scientific applications. During this period, he was also in charge of the Italian research program in Antarctica as a lidar specialist. Later he worked at Trumpf and Rofin-Sinar as an industrial laser products and processes specialist. In 2009 he rejoined Quanta System, organizing and managing a brand-new structure to produce sterile optical fibers for surgery. In addition, he oversaw the Italian and European research projects and he is the coordinator of WG3 – Life science and health of the Italian Coordination of Research and Innovation in Photonics CORIFI. With this massive amount of experience, he will be leading the technical team and will be sure to illuminate the path engaging the key companies in the photonics industry sector.

Source: EPIC

Antonio Raspa

www.epic-assoc.com

Aberration-free High NA Focusing Objective

Manufacturer: AdlOptica.
Supply: An improved version of the "aplanoXX_NA0.8" objective for diffraction limited focusing with NA 0.8 inside transparent materials, with compensation for spherical aberration at depths ranging from 0 to 4 mm.

Features: The high resistance of optics to radiation of high power ultra-short pulse lasers with wavelengths of 515 nm, 800 nm, 1030 nm and the special patented optical design are optimal for microprocessing fused silica, sapphire, glass, SiC, silicon and other materials in applications, such as dicing in the manufacture of LED, nanostructuring for optical data storage and recording of polarization converters, 3D micro- and nanofabrication. The aberration-free high NA focusing is also important in various types of microscopy. In response to practice requests, the objectives are equipped with a replaceable protective window that prevents damage of optical elements from chips and dust ejected during material processing. The aplanatic optical design guarantees low sensitivity to misalignments, which facilitates and simplifies the integration of the objectives in existing equipment and research setups.

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Automated cw OPO for Low-Noise Mid-Infrared High-Resolution Spectroscopy and Quantum Technology

Manufacturer: TOPTICA.
Supply: CW OPO System "DLC TOPO" that stands alone as the only fully automated, continuous-wave, Optical Parametric Oscillator laser source on the market. It is designed for high-resolution spectroscopy across 1.45 to 4.0 µm (2500–6900 cm^{-1}) with up to 4 W output power.

Features: The unique optical design enables broadly tunable laser light without exchanging any optic sets or modules. Additionally, the all-digital control electronics facilitate hands-free coarse wavelength tuning, fine tuning, and frequency locking. A wide mode-hop-free tuning range up to 300 GHz (10 cm^{-1}) enables visibility of full spectroscopic signatures. The narrow linewidth (2 MHz, $1 \cdot 10^{-5}$ cm^{-1}) gives a resolution that reveals narrow atomic and molecular features. As with all systems of this manufacturer, this system is low maintenance.

Applications: The wide wavelength coverage and low noise are ideal for molecular and biomedical spectroscopy, physical chemistry, quantum technologies, and integrated photonics applications.

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Innovative Spectrometer System for Turbid Media

Manufacturer: Gigahertz-Optik.
Supply: New and unique "SphereSpectro 150H" spectrometer system for simultaneously determining the spectral absorption and scattering coefficients for scattering samples. Conventional spectrophotometers (also called transmission spectrometers or absorption spectrometers) are used to determine the absorption coefficient of clear or colored media.

Features: The spectrometer system determines the absolute absorption coefficient for scattering media independent of the scattering properties of the turbid medium. At the same time, the effective scattering coefficient of the sample is determined, which provides additional information about the microstructure of the sample. This is a unique feature, which is not otherwise available on the market. The determined absorption coefficient is identical with the absorption coefficient determined conventionally for clear media and can be used for content determinations, for example. An integrating sphere measures the total reflected and transmitted light of an illuminated sample. From these two quantities, the absorption coefficient and the effective scattering coefficient are calculated based on the radiative transfer equation. The system covers the wavelength range between 200 nm and 2150 nm. Modular versions are also available for subranges within this entire spectral range. The unique measuring system is also characterized by simple operation, short measurement times and a large sample chamber with optimized sample holder whilst keeping overall size to a minimum.

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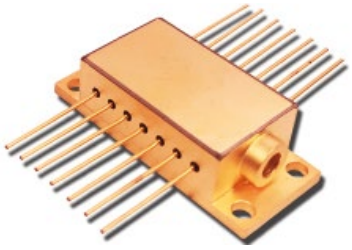
Free Space Narrow Linewidth Laser Diodes



Manufacturer: Frankfurt Laser Company (FLC).
Supply: Free Space Narrow Linewidth Laser Diodes from the "FRLD-VBG" series that are designed to meet Raman spectroscopy requirements.
Background: Raman spectroscopy is typically used to determine vibrational modes of molecules. It is popular in chemistry to provide a structural fingerprint by which molecules can be identified. The technique is based on inelastic scattering (Raman scattering) of monochromatic light at wavelengths typical in the visible range or in the IR range. This light is usually generated using a laser which fulfills key performance parameters like a narrow spectral linewidth, a good beam quality and a high and stable output power.
Features: The laser diodes are offered at wavelengths 532 nm, 638 nm, 785 nm, 808 nm, 830 nm, 976 nm, and 1064 nm, and with an output power up to 800 mW. The spectral linewidth is very narrow (typically less than 0.1 nm) due to an integrated Volume Bragg Grating (VBG). Careful thermomechanical control and high-precision alignment inside the laser is important to achieve high stability in the output wavelength and linewidth, especially when operating the laser at varying ambient temperatures. The laser diodes are packaged in a solid Butterfly package with a free space output. An integrated thermo-electric cooler (TEC) is optionally available.

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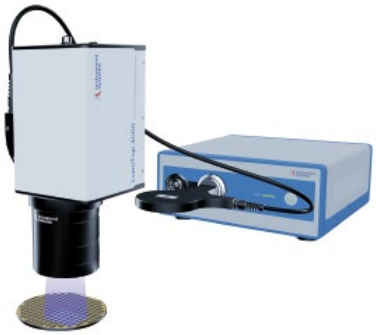
Comprehensive Optical Wafer Testing for µLEDs at a Single Test Station



Manufacturer: Instrument Systems.
Supply: Unique camera-based measurement solution "LumiTop 4000" for µLED wafer testing that generates 2-dimensional, pixel-resolved optical analyses within given cycle times. The system is ideally suited for use in the laboratory and production line
Background: µLEDs, an exacting new display technology, are smaller than 100 micrometers and have exceptional optical properties that enable the manufacture of displays with a broad color gamut, high contrast and extremely high resolution. Particularly in mass production, they present new challenges for the optical quality tests required at every stage of production, i. e. including wafer level. This cannot be achieved with standard tests, i.e. sequential testing. For efficient testing of thousands of µLEDs on a wafer, the test procedure must be parallelized.
Features: The system has a resolution of 12 MP and can detect the smallest of defects and iwnhomogeneities on the wafer. Thanks to a 100 mm macro lens, the camera enables fast parallel inline analysis of all µLEDs on a wafer at a single test station. The 2D camera is combined with a high-end spectroradiometer that serves as a simultaneous reference measuring instrument for highly accurate readings. The new system with a 100 mm lens is particularly well suited to µLED wafer testing. With a field of view (FoV) of approx. 1.0 by 1.4 cm, it can measure many thousands of µLEDs in parallel with a minimum pixel size as low as 30 micrometers. A hardware trigger synchronizes the camera with the given cycle time. The CMOS sensor offers a particularly broad dynamic range.
The accompanying comprehensive "LumiSuite" software enables wide-ranging analyses of the readings, including the preparation of a pixel intensity map or color map. Algorithms can search for and mark pixel defects according to selectable criteria.

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Easy-to-integrate Laser Marker Series

Manufacturer: Laserax.
Supply: New "LXQ" Fiber Laser Marker series that is easy to integrate into laser systems. The laser's features reduce integration time and cost, but also allow collaboration between system integrators and laser experts.
Features: The system has a remote connection capability that can grant control of the system to a Laserax expert or partner anywhere in the world. Relying on a secure cloud VPN, this allows laser experts to better support integrators and end-users through remote services such as installation, training, after-sales support and live demos. Several features were developed to make system integration straightforward: A web-based HMI can be displayed in any web browser for a quick control of the laser without programming. The system's interfacing can be done using the most standard industrial protocols. Fully configured peripherals are ready to be used, among them a "Cognex" camera for barcode validation, an air-knife for lens protection, and 3D-Autofocus sensors for automatic adjustments.
Apart from laser marking, the "LXQ" fiber lasers can treat any metal surface with laser cleaning, laser texturing, and laser hardening. Thus, system integrators can integrate the same laser regardless of the application.

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Active 4D Laser Beam Stabilizer

Manufacturer: Beam tracking system "4D Laser Beam Stabilizer" in combination with piezo actuated mirror mounts for the elimination of temperature shifts, air turbulences and mechanical vibrations that can influence the pointing stability of the laser beam.

Features: With the stabilizer, a laser beam can be actively held at a fixed position and angle. Position deviations of the beam are measured with two detectors that are located at different positions along the optical beam path. These signals are used as a feedback which enables a beam pointing compensation via the established Tip-Tilt mirror mounts that provide a unique combination of high resolution, fast response and a large adjustment range.
Applications: The laser beam stabilizer is ideal for the integration into existing laser beam paths or new optical designs. Applications range from scientific research to industrial integration, for example, to enable a stable beam positioning when focusing a laser through an objective in laser material processing or when coupling a laser into an optical fiber. Whenever an improvement in position and angular stability of a laser beam is needed, the beam stabilizer can help with its firmware based fast control algorithm to ensure stability and accuracy despite the surrounding conditions in systems and setups.

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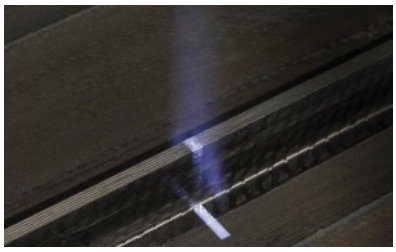
Automated and Robot Guided CFRP Cleaning with a Compact Excimer Laser

Carbon fiber reinforced plastics (CFRPs) are composite materials that offer a unique and highly desirable combination of physical strength and light weight. During processing, the residue on surfaces has to be removed. Various mechanical and chemical methods have been explored for the removal of these surface contaminations, but unfortunately, each of these methods has its own drawbacks.
The pulsed excimer laser at a wavelength of 248 nm has emerged as a promising tool for this task, while avoiding any damage to the CFRP fibers. Mobile excimer laser system solutions expand the applicability when it comes to large aircraft structures. The ***Fraunhofer IFAM*** in Bremen, Germany, is working to develop a compact excimer laser-based solution that lends itself to robotic automation.



Excimer laser surface preparation is a single-step, dry process that is capable of delivering superior results over other methods, and has proven to be highly reproducible, making it a consistent and stable process that is well-suited for volume production applications and even repair work. Furthermore, this same technology is applicable to cleaning of delicate surfaces in many other applications. The base is a ***Coherent*** "ExciStar 1000" excimer laser to be mounted on the end of a robotic arm and then rapidly moved over the surface of the part to be processed, following the 3D part contours as necessary. The high repetition rate (1000 Hz) and pulse energy (10 mJ) allow rapid processing and continuous movement of the laser beam over the part surface. Typically, every point on the CFRP structure is exposed to between two to ten laser pulses, which provides complete removal of surface contaminations. Processing speeds of up to 10 m^2/h are attainable using this method.

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New 1 mm Optical Filters

Manufacturer: Schneider-Kreuznach.
Supply: 1 mm thin optical filters with a high surface quality that are developed to be placed between lens and sensor.
Features: The filters are provided with an ultra-low reflection coating, important for e.g. traffic surveillance. The wavelength tolerance of only ±1 % makes them a preferred choice for metrology systems. Optimized for common LEDs used in machine vision, the filters are ideal for automated inspection systems as food and beverage control or logistics. For example, the blue "BP 465-70 HT" bandpass is often used in 3D measurement applications. For night/day vision cameras, the "VIS-85" type is offered, transmitting in visible range (430–680 nm) and 855 nm ± 15 nm. Self-evidently, the filters ensure that there is no impact on the resolution of the complete system. The quarter wave wavefront distortion also ensures that the MTF is not affected.

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LED Instead of Laser or Electron Beam

Additive manufacturing: new technology to revolutionize 3D metal printing

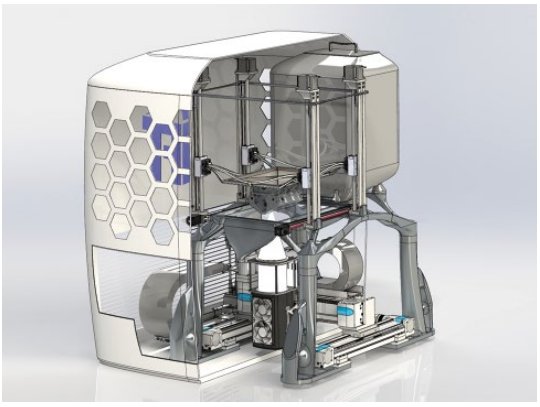
A technology developed at Graz University of Technology uses LEDs instead of laser sources for the additive manufacturing of metal parts and optimizes 3D metal printing in terms of construction time, metal powder consumption, equipment costs and post-processing effort. Selective LED-based melting SLEDM – i.e. the targeted melting of metal powder using high-power LED light sources – is the name of the new technology that a team led by Franz Haas, head of the Institute of Production Engineering at TU Graz, has developed for 3D metal printing and is now patent pending. The technology is similar to selective laser melting SLM and electron beam melting EBM, in which metal powder is melted by means of a laser or electron beam and built up into a component, layer by layer. However, SLEDM solves two central problems of these powder bed-based manufacturing processes: the time-consuming production of large-volume metal components and the time-consuming manual post-processing.

Unlike the SLM or EBM processes, the SLEDM process uses a high-power LED beam to melt the metal powder. The light-emitting diodes used for this purpose were specially adapted by the west Styrian lighting specialist Preworks and equipped with a complex lens system by which the diameter of the LED focus can be easily changed between 0.05 and 20 mm during the melting process. This enables the melting of larger volumes per unit of time without having to dispense with filigree internal structures, thus reducing the production time of components for fuel cell or medical technology, for example, on average by a factor of twenty.

Tedious reworking no longer necessary

This technology is combined with a newly-designed production plant which – in contrast to other metal melting plants – adds the component from top to bottom. The component is thus exposed, the required amount of powder is reduced to a minimum and the necessary post-processing can be carried out during the printing process.

A demonstrator of the SLEDM process is already being considered in the K-Project CAMed of the Medical University of Graz, where the first laboratory for medical 3D printing was opened in 2019. The process will be used to produce bioresorbable metal implants, i.e. preferably screws made of magnesium alloys that are used for bone fractures. These implants dissolve in the body after the fracture site has grown together. A second operation, which is often very stressful for people, is therefore no longer necessary.



Source: TU Graz

The 3D printer developed at TU Graz melts metal powder using high-performance LED light sources and then processes it into components with additive manufacturing.

The second focus is on sustainable mobility, namely the production of components such as bipolar plates for fuel cells or components for battery systems. "We want to make additive manufacturing using SLEDM economically viable for e-mobility and position SLEDM in this field of research at an early stage," says Haas, who will produce a marketable prototype of this 3D metal printer in the next development step.

www.tugraz.at

CCD Sensors Play Key Role in SARS-CoV-2 Diagnostics

Teledyne technology drives microscopy research and diagnosis of Covid-19 and other diseases

Teledyne is supplying high performance charge-coupled devices (CCDs) for Covid-19 diagnostic scientific instruments. These highly sensitive image sensors are used for low-light imaging applications such as microscopy and other scientific imaging techniques deployed for research and diagnostic testing for SARS-CoV-2.

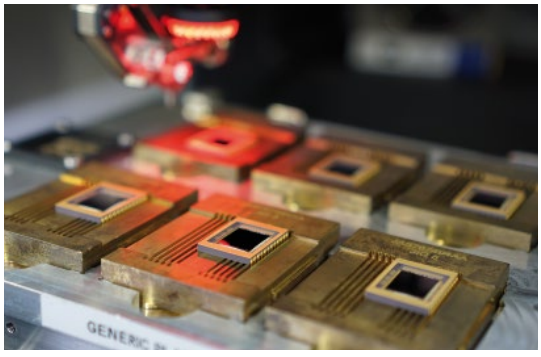
In the past few weeks, the UK CCD fabrication team have been producing hundreds of CCD77-358 devices that will be designed into camera systems to support Covid-19 diagnostics.

Miles Adcock, president of e2v's space and quantum business, said: "The Coronavirus outbreak has triggered increased demand and interest for CCD and CMOS sensors. We expect to have manufactured several times the forecast annual demand for the CCD77-358 devices by the end of this quarter alone. Our ability to expedite and meet urgent requirements is testament to the drive and commitment of the Chelmsford CCD fabrication operations team."

The CCD77-358 sensor is back-illuminated and has an image resolution of 512 × 512 pixels, a large pixel size of 24 µm and a high dynamic range.

Teledyne has advanced wafer-processing facilities in the UK and Canada. Testament to the resilience of CCD technology in the most demanding applications, the company is committed to the provision of a long-term vertically integrated, dedicated CCD fab and continues to make technology developments to the design and production of CCDs.

https://imaging.teledyne-e2v.com



Source: Teledyne

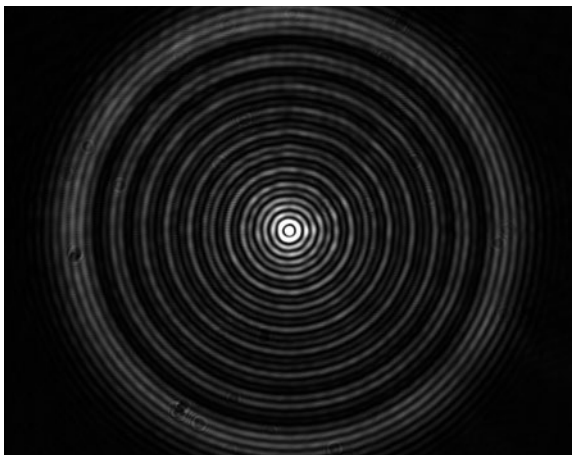
e2v CCD77-358 sensors in production

Breakthrough in Free Space Optics Powered 5G

Aircision using groundbreaking laser technology developed by CERN and IPP Prague

In January 2020, Ericsson and VodafoneZiggo opened the 5G Hub at High Tech Campus Eindhoven. There, two months later, Aircision announced its readiness to field test its groundbreaking laser-based 5G communications technology. This solution is based on a structured laser beam technology developed at CERN in Switzerland, which enables long-range, 100 Gb/s data transmission with high reliability.

"The lab tests we conducted with TNO, the Netherlands Organization for applied scientific research, of Aircision's free space optics (FSO) solution under adverse atmospheric conditions were promising enough to proceed to the next phase of outdoor testing," said Aircision CTO Dr. John Reid. "Our system is more resistant to atmospheric effects, such as fog, and brings incomparable improvement compared with existing FSO technologies. Most importantly, we offer a faster pathway to higher bandwidth, whereas microwave has significant hurdles to overcome on that front."



Example of a transverse cross-section of a beam produced by the structured laser beam. The central axis, which is very dense, is surrounded by several halos of light. This technology, used to align the components of accelerators, is breaking through into the field of telecommunications. (Source: CERN / IPP)

"We are excited to facilitate this 5G test project with our partners at the High Tech Campus Eindhoven," said Han Dols, head of business development at CERN. "We're not only rolling out the first 5G network in urban areas like Eindhoven, but we're also creating a key piece of technology crucial to bringing high-bandwidth communications to rural areas around the globe," HighTechXL's CEO Guus Frericks added. "In addition, FSO can be a permanent solution for remote areas of the world where fiber optics networks are not technically or economically viable to build out. Taking part in this 5G project is just a start."

In the next phase, TNO Space will help with assessing the technology, demonstrating feasibility and raising the technical readiness level further. The plan is to jointly conduct tests, analyze, and validate Aircision's free space optics under adverse atmospheric conditions using TNO's 5G network infrastructure in Den Haag and Scheveningen.

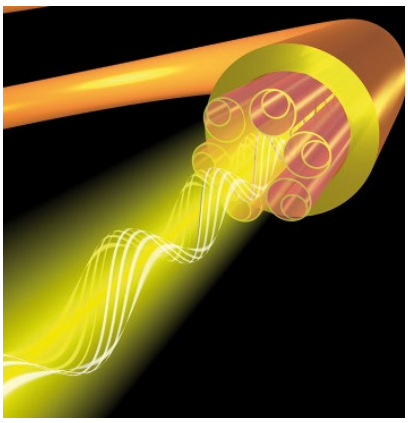
www.aircision.com

A New Hollow-Core Optical Fiber

Enhancing the potential of optical interferometric systems and sensors

The novel fibers' latest advances have underlined the technology's potential for next generation optical interferometric systems and sensors. Hollow-core optical fibers combine the free-space propagation performance of the most advanced interferometers with the length scales of modern optical fibers by guiding light around bends in an air or vacuum filled core. Researchers are engaging with industry partners, collaborating with the National Physical Laboratory and exploiting a UK network in the Airguide Photonics programme as they further expand the impact of the discovery.

Group leader Francesco Poletti said: "By eliminating the glass from the center of the fiber, we have also eliminated the physical mechanisms by which the polarization purity of an input beam can be degraded. With an attenuation as low as 0.28 dB/km and the prospect of soon achieving levels potentially below the Rayleigh scattering limit of conventional fibers, such waveguiding structures could soon provide vacuum-like guidance purity and environmental insensitivity at bespoke wavelengths and over hundreds of kilometers for the next generation of photonics-enabled scientific instruments."



Source: U. Southampton

To achieve the best possible performance, scientists currently need to propagate light through free-space in a vacuum, such as for example in the four-kilometer arms of the Laser Interferometer Gravitational-Wave Observatory LIGO in the US. Glass optical fibers offer a more pragmatic and portable alternative in sensing technologies but degrade polarization purity and suffer from detrimental nonlinear effects.

Hollow-core fibers overcome all of these challenges to enhance the potential of optical interferometric systems and sensors, for example within optical gyroscopes that form the core of inertial navigation systems or for the flexible delivery and coherent combination of intense polarized radiation for the next generation of megawatt lasers.

Reference: *A. Taranta et al.:* Exceptional polarization purity in antiresonant hollow-core optical fibres, Nat. Phot., online 11 May 2020; DOI: 10.1038/s41566-020-0633-x

https://hcf.soton.ac.uk

Coherent Optic Standards for a Bright Optical Future

by Rag Hagen, global product line manager, ProLabs

There are many standards for optical transceivers at data rates of less than 100G. The most important existing or developing standards used for dense wavelength division modulation (DWDM) at 100G or above have been well defined and market mature for some time. However, the pluggable optics of the future are those that support coherent detection.

With coherent optics on the forefront of tomorrow's advanced phase- or frequency-based modulation scheme improvements, the CFP2-ACO, CFP2-DCO, and QSFP56-DD form factors have emerged as the leading standards. These optical transceivers, when coupled with coherent technologies, are illuminating the way towards faster than 100G levels of service and larger bandwidth capacities for data centers and service providers around the world.

What are the CFP2-ACO and CFP2-DCO form factors?

In the analog coherent optic (ACO) module, the digital signal processor (DSP) is placed on the host line card, and the CFP2-ACO module passes an analog signal to the DSP. Therefore, the CFP2-ACO may only be used in a system that has the matching DSP on the host line card.

In contrast, in a digital coherent optic (DCO), the DSP is located within the optical transceiver itself. Having the DSP within the CFP2-DCO transceiver provides more flexibility because the module can be used with any line card.

Ultimately, the DSP is what gives coherent pluggable transceivers the ability to adapt the modulation scheme and/or baud rate to the application, distance, or data rate. Whilst these functions are under software control, there are currently no standards for the software interface to a DSP. Since each DSP vendor creates their own software environment, establishing interoperability between DSPs can be a challenge. As a result, coherent pluggable transceivers from the same vendor must be used on each end of the link.

100G to 400G with QSFP56-DD

The Optical Interworking Forum with MSA groups published the "Implementation Agreement for ZR" [1] in April 2020, defining interoperability requirements to support multiple vendor configurations. In the document, not only are interoperability requirements laid out, but ZR optics are specified to operate in DWDM networks at 400G Ethernet over single-span links. As well as this, the line signaling rate (60 Gbaud) and modulation format (16-QAM) are advised to be specified and fixed, among other parameters. In doing so, ZR is the first coherent optic interoperability standard for higher order modulation formats beyond PAM4.

The forward error correction (FEC) and optical transport network (OTN) framing parameters are also standardized in ZR as a part of ensuring these transceivers maintain interoperability requirements from vendor to vendor. Transmission distances of less than 120 kilometers are designated in the agreement, as well as the suggestion that optical links should provide an optical signal-to-noise ratio (OSNR) of approximately 30 dB.

DWDM ZR transceivers will be the first to hit the consumer market as interoperable coherent optics. Ongoing hardware and software standardization to support 200G, 400G and 800G interfaces will make low power, small footprint, coherent DWDM pluggable optics at these data rates available for a wide range of network applications. ProLabs is following developments with ZR standards, packaging options, electrical design, management interfaces and other areas to bring to market the widest variety of flexible, cost effective, high bandwidth, long reach solutions.

ZR+ is in concept and rapidly advancing as a solution for tomorrow's cutting edge in footprint-optimized, longer-reach, multirate, pluggable optical technologies at even faster than 200G. The primary associations discussing ZR+ standards are the Open ROADM MSA for ROADM applications and ITU-T Study Group 15, who are specifically addressing use cases of up to a staggering 450 kilometers.

The QSFP-DD is the form factor of choice for both ZR and ZR+ standards as it minimizes the size of the device in which they operate while maximizing the available bandwidth over non-double density variants. This optimizes and

Source: ProLabs

increases the number of transceivers that may be placed into the faceplate of a switch, router or optical platform, ultimately creating additional throughput with minimal cost to deploy.

Maximized performance, minimized budget

The ever-rising consumer demand for increased link distances, bandwidths, and speeds is driving standards organizations and MSA groups to consider innovative approaches to improving optical link connectivity. Coherent transceivers are a required underlying DWDM technology to achieve speeds above 100G while maximizing the data transfer capabilities (and thus, the value) of each fiber run.

While yet-to-reach market maturity technologies and solutions like these often come with a high price tag and the challenges of being an early adopter, ProLabs will introduce third-party optic transceiver solutions in the current CFP2-DCO form factor. These optical solutions from ProLabs successfully marry the cost and lead time benefits of third-party options with the high dependability, quality, and interoperability that they are well known for.

With such a critical jump in modulation technologies needed to support speeds beyond 100G, ensuring such technologies remain economically available to all optical transfer markets remains a priority.

www.prolabs.com

[1] Implementation Agreement created and approved by the Optical Internetworking Forum for a 400ZR Coherent Optical interface, OIF-400ZR-01.0, www.oiforum.com

Getting Crazy Makes a Lot of Sense Sometimes

Reaching new milestones and organising the world's first non-stop 24-hour online photonics event

EPIC – European Photonics Industry Consortium – is known for doing things a little differently. Bringing value to our members is our first priority and networking is a big part of that. So, when the pandemic hit, we decided to do something crazy: announcing fifteen Online Technology Meetings in less than six weeks. To date, we have held over thirty Online Technology Meetings and we're still going strong. With traveling further restricted, we dedicated our networking strategy to the online world. And it has paid off: not only have we received amazing feedback from members, it has resulted in actual business! Lars Penning, CEO of Next Scan Technology, arranged a visit to Infineon Technologies after meeting them at the EPIC Online Technology Meeting on Laser-Based Semiconductor Processing to discuss possibilities for further collaboration.

Lars Penning, CEO of Next Scan Technology (right) and Benjamin Bernard, unit process development expert at Infineon Technologies (left) celebrate their first personal meeting after having been virtually introduced to each other at the EPIC Online Technology Meeting on Laser-based Semiconductor Processing. (Source: Infineon / Next Scan)

The variety of topics and the concept of having an entire supply chain of end-users, component suppliers and system integrators in one room has proven very successful. The goal of our online technology meetings is always to explore new business opportunities and it is so nice to see that answering our EPIC question "What can you do for the others and what can the others do for you?" has become a well-known standard. We do not even need to ask the question anymore. Speakers incorporate it into their slides, showing the world what they offer and what they need. And yes, the world, because even though we have a selected group of people in the meeting, they are LIVE streamed on YouTube and available for viewing afterwards. By now, the videos of the Online Technology Meetings have reached over 50,000 views since we started them in April. We went from just over 200 subscribers on our YouTube channel to now having over 1,000 subscribers. That is a growth of over 500 % in just three months!

Reaching 1,000 subscribers was a milestone for EPIC. Seeing the success of online meetings, we decided to do something never-before-seen in the photonics community. On 24 June 2020, we hosted the "24 Hours World Photonics Tour" a 24-hour non-stop online meeting. This unique event had 72 speakers from 35 countries across 13 time zones, starting at 03:00 CEST in New Zealand and ending at 03:00 CEST the next day in the USA. Speakers were high level executives or technology experts - most were CEO or CTO level - who made a 15-minute presentation on technology, applications, and markets, followed by a 5-minute discussion. A great way to get the ins and outs of the industry worldwide within one day. The entire 24-hour meeting was hosted by Dr. Jose Pozo, EPIC's CTO and Director of Innovation.

The 24 Hours World Photonics Tour and all our Online Technology Meetings are available for viewing on our YouTube channel www.youtube.com/c/EPICphotonics. Watch, learn and network. If you see a company that you would like to be introduced to, be sure to write an email to Dr. Jose Pozo at jose.pozo@epic-assoc.com and he will be happy to make the introduction for you. Also, take a regular look at our website www.epic-assoc.com for updates on upcoming events. After the summer break, we have fourteen more Online Technology Meetings planned, which will become an integrated part of our networking opportunities, taking place every Monday at 15:00 CEST. We will see you there!

Upcoming EPIC events:

- 31 August 2020, 15:00 CEST
  EPIC Online Technology Meeting on Surface Disinfection and Antibacterial Surfaces (in cooperation with IUVA)
- 07 September 2020, 15:00 CEST
  EPIC Online Technology Meeting on New Pluggable Transceivers (in cooperation with COBO)
- 14 September 2020, 15:00 CEST
  EPIC Online Technology Meeting on Vision and Imaging Camera Systems
- 21 September 2020, 15:00 CEST
  EPIC Online Technology Meeting on MicroLED for Automotive (in cooperation with DVN)
- 28 September 2020, 15:00 CEST
  EPIC Online Technology Meeting on Photonic Integrated Circuits for Gas Sensing Applications
- 05 October 2020, 15:00 CEST
  EPIC Online Technology Meeting on Photonics for Dermatology and Aesthetic Applications
- 12 October 2020, 15:00 CEST
  EPIC Online Technology Meeting on Laser Glass Processing
- 19 October 2020, 15:00 CEST
  EPIC Online Technology Meeting on Additive and Advanced Metal Manufacturing
- 26 October 2020, 15:00 CEST
  EPIC Online Technology Meeting on Free Space Optical Communication and LiFi

www.epic-assoc.com/epic-events

IUVA and EPIC Sign Memorandum of Understanding

Implementing agreements and standards for ultraviolet technologies

IUVA, the International Ultraviolet Association, and the European Photonics Industry Consortium EPIC signed a collaboration agreement to strengthen the photonics industry on an international level, bringing together members and knowledge to better serve the industry.

The memorandum of understanding (MoU) signature was publicly announced at the EPIC Online Technology Meeting on UV-LED-based Technologies and Applications on 22 June 2020. The collaboration between IUVA and EPIC is focused on cooperative activities involving industry endorsement of standards and supports the development of an efficient and sustainable industry.

The partnership will encourage cooperation between the members, including participation at events, collaboration on information exchange and promotion, and advisory mandates to develop an efficient and sustainable industry. Dr. Jose Pozo, technical director of EPIC, said: "Having IUVA on board as a partner brings the opportunity to EPIC members to build potential collaborations and partnerships with the key players of the UV market. The main goal of this cooperation is to facilitate the communication between different parts of the value chain towards building a common voice for the interests of companies using ultraviolet technologies."

Implementing agreements and standards for UV technologies

"The collaboration with EPIC and its members helps IUVA support its core vision to help ultraviolet technology become a leading technology for public health and environmental applications" said Oliver Lawal, past president of IUVA and CEO of AquiSense Technologies. "For this, we need end-users, service providers, equipment vendors, and technology providers to work together using worldwide standards. The huge network of EPIC will support this mission."

IUVA was established to provide a forum for the discussion of all scientific and technological issues that relate to the use of UV light; to provide a common voice for the interests of companies using ultraviolet technologies and manufacturing UV lamps or equipment; to organize periodic international and national conferences, to encourage the establishment of rational terms, units and nomenclature in the fields of UV technology; to encourage research into the advancement of the applications, and to encourage the adoption of rational environmental regulations that would encourage the use of ultraviolet technologies.

Oliver Lawal of IUVA (top) and Jose Pozo of EPIC (below) during the EPIC Online Technology Meeting on UV-LED-based Technologies and Applications (Source: EPIC)

www.iuva.org
www.epic-assoc.com

EMVA Vision Knowledge Center Opens Its Virtual Doors

Knowledge transfer and education in Corona times

Even in times where technical conferences, seminars and similar events are not possible, the European Machine Vision Association EMVA has the goal of fostering knowledge transfer and educational activities in its industry.

The EMVA Vision Knowledge Center is a hub of expertise and the meeting point for relevant technical and environmental topics in the machine vision and image processing industry.

It benefits from the enormous amount of valuable contributions collected over the years at the numerous EMVA events now being available on their website. The hub provides access to high-quality presentations on technology, applications and vision ecosystems, webinars, videos and technical papers which are of great interest to the vision tech network.

The EMVA team will continuously add further valuable content but one can already take a first look at the association's website:

www.emva.org/vision-insights/vision-knowledge/

EMVA Vision Knowledge Center web site

"Every Change We Made on the Chip Was an Adventure"

A portrait of Pim Kat, founder and former CEO of Technobis Group

Jose Pozo

EPIC's chief technology officer Jose Pozo had the opportunity to talk to Pim Kat, CTO of Technobis, one of the earliest adopters of integrated photonics for industrial applications in Europe.

Pim Kat (left) and Jose Pozo meeting at the Universitat Politècnica de Valencia (Spain) during the Photonic Integration Week in January 2020. (Source: EPIC)

The early years

After graduating with an engineering degree from Hogeschool van Amsterdam in 1980, Pim worked as an engineer with Sun Electric Systems and then, from 1987 – 1996, as a researcher at Hoogovens, a Dutch steel producer in IJmuiden.

By the mid-90s, steel production and related research projects in The Netherlands had declined significantly and Pim and his colleague Bram Kruk were asked to help one of Hoogovens's customers who was developing a range of new precision movement instruments and machines. However, two years later, the company ran into difficulties and in 1996, by mutual agreement, Pim and Bram cofounded Technobis Group with the aim of building and supplying the machines they had been developing.

Having inherited a backlog in deliveries of around fifty machines, Technobis was able to make a flying start. Over the next eight years, Pim used his knowledge of computer-controlled motion to develop a range of precision movement machines. But in the early 2000s, faced with increasing competition and a slowing market, Pim and his colleagues decided to move into a new technology and began building microscopes and other optical systems for OEMs in Germany and the US. By 2004, optics had become a key part of the company and Technobis was beginning to establish a reputation as a "go to" company for providing state-of-the-art, high resolution optical systems with minimal thermal drift and mechanical vibrations.

Move into integrated photonics

During the process of building instruments and supplying third parties, Technobis began to think about developing their own products and becoming an OEM themselves. To this end, in 2005, they started a new business, Technobis Optronics in Eindhoven, and one year later, Technobis Fibre Technologies.

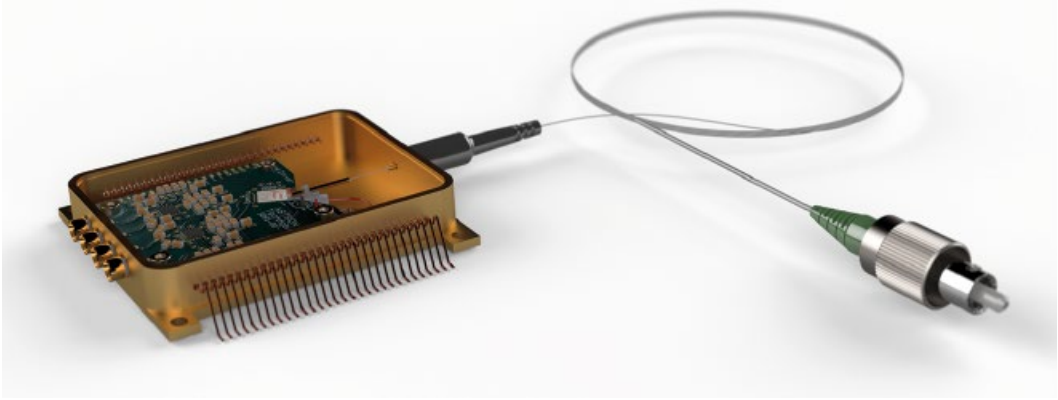
The first device they developed was an FBG interrogator for fiber-optic sensing, which was basically a spectrometer. Their aim was to develop a completely new sensing system that

Company

Technobis Group

Technobis is a developer and supplier of high-tech instruments and modules for OEM companies around the world. Technobis tft-fos is specialized in the development and supply of fiber optic sensing systems and applications. All developments are spectrometry and or interferometry-based. Starting with free-space optics 17 years ago, nowadays all new developments are based on integrated photonics. Application-specific photonic integrated circuits, ASPICs, allow custom and highly dedicated system designs for a versatile range of improved performance requirements. Technobis is a specialized solution provider for ASPIC packaging by supplying dedicated and mid-range volume packaging services. As ASPIC packaging requires complex dedication, our key values are thermal and mechanical stability, high performance, low-noise, low power consumption, easy but versatile integration, reliable and repeatable quality. Technobis mechatronics is specialized in carrying out complete product development projects, going from an idea to a successful turnkey product, prototype or series product.

www.technobis.com



The system-in-a-package concept is considered a next generation of fiber sensing interrogator modules for OEMs. (Source: Technobis)

had a higher scanning speed and was more accurate and cheaper than their competitors. Then in 2007, ASML asked Technobis to develop an interrogator with the incredible wavelength resolution of 0.1 femtometers, which required the drastic technology switch to integrated photonics. Pim already had some experience with this technology as a result of participating in two European projects (Jeppix and Paradigm) and also with Meint Smit's research group at TU Eindhoven. After much trial and error, a prototype interrogator was developed and Technobis were able to put their standard interrogator chip designs on the same runs, resulting in a family of photonic integrated chip designs with incredible speed, resolution, and multiplexing capacities.

Technological challenges

By 2007, Technobis had fully embraced integrated photonics in their component design and became one of the earliest adopters of integrated photonics for industrial sensing applications in Europe. But as Pim is at pains to point out, this was just the beginning as it took a further ten years before they were able to launch a qualified industrial product.

The basic problem was that, as pioneers of a new technology, they had nothing to go on. As Pim says: "We were the only player making integrated photonic devices and when we started, we didn't really understand the technology. Every change we made on the chip was an adventure as just turning the device on the chip or changing the orientation of the material completely changed the behavior of the chip."

It took them about two years before they fully understood what was happening and why some devices were successful, and others were not. At the same time, they had to solve problems of integrating the electronics and packaging and came to realize that developing a single device involved three or four parallel developments, not just one.

Investment and time to market

Their experimental, trial and error approach began to eat into their resources. By 2012, they had spent more than ten million euros on R&D but, having already invested so much money, stopping the project was no longer an option. The funding problem was exacerbated by the fact that time to market for their target markets, aerospace and, to a lesser extent, medical, was typically ten years. Technobis targeted these markets from the outset, partly because they were lucrative niche markets but also because if a device is adopted as a standard product in an aircraft it will be accepted much more easily in other markets. But even now, introducing a new technology to aerospace is a long process. As a case in point, Technobis are currently producing prototypes for sensors that were flight-tested in 2017 and which will be implemented in aircraft from 2023 onwards.

Technobis today

The company currently has four business lines:

Technobis mechatronics, focusing on instrument development for OEM customers using precision mechanics, photonics and thermal stability for microscopes, analyzers, laboratory instruments etc. This arm carries out complete product development projects, going from an idea to a successful turnkey product, prototype or series of products for medical, life-science and high-tech industries operating in highly demanding environments.

Technobis tft-fos, specializing in the development and supply of fiber optic sensing systems and applications. All developments are spectrometry and or interferometry-based and, nowadays, all new developments are based on integrated photonics.

Tipps. Set up in 2014**,** Technobis IPPS (integrated photonics packaging services) provides services to startups and larger companies in integrated optics (datacom, telecom, RFoF, lidar), and designs and supplies packaged chips for all platforms (InP, SOI and SiN).

Technobis crystallization systems provides devices, for example, for ana-

Organization

EPIC – European Photonics Industry Consortium

EPIC is the world-leading photonics industry association representing over 550 members across 33 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

lyzing the crystal/molecular structure or the formation of hydrates of active ingredients to increase the understanding of their physicochemical properties, mainly for the pharmaceutical and agrochemical sectors.

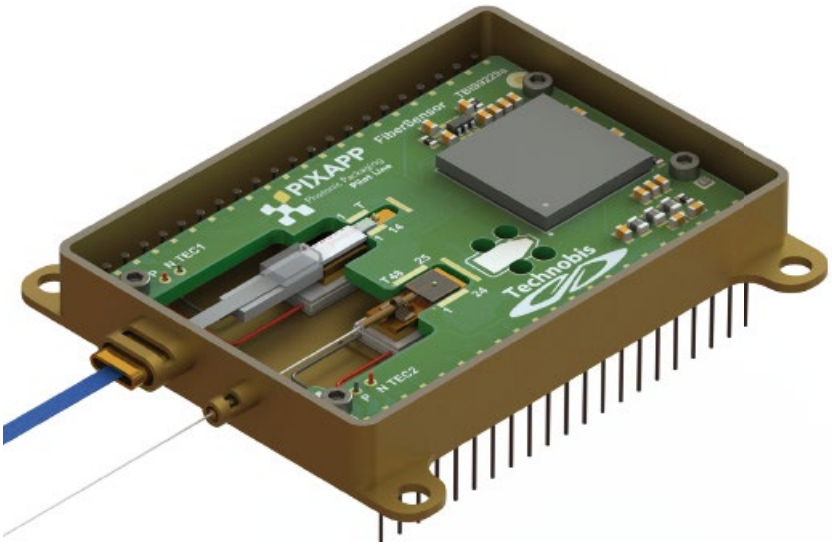
Tipps is a good example of how early adopters of new technologies often have to create their own supply chain and become vertically integrated. In Technobis' case, as there were no companies who could provide packaging for optical chips for sensing applications in series, Technobis had no choice other than to set up their own packaging facility.

Over the past five years, the company has acquired a lot of IPs and know-how on packaging. However, at a cost of between 350,000 and 750,000 euros per machine, the relatively small quantities they produce make it an expensive investment. As a solution, Technobis have opened up their foundry for packaging to third parties and around eighty percent of machine time is devoted to packaging solutions for a range of external companies operating in the telecom, datacom, RFoF, lidar and crosspiece sectors as well as start-ups, universities and research institutes.

The future

In recent years, Technobis has attracted interest from a number of large companies and in 2019, Pim decided that as he was approaching retirement it was the right time to sell the majority of his shares in the company. A new CEO and CFO were brought in and Pim became company CTO, responsible for developing next generation technology. He has since been working on an interrogator for the medical and automotive markets, the size of a memory stick and for a price of around 1,000 euros for a complete system.

Pim is also looking at how to reduce packaging costs. One of the key features of Technobis packaging services is their low prices. They offer standard packaging at just under a thousand euros but for something special, like ultrafast fiber arrays, the cost goes up to 2,000 and as high as 35,000 euros for prototype packaging with extreme requirements. As packaging costs are an issue for most smaller companies, Technobis are currently researching the possibility of reducing costs down to tens of euros, but this will require a non-controlled thermal process for a specific operational temperature.



This component represents a system-in-a-package concept, for which Technobis conceived a demonstrator in the PIXAPP Pilot Line. (Source: Technobis)

If you could start again, what would you do differently?

"To be honest, I don't think I would change very much if I started again. I've always been curious about new technology and I've always been in touch with the University to know what's going on at the cutting edge. Right from the start we've had students involved in company projects."

"I started Technobis when I was forty years old, so I sometimes think that maybe I should have started earlier. On the other hand, the 16 years I spent working in industry and acquiring experience in the technology were invaluable. I don't know many successful entrepreneurs who started straight after university and that's because before starting a company, you need to get experience with the technology and the business and to know who you are, what you can do and what you want to do."

What advice do you have for the new generation of entrepreneurs?

"First, don't be afraid of being different from the competition and of being an early adopter of new technology."

"But second, be realistic about the investment you'll need to reach the end point. In our case, if we hadn't had two running businesses behind us, we wouldn't have been able to cover the initial R&D costs and we would have had to stop at an early stage."

"Developing new technology can be extremely expensive. We spent almost 20 million euros and if you don't have alternative sources, you'll need to raise tens of millions of euros. To do this, you'll need to be fairly confident of reaching the end point and at some stage, you'll need to demonstrate success so you can keep the investment flowing and reach the end point."

Author

Jose Pozo is director of technology and innovation at EPIC, and as such he represents more than five hundred leading corporate members active in the field of photonics. His work consists of actively engaging with them and providing them with the tools to strengthen their position in the supply chain. He has twenty years' background in photonics technology, market knowledge, and a large network within the industrial and academic photonics landscape. Jose holds a PhD in electrical engineering from the University of Bristol, UK, and an MSc and a BEng in telecom engineering from Spain and Belgium.

Dr. Jose Pozo, European Photonics Industry Consortium EPIC, 17 Rue Hamelin, Paris, France; e-mail: jose.pozo@epic-assoc.com, Web: www.epic-assoc.com

Laser Forensics: The Invisible – Revealed and Measured

IR laser technology from Scanovis revolutionizes forensics; Ophir measurement technology simplifies adjustment of the optics

Source: Sergii Iaremenko/Science Photo Library/Getty Images

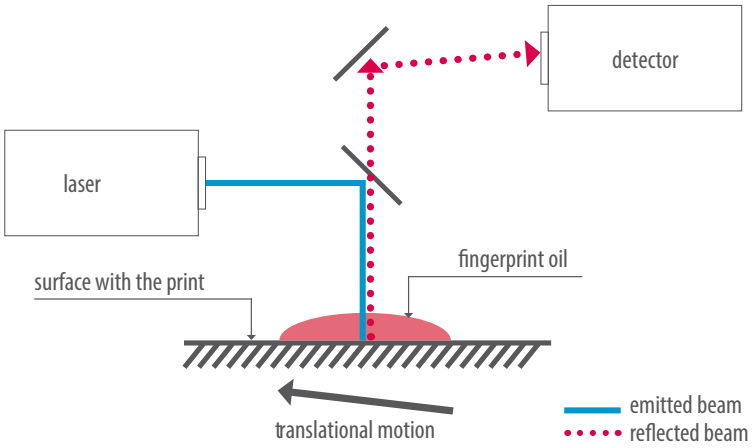
According to the developers at Scanovis – a start-up company based in Koblenz – brushes, powder and chemicals will soon be tools of the past for securing evidence at crime scenes. The company has developed a laser-based solution that, among other things, uses IR laser radiation to detect fingerprints at the scene of a crime, quickly making them visible in a 3D scan and recording them digitally. Decisive factors for this technological breakthrough are the precision of the results delivered by the laser scanner and the easy handling of the system. But how to adjust the optics of a system using a low power laser in the mid-infrared spectrum (MIR)? Working together with Ophir's measurement experts, the company was able to combine different measurement methods to this end.

The advantages of this new system are clear: With the MIR laser scanner, results are immediately available, fingerprints are digitally captured and can be directly matched, DNA traces remain unaltered by the use of chemicals, and employees do not have to handle any toxic substances. The underlying operational principle is based on the fact that residues of body fluids, natural oils and sweat absorb radiation in the infrared range. The Scanovis scanning solution directs a focused laser beam onto an object via an oscillating mirror system. The same optical path is then used for the reflected beam, which is measured with a photodiode. If a surface with a fingerprint on it is hit by the laser beam, only part of the signal is reflected – in contrast to areas without traces. The whole room is analyzed in this way. The oscillating mirror system makes it possible to scan the areas point-by-point and line-by-line, and thus generate an image.

The challenge of fine-tuning

In order to deliver precise results, the laser system must be correctly adjusted. With visible laser beams, some settings can be fine-tuned directly by observation, but the Scanovis system uses non-visible IR laser radiation. The beam can only be made visible – temporarily – using thermo-chromic substances, but this still does not allow it to be measured precisely.

To adjust the collimating lenses correctly, the developers at Scanovis



The measuring principle of the Scanovis system is based on the partial absorption of the returning IR laser beam when it is reflected off a fingerprint. (Source: Ophir)

Method	Laser at 3.5 µm		Adjustment Time	Measuring Time
	short axis	long axis		
Knife-edge (13.5 %)	52.1 ±5.0	83.5 ±5.0	1 h	5 min
NanoScan (13.5 %)	52.4 ±1.9	80.2 ±2.9	<5 min	<2 min

Results of determining the focus diameter using the knife-edge method vs. the Ophir NanoScan

previously had to resort to manual methods like moving a single-point detector within the beam. But Sven Kern, sales engineer at Ophir, instead recommended slit-based measurement using an Ophir NanoScan Pyro combined with an Ophir Starbright laser power meter. The scanning slit sensor consists of a scan drum with an encoder and a motor for optical positioning, as well as scan slits and a pyroelectric sensor surface. The laser beam can thus be measured easily and without additional optical components. Vincent Gewiese, development engineer at Scanovis, explains: "The measurements with the scanning slit device proved much faster and more precise than all the other measuring methods we had used before."

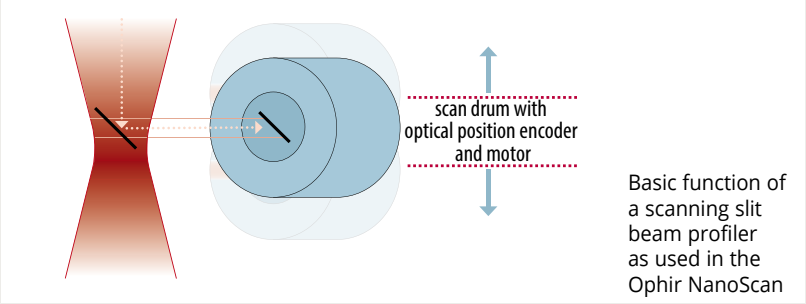
Fast measurement of the focus diameter

This scenario played out again when it came to measuring the focus diameter, which is used to determine the laser's actual performance. This measurement had been carried out via the 'knife-edge' method, in which a razor blade is gradually pushed into the beam. With the Ophir NanoScan, however, not only were the measurements faster, the results were much more precise. Since the laser in the focus has a power of just two milliwatts, the NanoScan needed thirty seconds accumulation time. And disturbances due to diffraction and reflection, as commonly occurs with the knife-edge method, could be almost entirely excluded.

Infobox

Scanning Slit Profiling

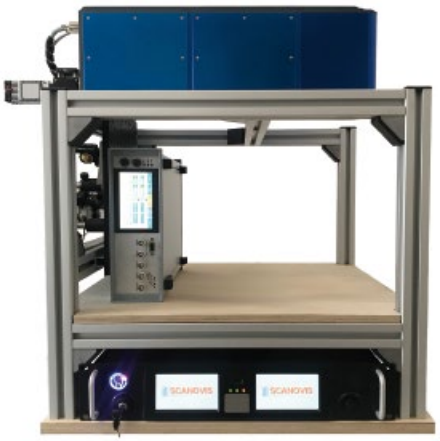
Scanning slit based beam profilers employ microscopic slits mounted orthogonally such, that part of the impinging laser beam transits the slit and is detected by a single element sensor. As the drum rotates, a high-resolution optical encoder mounted on the drum describes the location of the slits. The signal from the detector represents the integrated profile of the beam under test in the axis orthogonal to the direction of the slit. By subsequently digitizing the signal produced by a beam as it transits both slits, the intensity distribution as integrated along the scanning axis in both x and y axes of the beam can be measured. Considering the beam propagation axis, the plane of the slits becomes the measurement plane. The rotation speed of the drum and frequency of the sampling of the digitization of the single element detector as a subset of the rotation transit time becomes the spatial resolution of the measurement system.



Basic function of a scanning slit beam profiler as used in the Ophir NanoScan

Pyroelectric Beam Profiling Camera

A pyroelectric array camera can be used to profile lasers of very short wavelength UV light or Infrared from the near IR wavelengths to the very far IR and even terahertz wavelengths. Light impinging on the pyroelectric crystal is absorbed and converted to heat, which creates charge on the surface. The multiplexer then reads this charge onto the video line. For use with short laser pulses, the firmware of the camera creates a very short electronic shutter to accurately capture the thermally generated signal.



The Scanovis scanner system uses an infrared laser to detect traces of body fluids, natural oils and sweat on surfaces. (Source: Scanovis)

Calibration of the scanning unit and scanner axes

In particular, functions like tracking the focus on curved objects require the laser system to be calibrated exactly to the geometric arrangement of the individual components. The scanner must be specifically aligned to the geometry of the measured object. To achieve this, the position of the laser focus must be measured accurately in all three dimensions. To measure this position, especially in the lateral direction, Ophir experts recommended the Pyrocam. Its high-resolution, broadband pyroelectric camera has a semiconductor array that swiftly detects the laser beam and immediately outputs its position via the BeamGage software. To calibrate the Scanovis scanner, the values determined during the measurement are compared with the calculated values; adjustments are made as necessary. In addition to the required precision – the measurement must be accurate to 100 micrometers – the short time that the pyroelectric measurement took was also a decisive factor. Compared to other measurement methods, the Ophir Pyrocam has a much shorter measurement time, and it eliminates the need for complex mathematical transformations. By moving the Pyrocam step-by-step via a suitable axis system, even larger areas can be measured all at once.

To calibrate the scanner axes, the laser beam is moved by the scanning system in a rectangular pattern, the long sides of the rectangles are measured by the pyroelectric camera, and the lateral axes are calibrated based on that data.

Mandatory quality control

For Vincent Gewiese, one thing is clear: "Each of our scanner systems must be checked in production to guarantee the quality of the scan at the crime scene. Measuring the focus diameter with the Ophir NanoScan gives us a reliable indication that the scanner is working properly, and the Pyrocam measurements simplify the calibration enormously. The advice of the Ophir team helped us solve our measurement challenges." Incidentally, the new scanner system does more than just make it possible to rapidly investigate a crime scene: In medicine, compliance with hygiene regulations in hospitals is becoming increasingly important due to the spread of resistant germs. Here, too, the system provides valuable assistance in verifying the cleanliness of critical areas. Due to its speed, the measuring method can also be used in industrial production for quality assurance in incoming material inspections or final tests. Ensuring the correct functioning of the laser system – also for the protection of the operator – is essential in all cases.

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Update July 2020: Scanovis is no longer a legal entity, we will keep you posted if and how the technology will be further explored

Company

Ophir

Ophir is a brand within the MKS Instruments Light & Motion division. The Ophir product portfolio consists of laser and LED measurement products including laser power and energy meters, beam profilers, high-performance IR thermal imaging lenses and optics for CO_2 and high-power fiber laser applications.

www.ophiropt.com

Confocal Laser Vibrometry

Visualizing vibrations inside microelectromechanical systems

Semjon Köhnke, Malte Ennen, and Iwan Schaap

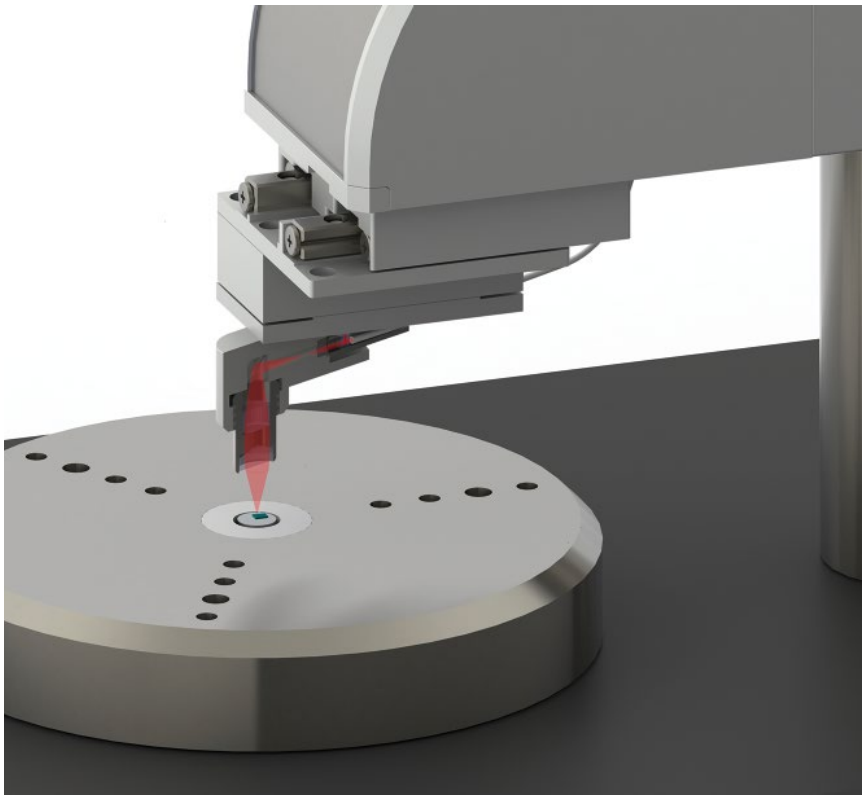

Fig. 1 The SmarAct PicoScale Vibrometer consists of a 3-axis positioner that scans the measurement laser beam over the sample. The sample is mounted on a high-bandwidth shaker stage for mechanical excitation. The system is completed by a controller and a software package to control and analyze the measurements. (Source all images: SmarAct)

With laser interferometry vibrations can be measured with picometer resolution. A prerequisite for such measurements is that the sample is optically accessible for the measurement laser. However, because MEMS sensors are increasingly designed with multiple layers and are encapsulated in silicon packages, their vibrations are often out of reach for conventional laser vibrometers. Here we show that with a smart combination of scanning microscopy and laser interferometry it is now possible to measure vibrations within encapsulated MEMS devices.

Measuring vibrations with interferometry

The ideal test of vibrational behavior is performed under conditions that disturb the investigated object as little as possible. Laser interferometry is a contactless technique that allows the detection of even picometer vibrations. The only condition to be met is that a fraction of the measurement laser beam is reflected back to the detector.

The movements of the sample are measured interferometrically at the focused laser spot. For this purpose, a miniature Michelson interferometer is integrated into the microscope objective. A beam splitter cube is placed in the beam path between the glass fiber and the objective lens in order to split the laser light into two beams (Fig. 2). The transmitted beam is focused onto the sample where it reflects. The second beam, which is directed onto the mirrored side-surface of the cube, serves as an intrinsically stable reference. After reflection, both beams interfere at the beam splitter. This interference signal is coupled into the fiber and detected by a photodiode. When the sample is displaced along the optical axis, the optical path of the first beam changes, resulting in an optical phase shift between the two beams. From this phase shift the displacement of the sample is calculated. Since the individual points of the sample are measured sequentially, the individual measurements must be synchronized. For this purpose, a digital dual-phase lock-in amplifier has been

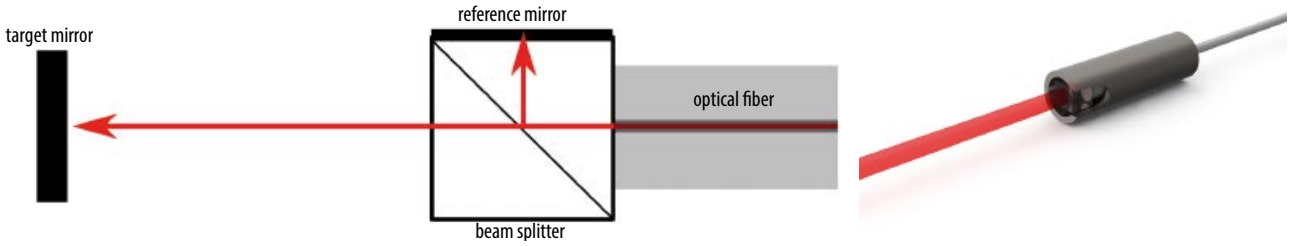

Fig. 2 Working principle of the Michelson interferometer. One side of the beam splitter cube is highly reflective and provides a stable position reference. The other part of the beam is reflected by an external target mirror and thus used to measure the displacement with respect to the reference.

integrated into the interferometer controller. The position signal of the interferometer is fed directly into the lock-in amplifier, which outputs the amplitude and phase of the measured oscillation. The oscillation frequency of the sample can be freely selected.

For active excitation of the sample, the vibrometer has an amplifier output and a piezo-based sample stage. The so-called shaker stage is based on a fast piezo actuator that is mounted in a solid stainless steel housing. It allows for a mechanical excitation of samples like motion sensors or cantilevers in order to find their resonance frequencies and bending modes. Frequency and amplitude of the drive signal can be configured via the PicoScale Vibrometer controller. The vibrations are generated by the active piezo area of 5 mm diameter in the center of the shaker stage. Samples can be mounted on the shaker stage with a small amount of adhesive material such as vacuum grease or double-sided sticky tape. The mechanical excitation amplitudes depend on the driving voltage and frequency but also on the mass of the sample.

Since the phase is measured relative to the excitation signal, the vibration mode of the sample can be completely reconstructed (Fig. 5b).

Looking through silicon with confocal infrared microscopy

To perform confocal scanning vibrometry, the interferometric vibration measurements must be combined with microscopy. In reflection microscopy the image is created by measuring the amount of light reflected back from the sample. However, reflection microscopy will suffer from disturbances of scattered light at spurious surfaces. When imaging a sample that consists of multiple semi-transparent layers, a fraction of the illumination light will reflect off each surface and reach the detector resulting in a parasitic signal. Ideally, only light that is reflected from the focal point should reach the detector while all other light is rejected. This is the principle of confocal laser scanning microscopy.

A laser beam is focused into a small measurement spot. Before the reflected light can reach the detector it has to pass through a pinhole which has a size comparable to the focused spot and is placed at a conjugate plane of the focal plane. Thus, only the reflected light that originates from the focal volume will be detected while all other light will be blocked by the pinhole. Instead of a pinhole a single mode optical fiber is used in the PicoScale Vibrometer, which fiber core is exactly placed in the conjugate of the focal plane (Fig. 3). To create an image, the focused laser beam is raster scanned over the sample while recording the reflection intensity at each pixel.

By using this confocal optical design the measurements become insensitive to light scattering layers that are placed in the path of the laser beam. Silicon layers are almost transparent to near-infrared light, which is why the PicoScale Vibrometer employs a 1550 nm laser source.

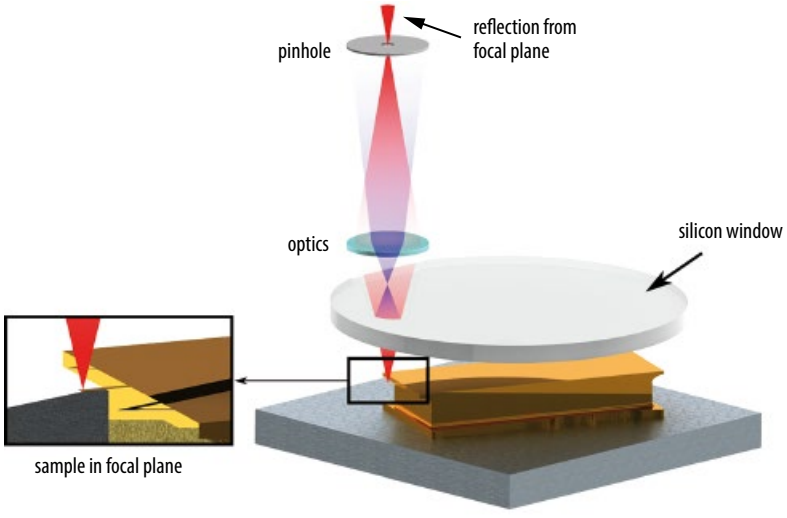

Fig. 3 Light that is reflected from the focal plane follows exactly the same path back (shown in red) and can re-enter the optical fiber aperture which is visualized as a pinhole. Light reflected from the silicon window (shown in blue) is blocked by the pinhole and will remain largely invisible in the measurements.

Company

SmarAct GmbH

SmarAct is a rapidly growing high-tech company based in Oldenburg (Germany) and develops micro- and nanopositioners, compact control systems, miniaturized robot systems as well as high-end measuring equipment such as interferometers and vibrometers.

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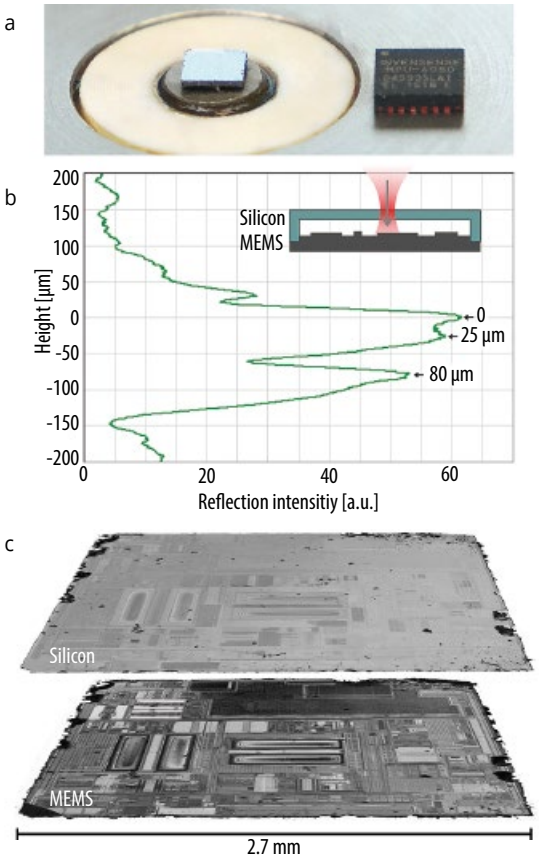

Fig. 4 The MPU-6050 motion sensor without its plastic enclosure, mounted on the shaker stage. For comparison, the covered chip is shown on the right (a). With confocal microscopy, the multiple interfaces of the sample can be detected. The peaks that show the top and bottom of the silicon window are 25 µm apart, which has to be multiplied by its refractive index to obtain the thickness of the silicon window of 90 µm. The distance between the lower surface of the silicon window and the MEMS is 55 µm (b). 1-megapixel images of the top surface of the silicon window and the underlying MEMS structure (c).

Combining high resolution with a large field of view

The PicoScale Vibrometer uses a compact microscope objective that is optimized for the imaging of microstructures with lateral resolutions as high as 2 µm. The light of the laser is guided to the objective through a single-mode fiber and is focused into a micrometer sized spot (Fig. 1). The objective is mounted onto a three-axis positioning system which scans the laser beam across the sample. The positioners provide a 30 nm repetitive accuracy at a traveling range of 20 mm making megapixel measurements possible. Such a large field of view with this resolution cannot be achieved with galvanometer scanning mirrors that are used in conventional vibrometers.

The vibrometer owes its compact design to the dual use of the entire optics. The same optics which are used for microscopy imaging are also used for the interferometric measurements of vibration with pm resolution.

Measuring vibrations within an encapsulated motion sensor

MEMS allow the miniaturization of devices that generate and detect motion. With continuing innovation in the field of smartphones, vehicles and IoT further demand for miniaturization is present. The actual testing of the mechanical motion within MEMS plays an essential role during their development and allows to find causes for unexpected responses. The PicoScale Vibrometer was designed to meet these demands even for devices packed in silicon enclosures. Here, the MPU-6050 multiaxis motion sensor from InvenSense (TDK Group Company) was tested. This motion sensor is widely used in consumer and automotive electronics to track motion, a function that has become indispensable for many applications.

For the experiments, the molded plastic enclosure was removed from the top of the motion sensor in order to gain access to the silicon package (Fig. 4a). By moving the objective along the optical axis while recording the reflection signal, the different interfaces can be detected. Fig. 4b shows that two main peaks can be distinguished, one for the silicon window and one for the MEMS structure. Within the silicon peak, two subpeaks can be distinguished that represent the upper and lower side of the silicon window. By adjusting the focus of the microscope to the respective peaks both the top of the silicon window and the actual MEMS structure can be imaged (Fig. 4c). Fine structural details can be resolved on the MEMS structure which allows for a more detailed study of the vibrations of its moving parts. To study the moving parts of the sensor, the image size was reduced and the local motion was measured by positioning the measurement laser at the indicated point (Fig. 5a) while the sensor was mechanically actuated from 1 – 600 kHz. The measured response shows multiple pronounced resonance peaks (Fig. 5b). To image the associated bending modes the sensor was actuated at these frequencies while recording an image of the vibrations. The inset figures in Fig. 5b reveal bending modes of increasing complexity. Thanks to the large scan area and megapixel imaging capability of the PicoScale Vibrometer

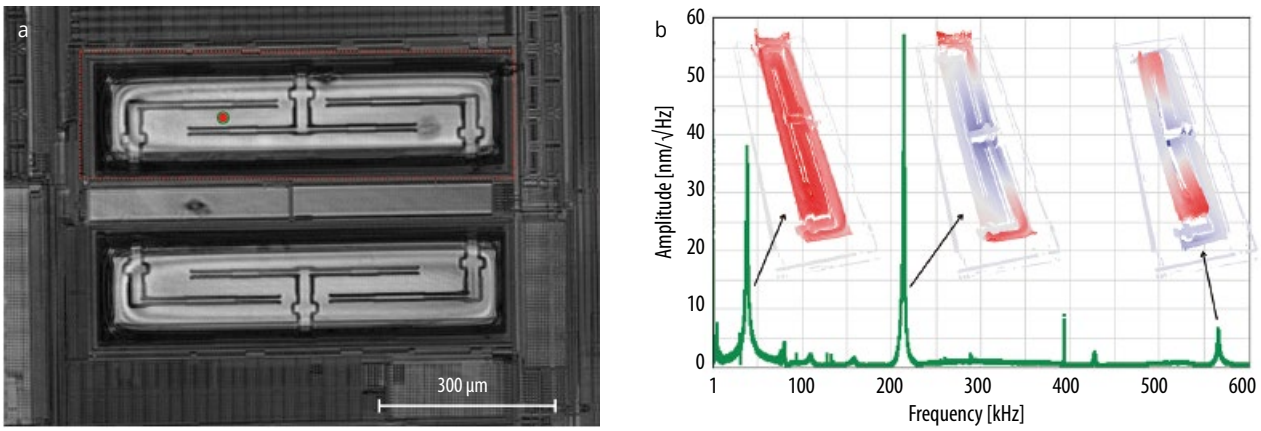

Fig. 5 Modal analysis of the motion sensor through a silicon window – the vibrations were first measured at the indicated point (a). The amplitude spectral density plot (b) shows multiple resonance peaks. At the indicated peaks, a modal analysis was performed of the part of the structure that is indicated by the red box in a). The inset figures show 3D renderings of the motion.

it also the motion of different parts of the MEMS can be directly compared in one recording.

Conclusion

The PicoScale Vibrometer is based on an infrared 1550 nm laser source with confocal optics. A unique advantage of this combination is that it allows to 'look' through silicon layers to measure vibrations of underlying structures, a feature that will help to test and improve MEMS design. Nevertheless, objects that are made out of silicon or other materials can be imaged and characterized, too.

Acknowledgements

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Authors

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Malte Ennen helps project managers and engineers with using interferometric encoders for their machine integration applications. He studied engineering physics in Oldenburg and has a background in the field of custom laser machine development and microstructuring.

Iwan Schaap has led the development of the PicoScale Vibrometer at SmarAct. Prior, he held a position as associate professor at Heriot Watt University in Edinburgh and as group leader at the University of Göttingen, where he developed instrumentation and methods to study problems in life science.

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Advance Online Publication

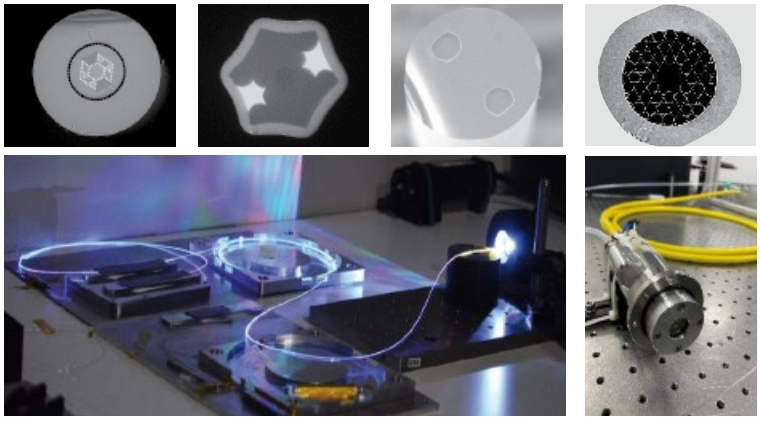
New Microstructured Optical Fibers for Innovative Lasers and Beam Transportation

L. Bigot, P. Roy, T. Taunay, F. Benabid, and E. Mottay

The French 4F consortium has obtained new results on microstructured optical fibers for the development of Ytterbium active fibers with a large core and for the transport of intense laser beam via hollow-core photonic crystal fibers.

In the case of active fibers, several methods to obtain fiber preforms have been tested (MCVD, OVD, powders, sol-gel), as well as suited designs. The fiber specifications are targeted for optimum laser performances, such as a mode field diameter larger than 30 µm, a polarization extinction ratio greater than 15 dB, no air clad and a cladding absorption at 976 nm larger than 10 dB/m.

The bending radius is also limited to a relatively small diameter (about 20 cm). The fiber will allow a laser operation exceeding 150 W. The fiber for beam delivery consists of inhibited-coupling guiding fiber and allowing guidance of high levels of pulse energy and average power.



Source: Amplitude Laser

This article will be included in PhotonicViews issue 5/2020 but is available online already through the given link (see QR Code).

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THz-Raman – A New Analytical Tool

Extending Raman spectroscopy to other spectral regions – modality for microscopes, vials and well plates

James Carriere and Matthias Schulze

Source all images: Coherent

THz-Raman is a new analytical technique that uses optical sensing to obtain quantitative information about macroscopic motion and structure in samples, including phase changes, ligand binding of proteins, and biopolymer conformational data. This technique is now packaged for easy integration into optical microscopes and spectrometers for research use, as well as in stand-alone well plate readers for use in high-throughput drug discovery and related applications.

Optical interrogation of samples, often involving lasers, is key to several types of automated and high throughput analyses in fields such as drug discovery, flow cytometry for blood assays, and DNA sequencing. Most of these life sciences applications entail determining the molecular (chemical) composition of the target, often by using laser-induced fluorescence to do spatial mapping.

The current world health backdrop where we are running out of non-resistant antibiotics was already creating pressure to conduct drug discovery faster and more intensely than ever. But the immediate threat of the Covid-19 pandemic has naturally driven researchers to push that much harder in all aspects of life science research, in order to speed up fundamental understanding of the virus, develop therapeutic drugs to mitigate the effects of infection and, at some point, to create a vaccine to stop this pandemic. Any and all current analytical methods are being used in this urgent worldwide multidisciplinary effort.

A completely new type of modality has recently been added to the analytical arsenal. Specifically, THz-Raman is yet another optical technique that can be harnessed for life sciences applications, with all the usual benefits inherent to optical methods, including automation, speed, microscopic resolution and so forth. But unlike other optical techniques, this new modality maps the local physical state or phase of a sample rather than just its composition: the degree of crystallinity, the amount of different drug polymorphs, distinguishing between polymer conformations, whether two materials are co-crystallizing, and whether a protein and ligand are binding or not, etc. Moreover, because it can be seamlessly integrated with 'conventional' Raman, it provides a unique means to simultaneously interrogate both the local chemical and structural composition information.

Raman vibrational spectroscopy

Every chemical, i.e., every molecular species, has a unique arrangement of atoms and interatomic bonds. The vibrational energy states of these bonds correspond to photon energies of infrared light. So each molecular species has a unique pattern of resonance peaks – a chemical signature – in its infrared

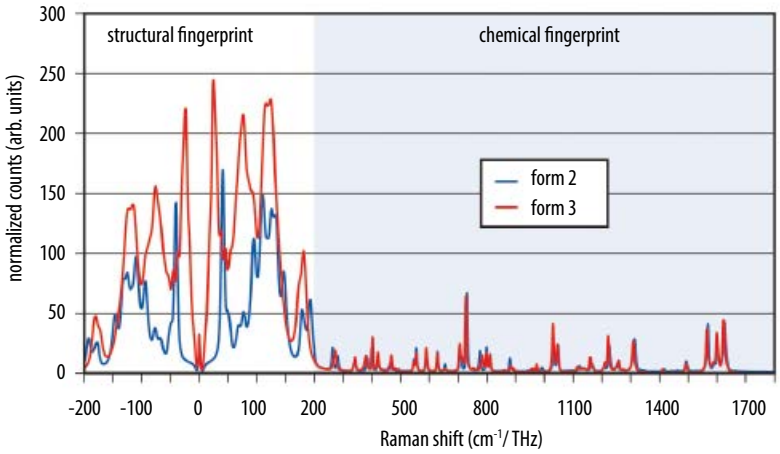

Fig. 1 A THz-Raman spectrum of two forms (polymorphs) of a pharmaceutical compound: Conventional Raman provides chemical fingerprint data (blue section), where differentiation of form is difficult to detect. Extending Raman to the low frequency (THz) domain (white section) provides unique structural fingerprint information with dramatically higher magnitude and highly differentiating characteristics.

spectrum. This is the reason that infrared absorption, usually in the form of Fourier transform infraRed (FTIR), is one of the most common analytical tools in chemistry and biochemistry research labs. But infrared light is limited to larger vibrational energies that correspond to submolecular bonds. To probe the crystal phonon modes or detect some of the other conformational changes related to changes in the structural properties of these materials, the required frequencies extend into the terahertz range which are much more difficult to produce and detect, requiring special sample preparation and suffering from poor signal to noise. Fortunately, a once obscure technique called Raman spectroscopy provides an alternative route to the same data that avoids most of these limitations.

When light interacts with most molecules and material samples (solid, liquid or gas) a small amount of the light is scattered at different frequencies, leaving the molecules in a different final energy state. Conservation of energy means that the scattered light can be at a longer wavelength (Stokes-shifted) or shorter wavelength (anti-Stokes) depending on whether the sample is left in a higher excited state or lower excited state. This is called the Raman effect. Whereas direct absorption requires infrared frequencies (wavelengths) to change the vibrational state, in Raman the signal is shifted relative to the original light source by an amount corresponding to that change in vibrational energy state. If the excitation light source is monochromatic, the Raman-scattered signal can be dispersed to reveal a frequency spectrum of sharp vibrational peaks in a frequency band called the chemical fingerprint region.

Compared to FTIR, Raman has the advantage that it can be performed using visible light or NIR light, enabling non-contact sampling through glass windows, microscope optics and using standard silicon CCD-based detectors. However, Raman scattering is a second order effect and relatively weak and therefore requires a laser source to provide measurable signal intensity. At the same time, laser light scattered by the sample (Rayleigh scatter) and by the system optics is orders of magnitude more intense than the Raman signal and creates a noise background that must be selectively blocked. This limited the early adoption of Raman. But over the last twenty to thirty years, advances in solid-state and diode lasers, holographic gel-based filters, and scientific grade cameras have all combined to eliminate the need for inefficient cumbersome equipment such as scanning monochromators, and eventually enabled the development of compact self-contained Raman spectrometers and Raman microscopes.

THz-Raman

What about extending Raman to look at other types of resonances (i.e., different spectral regions) in a sample? With larger molecules like polymers and proteins, macroscopic motion of the large molecules or crystal lattices can occur at sample-specific frequencies, particularly in the 0.15 – 6 THz energy range corresponding to 5 – 200 cm^{-1} Raman shifts. Spectral data here can reveal tremendous details about the local intermolecular environment: the amount of crystallinity vs. amorphous material, the amount of liquid phase, the coiling and uncoiling of proteins and other polymers, and the binding of proteins, etc. Recently, scientists have been studying samples in this under-exploited part of the spectrum. However, THz is a much more difficult radiation to generate, detect and manipulate. The sources are complex and inefficient, often based on ultrafast lasers. And the detectors are equally complex. As a result, THz spectroscopy and imaging has struggled to translate from a research subject to an analytical technique with a few very small niche exceptions.

In theory, low frequency Raman, i.e., Raman with THz shifts, could easily get this same data. But in practice, as the Raman shift is decreased and the intense

Company

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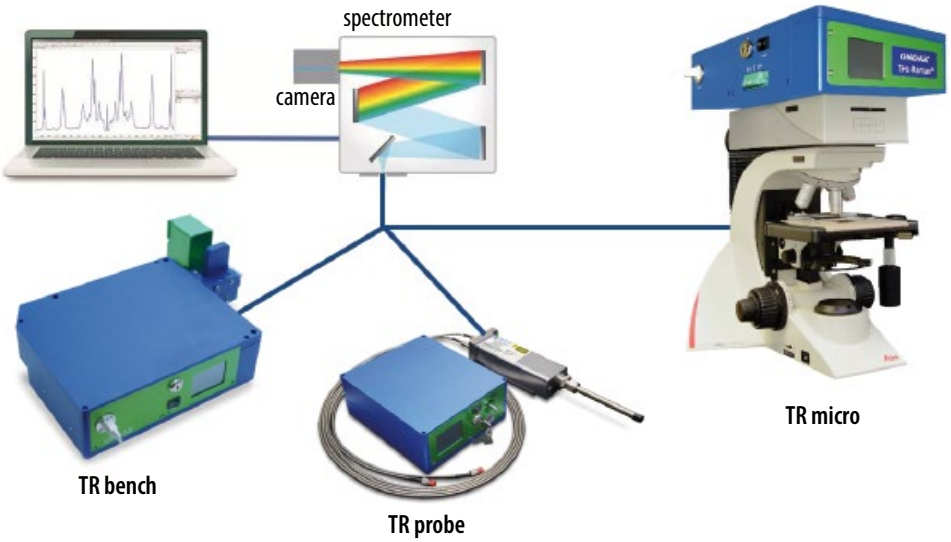


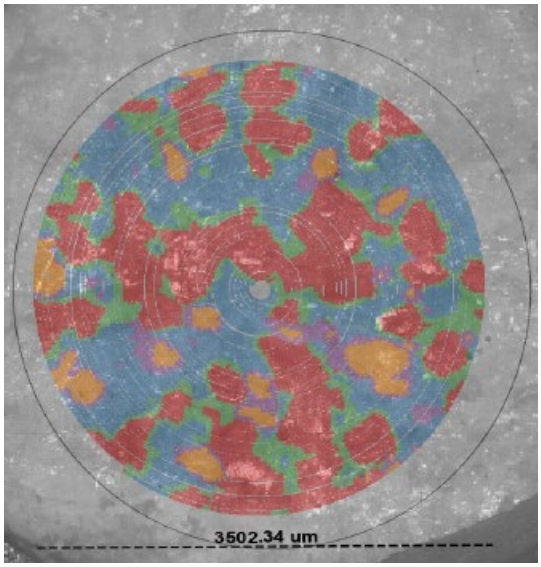
Fig. 2 A cost-effective way to support THz-Raman applications is to package the technology as an add-on module for existing Raman spectrometers and microscopes.

Rayleigh wavelength is approached, the blocking characteristics of the filters attenuate the signals and even weak broadband amplified spontaneous emission (ASE) from the laser means that there is a steep non-linear increase in the background noise. This limited most Raman systems from capturing <200 cm^{-1} Raman signals (also known as the low frequency or low wavenumber region) with conventional Raman technology. Low frequency Raman therefore required a quantum leap in wavelength blocking and discrimination efficiency, i.e., filters with much sharper cutoff characteristics and narrower bandwidths.

Fortunately, a new type of volume holographic optic based on photosensitive glass (rather than gels) has solved this problem. These filters are used to clean up the laser output in terms of its spectral spread, and then efficiently filter the signal to eliminate the Rayleigh-scattered laser light. As a result, instruments based on these optics can now provide excellent signal to noise in the 5 – 200 cm^{-1} region of the spectrum, now nicknamed the 'structural fingerprint' region – see Fig. 1.

Turnkey spectrometers, modules and microscopes

To support and grow the nascent field of THz-Raman requires not just novel optics, but turnkey instruments that incorporate those optics. However, since most applications for Raman will benefit from having both chemical and structural information, a particularly cost-effective way to package THz-Raman for these applications is in the form of turnkey modules that add plug-and-play THz functionality to existing Raman spectrometers – see Fig. 2. These modules all include a wavelength stabilized laser, high performance spectral cleanup filters, and ultra narrowband notch filters to block only the Rayleigh line of the scattered spectrum. They are available in benchtop and microscope module formats; or by decoupling the laser from the filter head, a more compact probe format. To enable testing of multiple sample types, various optional sample interface accessories can be easily attached and interchanged, including a vial holder to support typical analytical applications, a contact/immersion probe tip, a non-contact optic, and a large area illumination adapter. Each module interfaces to an existing spectrometer via a simple fiber connection



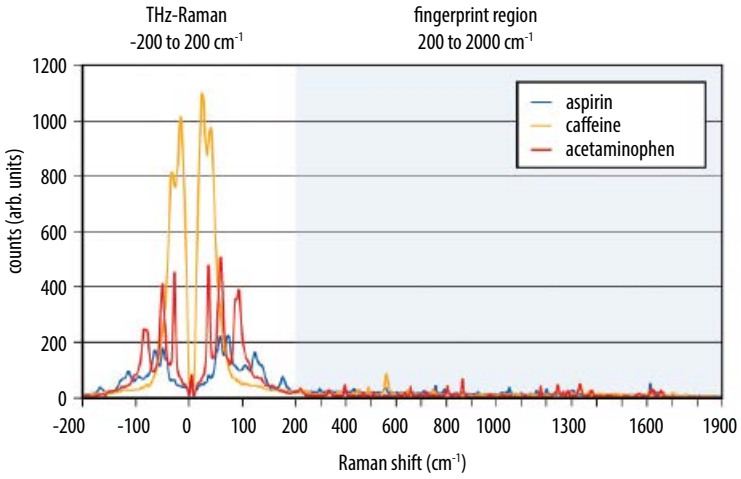


Fig. 3 Rapid tablet mapping image of an excedrin tablet placed in a well, based on >27 k spectral data points collected over a 3.5 mm diameter region of the tablet in nine minutes. The colored Raman map showing the various components is overlaid on the polarized light microscopy image for easier data visualization. The corresponding spectra to the right illustrate the strong signals found in the structural fingerprint region.

that is already common for most of the spectrometer installed base, making them a simple solution to upgrade the performance of Raman instruments in the field. Alternatively, any of these modules are also available integrated with its own stand-alone spectrometer as a stand-alone instrument.

Raman well plate readers

At this time, a particularly important area for virtually any analytical instrumentation is supporting high throughput drug development. As the rapidly developing worldwide Covid-19 pandemic has shown, the need to quickly evaluate the efficacy of new and existing drug candidates is greater than ever. To enable massive parallel analysis, much drug discovery work is performed in well plates. Here, the combination of conventional and THz-Raman with its optical microscope compatibility can deliver fast, sensitive and reliable measurements of both chemical composition and molecular structure.

Coherent supports these applications with a completely self-contained specialty Raman instrument called the THz-Raman Well-Plate System (TR-WPS). This automatically captures the entire Raman spectrum from -400 to +2100 cm^{-1} for common well-plate formats; it is configured to accept standard well-plate sizes from 6 to 1536 wells. The software and user-selected objectives mean that intrawell mapping is also possible with a spatial resolution on the order of several micrometer – see Fig. 3. Moreover, the TR-WPS utilizes a linearly polarized illumination source to also provide polarized microscopy images of the wells that can be spatially overlaid with the Raman data for direct visual comparison of spectral features. (Polarized microscopy is a proven method of imaging polycrystalline and mixed phase samples that highlights the discontinuities and phase boundaries.)

The TR-WPS is thus ideal for screening well plates for chemical make-up as well as for new optical measurements for the identification of polymorphic compounds and co-crystals, or for quantifying the degree of crystallinity in pharmaceuticals, or for following conformational changes in biopolymers, e.g., tertiary and quaternary protein conformations, as well as for the binding of proteins and ligands, to name just a few applications.

Summary

In conclusion, a new analytic modality, THz-Raman, enables fast non-contact and quantitative assessment of structural information about samples. Now packaged with conventional Raman in a well-plate reader, THz-Raman brings a new dimension by which researchers can rapidly and automatically analyze their samples.

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Lightweight Design for Commercial Vehicles

EMAG LaserTec is developing a holistic production solution for large truck differentials

When the catch phrase "lightweight design" is used for automobile production, it typically refers to passenger cars, rarely commercial vehicles. However, there is an enormous amount of potential for weight reduction and cost savings when considering the large, heavy parts needed for the drivetrain in trucks. Recently, a supplier in North America demonstrated the possibilities and benefits that a complete laser welding production system from EMAG LaserTec can provide. The commercial vehicle specialist currently uses one of its production systems that welds three different parts together to manufacture a large truck differential – eliminating approximately forty costly screwed connections. Before production starts, a truck differential consists of two housing parts and the ring gear. These each weigh up to 130 kilograms (287 lbs) and have a diameter of up to 600 millimeters (24 in). The detailed sequence is as follows:

The line guarantees a perfectly timed sequence for truck differentials (Source: EMAG)

- After being fed by two separate loading stations, the two housing parts and the ring gear run through an EMAG laser cleaning system – a new in-house development that already looks and feels like a standard machine. The process is extremely fast and removes all residues, such as coolants or preservatives, using a focused laser beam.
- Robots then remove the parts from the laser cleaning machines. The ring gear is first preheated with induction heating and is then transported to the joining station (preheating is performed using a low-frequency generator by EMAG eldec). The two halves of the housing are directly fed into the joining station and press-fitted together with the ring gear. The process is performed under force/path monitoring.
- The subassembly is now ready for welding – a robot loads it into the EMAG ELC 600. After axial clamping, the housing is closed, and the ring gear is joined with the housing using two welds.
- An EMAG ultrasonic testing system automatically checks the quality of the welded joint – a key step in the process that is just as important to specialists as the machining of the workpiece.

The development of this process was completed within twelve months. The specialists at EMAG LaserTec had to overcome a number of process-related challenges during this time – after all, the weld seams are deep cast steel/case-hardened steel connections, which are welded with an 8 kW (11 hp) solid-state laser and welding additives.

Apart from that, the dimensions of the manufacturing system are impressive: the whole system consists of two laser cleaning stations, a heating station, a joining station, the ELC 600, and the ultrasonic testing station, which are interlinked with complex feeding technology and two industrial robots (pictured).

www.emag.com

Lasers for Lightweight Design and Structural Durability

"Selective laser melting contributes to low-emission and resource-efficient mobility"

How can SLM be used to develop automotive lightweight structures subjected to cyclic loads? The Technische Hochschule Mittelhessen THM is focusing on this issue in a 600,000-euros project, funded by the Federal German Ministry of Education and Research. The Friedberg-based researchers are working together with Continental Engineering Services from Frankfurt, and colleagues from the Technical University of Darmstadt.

Material and component properties such as strength, stiffness and ductility are indispensable in this process. The material consistence in the surface layer of the component is decisive. There must be no gas inclusions (voids) and also defects such as unmelted powder.

"The goal of our project is to use appropriate laser scanning technology to develop and produce vehicle components that exhibit a very high outer surface quality. In contrast, the inner surfaces can be of a lower quality when using the laser melting process, thereby lowering the production time and costs without affecting the component quality," explains project leader Prof. Udo Jung.

"The targeted insertion of such graded material properties by modifying the manufacturing process of the laser scanning and buildup strategy of metals has not been investigated yet. In doing so we see the chance to improve the process of metal laser melting and to use it for a new vehicle technology", said the mechanical engineer. "This process could be used for suspension components such as the axle assembly, the strut or for engine mounts, which are all subjected to heavy cyclic loads," he added.

www.thm.de

A brake caliper that has been produced using 3D printing technology (Source: A. Eikenberg, THM)

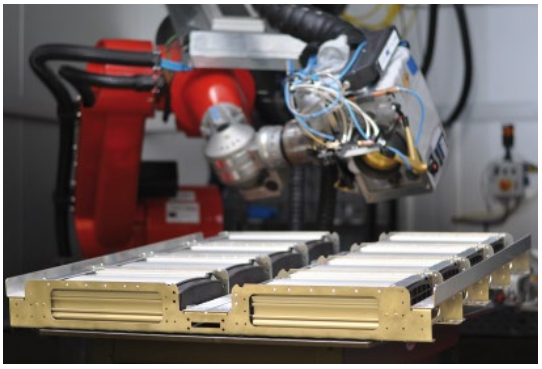
Efficient Small Series Production for Electromobility

Completion of the ProeK research project

In addition to general trends and challenges in automobile production such as shorter innovation cycles or individualization, electromobility has become a new factor in increasing the number of variations in the production of different vehicle types. At the same time, the production volume per vehicle type is decreasing, this requires efficiency enhancement measures to achieve high product quality with less effort, even in small-series production. The ERDF-funded research project "Production Efficiency in Small-Series" (ProeK) investigated new, practice-oriented technical solutions to enable small series production to be as cost-effective, efficient and flexible as possible. Project partners were the electric vehicle manufacturers Street-Scooter and e-Go Mobile, the component manufacturer LBBZ, the FH Aachen and the vehicle production department of the Laboratory for Machine Tools and Production Engineering WZL of RWTH Aachen University, with Trumpf as an associated partner.

The "Body" sub-project focused on reducing expenditure and conserving resources in fixture construction. The concept of jig-free joining for new components that are specific to electromobility – such as the battery pack housing – using plug-in connections was developed further. A corresponding alternative production chain from component manufacturing to the joining concept allows greater flexibility and material savings when using edge components and laser beam welding processes.

The emphasis of the '"Shell" sub-project was on reducing the effort and saving resources in quality adjustment and assurance. Different concepts for an integrated adjustment process were investigated, for which tools for adaptive quality adjustment were developed. These included the use of additive manufactured tolerance compensation elements as well as the use of cross-linking and machine learning for the adaptive adjustment of joining processes. In the course of the latter solution, a cost-effective sensor concept was developed that promises significant investment and effort savings compared to classical downstream quality assurance. The integrated adjustment process reduces scrap and reworking. Although still required to a lesser degree, the reworking was supported by additively manufactured gauges for the adjustment of exterior components and by tool guidance.



Jigless laser-welded, low-cost battery pack housing made of high-strength aluminum (Source: WZL RWTH)

www.wzl.rwth-aachen.de

Innolux Adopts Corning Laser Technologies' Latest Innovation

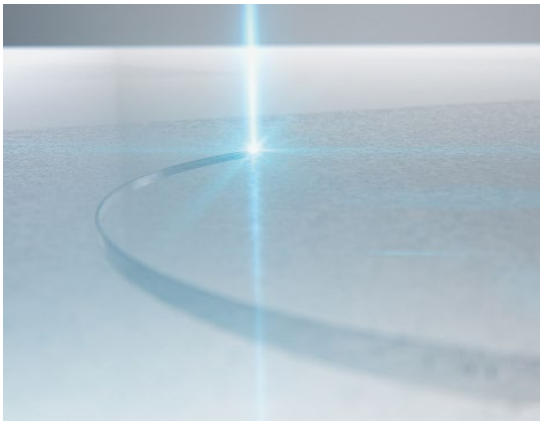
Bringing new design and manufacturing opportunities to the auto panel industry

Innolux Corporation will use Corning Laser Technologies' large platform cutting tool and full automation system for its high-end display panel manufacturing process, enabling enhanced design flexibility, improved cutting accuracy, and manufacturing excellence of glass sensor panels for automotive applications.

Corning Laser Technologies (CLT) specializes in high precision laser process innovation. CLT offers proprietary laser cutting systems that cut glass with low surface roughness, increased bend strength, and high throughput. The large platform cutting tool and full automation systems use the enhanced nanoperforation technology developed by CLT. This patented technology for laser-glass interaction allows unprecedented edge strength and process stability compared to other laser cutting methods.

"Innolux and Corning have worked together for many years to enable new innovations in the display, automotive, and mobile consumer electronics industries. This new collaboration introduced CLT to automotive panel manufacturing, and we are excited that Innolux will utilize our laser technology for their process," said Michael A. Müller, business director, Corning Precision Glass Solutions and Corning Laser Technologies. "This new technology brings unprecedented benefits to auto panel design and new manufacturing opportunities for the automotive industry."

"Even during this economic downturn resulting from the pandemic outbreak, Innolux has maintained its continuous investment in innovation. By leveraging CLT to accomplish complex and delicate glass cutting, we continue to strengthen Innolux's leadership in the auto industry," said James Yang, president, Innolux Corp. "This collaboration is one of Innolux's largest investments in recent years. We look forward to driving new developments in the automobile industry and introducing more advanced and high-performance auto display panels and solutions with this partnership in cutting-edge auto panel technologies."



Compared to other laser cutting methods, nanoperforation technology enables unprecedented edge strength and process stability. (Source: Corning)

www.corning.com
www.innolux.com

Visual Final Inspection After Manual Assembly

The Pictor M intelligent camera system from Vision & Control delivers 100 % quality control for manual assembly of truck oil pumps

When it comes to the manual assembly of truck oil pumps, which involves many steps, a full final inspection is absolutely essential. This is why the imaging specialists from Vision & Control have integrated an intelligent camera solution for visual inspection in the test bench for pendulum-slider oil pumps at Mahle Filtertechnik. This system checks and documents all components to make sure they are present and correctly positioned.

Source: Vision & Control

At the heart of the test system is a compact camera from the Pictor M series. Image processing is already integrated into these models, along with a number of standard test sequences. Pictor M can be programmed and operated from any PC within the same network via Ethernet using the vcwin Windows-based user interface. Thanks to the graphical and intuitive user interface, this does not require in-depth IT skills.

The lens used is a fast entocentric lens from the VCN series. Together with a square diffuser plate with an aperture for the camera, an RK series ring light mounted in front of the lens ensures shadow-free illumination of the test object.

Once the image has been captured, the first step is for the outer slider to be positioned using the 'point probe' function. From there, the test program finds the middle rotor and checks whether all pendulums are present. Any pendulums that are not latched are identified by searching for dark pixels along a circular path around the rotor. Based on the asymmetrical contour of the pendulums, the subsequent shape check identifies whether or not they are correctly oriented.

In the event of a problem, an incorrectly assembled oil pump is handed to the worker for reworking. Only if everything is correct is the image saved together with the documentation and the oil pump released.

www.vision-control.com

Boosting Speed, Reliability, and Accuracy of Quality Assurance

Baumer's hardware, software, and vision design expertise helps tier shift from unreliable manual inspections of its clutch return spring packs to a fast, automated solution

Product recalls have cost the automotive industry as much as 22 billion dollars in claims and warranty accruals during a single year, prompting many tier suppliers to replace their manual quality assurance inspections with more consistent, thorough, and accurate machine vision solutions. Baumer's Vision Design Center helped a tier 2 automotive supplier make its transition simple and effective with a machine vision system that performed seven inspection functions with a single algorithm.

The customer, a leading industry supplier of clutch return spring packs, had previously relied on manual inspection to confirm that the multiple coils in its clutch return spring packs were properly shaped and seated and free from defects. This approach, however, produced unreliable results with expensive and dangerous consequences. A single flawed spring in these assemblies can adversely affect the quality of the full pack and, ultimately, the performance of an automotive clutch plate. The automotive supplier developed the inspection station but sought Baumer's expertise to incorporate the vision component. Its system requires an operator to load the spring packs and activate the inspection process, which rotates the assembly so a fixed camera can capture images of each spring.

The Baumer design team backlighted the assembly with an inexpensive diffuse LED lighting strip and selected a Verisens VGA camera to optimize system speed and throughput.

Maintaining high throughput was a key challenge for the image analysis process. Specifically, the system needed to complete seven functions for each spring pack, including inspections for:

- Missing springs
- Springs unseated on the tab end
- Springs unseated on the extrusion end
- Improper seating on the tab or extrusion end
- Incomplete seating on the tab or extrusion end
- Double stamping
- Correct assembly height

The inspection station needed only distinguish good assemblies from bad. So, using Baumer's free, award-winning vision software, the design team was able to script a single algorithm that could quickly flag assemblies with any one of these seven possible flaws.

They built the algorithm on a product variant model based on the exact periodicity and contours of a correctly seated spring. The team then developed a software routine that compared assemblies against that model. If a camera image failed to show a statistical match with this one critical feature, then the inspection station would signify the assembly needed rework.

As a result of Baumer's hardware, software and vision expertise, the tier 2 manufacturer was able to significantly improve the throughput of its inspection process and ensure 99.5 % accuracy. This success has led the manufacturer to further discuss how vision technology can improve the speed and accuracy of spring sortation.

www.baumer.com

ADAS Sensors and Computing: A 22 Billion Dollar Market in 2025

Radar and camera are expected to lead the market, but more computing power and a new E/E architecture will be required

Pierrick Boulay and Cédric Malaquin

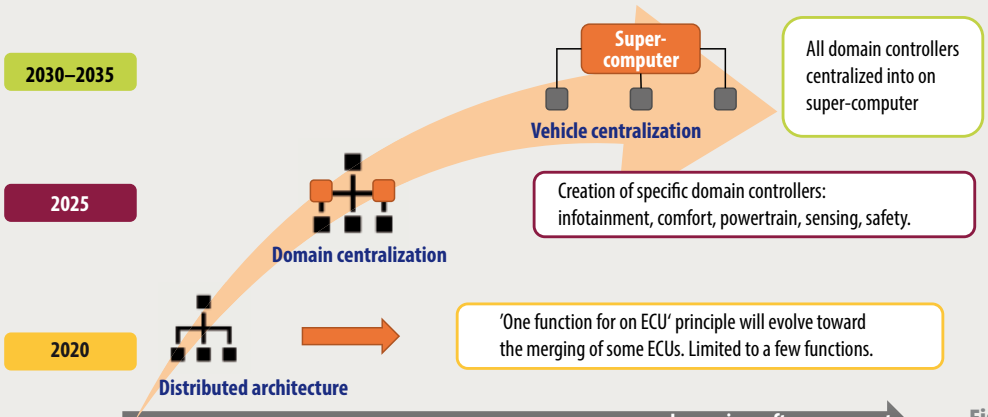


Fig. 1 E/E architecture evolution (Source all images: Yole Développement, [1])

Advanced driving assistance systems (ADAS) based on a combination of sensors and electronic control units (ECUs) have been developed to support the driver. These systems have helped to reduce road fatalities, alert the driver to potential problems and to avoid collisions.

ADAS relies mostly on radars and cameras with the corresponding ADAS computing to process the data generated by these sensors. Recently, the development of more powerful computing chips has allowed the development of more advanced functionalities.

ADAS functionalities were initially developed for safety but are now also used to enable some automated driving features. The implementation of such features requires the use of more sensors, more computing power and a more complex electric/electronic (E/E) architecture.

Greater ADAS functionality with a new E/E architecture

The top priority for OEMs is the development of ADAS for safety and automated driving features. The development of advanced emergency braking systems (AEB) is a great step to avoid forward collisions but still needs perfecting, as demonstrated by the American Automobile Association (AAA) in October 2019. Automated driving features in traffic jams or on the highway will also be developed by OEMs as consumers are looking for these to make driving easier. The development of such features will be a way for OEMs to differentiate themselves.

To do so, the addition of more sensors, more computing power and a new E/E architecture will be required. The E/E architecture is expected to evolve from the current distributed architecture to a domain centralized architecture and then further to a vehicle centralized architecture in the long term. However, there are two major drawbacks to this evolution: the communication bandwidth necessary to transport all of the 'raw' data to the centralized node expands to the order of Gigabits per second, and the computational expense of associating all of the raw data to possible targets rises significantly.

Traditionally, cars have been built using a distributed architecture with one ECU for each function. In order to enable automated driving features, however, OEMs will have to develop smarter ECUs or domain controllers to process the data that is simultaneously generated by multiple sensors.

Audi and Tesla have initiated this trend using a combination of radars, cameras, and a lidar in Audi's case. Audi

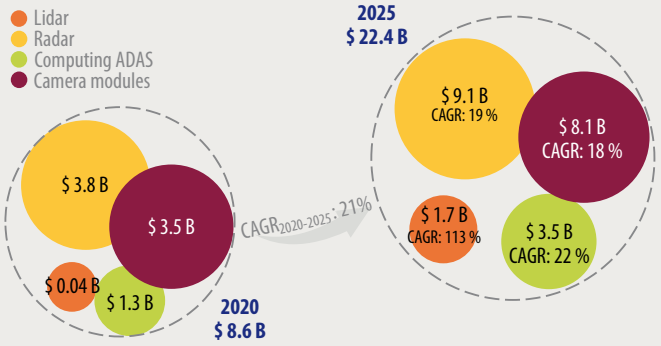


Fig. 2 2020-2025 sensor and computing for ADAS vehicles market revenue forecast

and Aptiv developed a domain controller to merge the generated data, the zFAS. Tesla goes one step further in the development of domain controllers with its Autopilot hardware. Autopilot is much more complex and has more functionality, with the ability to perform frequent over-the-air (OTA) software updates. Innovation brought by such features will be a key differentiator for OEMs looking to relaunch the market (see Fig. 1)

A sensor market worth $22.4B in 2025, led by radar

In 2020, it is expected that the global market for radar, cameras, lidar and computing ADAS will reach 8.6 billion US dollars [1]. Almost half of this revenue will be generated by radar with $ 3.8 B, followed by cameras with $ 3.5 B. Lidar will not be significant, accounting for 40 million dollars and computing ADAS will generate $ 1.3 B.

With high penetration rates of radar and cameras in cars, the associated revenues will recover rapidly from the coronavirus crisis. Radar market revenue is expected to surpass 2019's revenue in 2021 and will reach $ 9.1 B in 2025 at a compound annual growth rate of 19 %. Camera market revenue will also surpass 2019's revenue in 2021 and will reach $ 8.1 B in 2025 at a CAGR of 18 %. Revenue from computing ADAS market is expected to reach $ 3.5 B in 2025 at a CAGR of 22 %. Lidar revenue is quite limited today as only one OEM is implementing this sensor as an option in some of its cars. Other OEMs, such as BMW and Volvo, are expected to follow in the coming years, but the implementation will remain limited to high-end vehicles, and therefore limited volumes are expected. In this context, lidar market revenue is expected to reach $ 1.7 B (see Fig. 2).

Better sensor performance and more computing power to enable automated driving

Today, radar and cameras are the main sensors used by OEMs to develop safety and automated driving features. Consequently, the penetration rate of forward ADAS mono cameras will increase from 51 % in 2020 to 85 % in 2025. This type of camera is multipurpose and is used for AEB as well as for other functionalities in mainstream cars, such as lane-keeping assistance (LKA) and traffic sign recognition (TSR). For most advanced cars, forward ADAS triple cameras are being used to develop the advanced automated driving features like Tesla's.

Radar is keeping pace, and the technology is continuously improving. Starting in 2019, the use of 3D radar with a better vertical field of view has enabled detection of vehicle height. Radar performance will continue increasing with

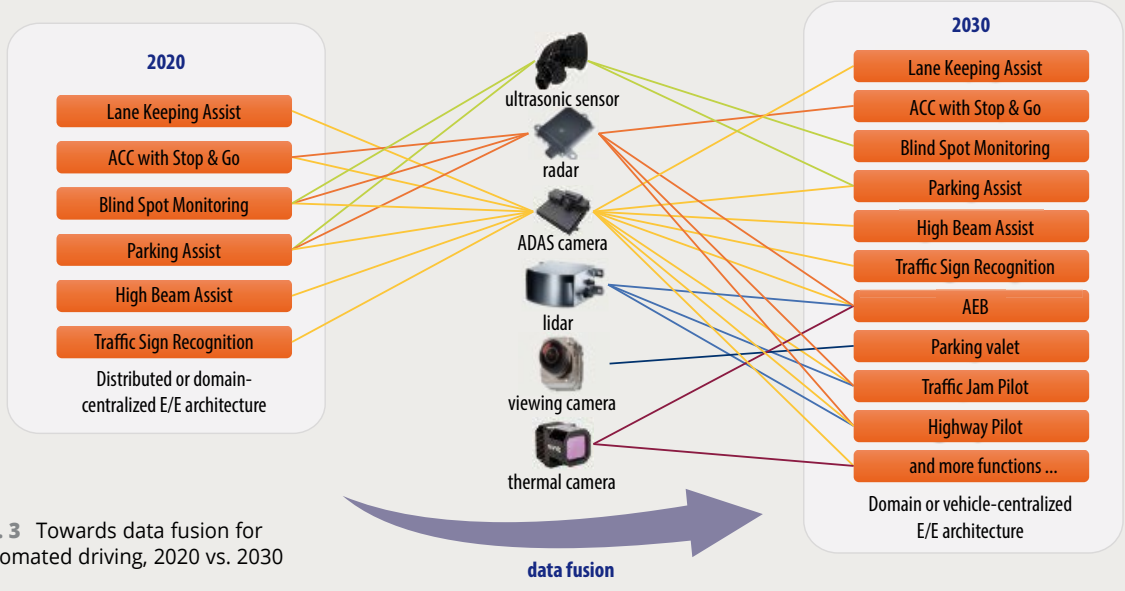


Fig. 3 Towards data fusion for automated driving, 2020 vs. 2030

the implementation of imaging radar expected to start in 2021.

On the lidar side, technology is moving from macro-mechanical scanning to MEMS scanning and flash. Most lidar manufacturers are involved in these solid-state technologies. One of the issues for lidar is its integration into the vehicle. Today, its integration in the grill may not be the ideal solution and two other positions, in headlamps or behind the windshield, are usually targeted by tier-1s and OEMs. Volvo recently unveiled its partnership with Luminar to integrate a lidar on top of the windshield for its next generation of cars (cf. p. 6). This shows a third possible position for lidar and, in contrast to Audi and BMW, they are using a lidar with a wavelength of 1550 nm from a fiber laser. This wavelength will allow long range detection, but Volvo and Luminar will have to work on the cost of the lidar as fiber lasers are much more expensive than the widely used 905 nm laser diodes. Luminar said that they are aiming for a cost of around 500 dollars for ADAS applications, which is lower than the current cost of the Valeo Scala lidar, so technical optimization and high volume will be required to reach that target.

More R&D will be necessary to reduce the size of the sensor and to realize this lidar integration. The requirement for aesthetic appeal is one of the main differences between robotic vehicles and ADAS vehicles. Perfect integration of sensors into the bodywork is required as aesthetics are essential in ADAS vehicles. Another issue for lidar is the need to process the large quantity of data it generates. A final issue with lidar is its cost compared to the two other technologies – it is about ten times costlier than an ADAS mono camera. Alongside size reduction, cost reduction will also be required for significant adoption by OEMs.

Because of the need for high performance, reliability, redundancy and safety, computing hardware and related software for autonomous vehicles have improved impressively in the last five years. ADAS hardware solutions have mainly been built around FPGA for development and pre-processing purposes. Then, with the introduction of the Mobileye solutions, vision processors took the lead, principally because they were easier to use, particularly on the software side. With the multiplication of sensors, it increasingly makes sense today to create a fusion platform for ADAS functionalities. FPGA will stay in place for high computing power for as long as there is a need for fast, reprogrammable software. It will then either be replaced by an ASIC or its functions integrated into a fusion platform such as that offered by Renesas or NVidia. Globally, high computing power at over 25 tera-operations per second (Tops), will be necessary to gather data from all ADAS sensors so that the system will be able to clearly distinguish and classify objects on the road, such as pedestrians, cyclists, cars or any other potential danger. The combination of a centralized architecture and high computing power will enable the creation of more automated driving functions. (see Fig. 3).

[1] Sensing and Computing for ADAS vehicle 2020 report, Yole Développement, 2020

Authors

Pierrick Boulay works as a market and technology analyst of solid-state lighting and lighting systems and carries out technical, economic, and marketing analyses as part of the photonics, sensing and display division at Yole Développement. Pierrick has authored several reports and custom analyses dedicated to topics such as general lighting, automotive lighting, lidar, IR LEDs, UV LEDs and VCSELs. Prior to Yole, Pierrick worked in several companies where he developed his knowledge of general lighting and of automotive lighting. In the past, he mostly worked in R&D departments on LED lighting applications. Pierrick holds a master's degree in electronics (ESEO – Angers, France).

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More Flexibility and Sharp Edges

Laser technologies extend the freedom of day-night design and can also be applied to chrome (III)

Marco Läufle

Today, many components have to present an opaque surface in daytime design and be transparent in nighttime design, like this backlit element manufactured by KTB for the instrument panel on the passenger side of the Audi A6. (Source all images: Kunststofftechnik Bernt)

Manufacturers swear by plastic for panels, knobs and controls in modern vehicles because the material is lighter than metal and the manufacturing and processing costs are comparatively low. In order to still meet the requirements for good haptics, scratch resistance and a noble design, the plastic components are electroplated to give them a metallic surface. However, the industry is facing new challenges that make it necessary to adapt the electroplating processes.

Among other things, the demands on the design and functionality of these control elements are increasing. For example, many of them have to be provided with partly multicolored symbols and be easily recognizable at night, i.e. they must be designed in a day-night design. Kunststofftechnik Bernt meets these challenges with an adapted process chain in which several lasers play a special role. The laser technology allows a high degree of flexibility in design. In addition, symbols, fonts and structures can be implemented very sharply and cleanly to generate a high-quality appearance.

Multicolored symbols that are backlit, finely structured surfaces and high-quality gloss with a convincing feel: these are just a few of the requirements that automobile manufacturers place today for a customizable interior ambience. For electroplating companies that process and finish the necessary parts before final assembly, this increasingly means developing and adapting their own processes to meet the increasing quality demands. Precision and attention to detail in production should be felt and visible in the vehicle. This makes it all the more important that the contrast between the surfaces and symbols does not run or that they appear unclean or are unevenly backlit in the night design. But this requires new, mature processes that go beyond normal printing methods or the simple manufacture of the components using multicomponent technology.

With multicomponent technology, it is possible to let the transparent component pass through to the A-side surface and thus create backlit symbols or structures. However, there are considerable limits to the richness of detail and the fineness of the structures with this technology. Conventional printing

Since KTB has its own injection molding facilities, raw parts consisting of three components can also be produced on site. In addition to 2 K components, these can also be easily structured and processed with a laser. Here: a 3 K panel in the multifunction steering wheel of the Mercedes S-Class

technologies generally use pad printing to print a covering coating on the surface of the component to keep the illuminated structures free of the metal layer. However, these methods have the disadvantage that the edges of the translucent structures look washed out and imprecise. Laser technologies offer an alternative. Although they involve a higher initial investment, the running costs can be limited, as the otherwise necessary production and provision of new or different tools can be dispensed with. Laser marking allows several different variants with different symbols to be created on the basis of a component. In theory, this technology also allows the personalization of components.

However, an injection-molded part cannot simply be coated with the desired metal optics and then directly processed with a laser. The applied finish is simply too thick and if the entire metal layer were treated, the underlying plastic would melt.

For this reason, Kunststofftechnik Bernt uses a process in which the component is ejected from the system after pretreatment before the actual electroplating process and then processed with a laser.

The pretreatment layer (electroless nickel) is a very thin layer that can still be easily processed with the laser without excessive heat input into the plastic component. Due to the fast and punctual processing, very fine geometries and symbols can be defined and worked out. The high precision ensures good reproducibility, so that automation is both sensible and possible for large quantities.

Hidden line: more flexibility in day-and-night design

But there are further challenges: today, many components have to present a closed surface in daytime design and be transparent in night-time design. This is achieved with many fine structures, such as rectangles with an edge length of less than 0.5 mm. The production of such structures requires laser systems of the highest precision and very fast scanning heads. Kunststofftechnik Bernt has several such precision lasers. In principle, this method is suitable for all components that are to be illuminated in day-night design. How precisely the laser can structure can be shown with a magnification of a typical component. If, for example, the elongated area of a decorative panel is to be fitted with fine diamonds measuring 200 × 200 µm and spaced 50 µm apart, the laser can be moved very close to the edge surface without risking inaccuracies. The high repetition accuracy means that this component can be used to produce around 40,000 squares in a few minutes, precisely and reproducibly.

3-shot molding technology: multicolour day-night design

Since Kunststofftechnik Bernt has its own injection molding facilities, raw parts consisting of three components can also be produced on site. In addition to 2 K components, these can also be easily structured and processed with a laser. An additional component is useful, for example, to avoid creaking noises and to enable active steering wheel lighting. Active steering wheel lighting means that individual symbols are illuminated separately from the others. This requires light-tight bulkheads that prevent extraneous light from illuminating the other symbols. In both cases, an intermediate layer is required which serves either as a noise buffer or as a light barrier. The lowest layer under the symbols is formed by light guide components made of transparent polycarbonate (PC) which scatter the light and direct it to the surface. The middle layer is black PC, which acts as a light barrier or light labyrinth. It separates the illuminated areas from the non-illuminated areas. The third component is a plastic (for example ABS/PC), which can then be electroplated. Fully automatic camera control in the injection molding, laser and final quality control process stages checks the radioscopy and the symbol position.

Company

Kunststofftechnik Bernt

Kunststofftechnik Bernt GmbH is a competent, reliable and certified development partner and supplier of high-quality plastic parts. The company has extensive expertise at all stages of the value-added chain, from parts development and tool design to mold making, plastic injection molding and surface finishing in its own plastic electroplating shop. The range of services extends from precise technical functional parts to surface finishing; often it includes the production of complete assemblies. New technologies and process applications such as lasers and automation components are also used. Customers include companies with a focus on the automotive, household appliance and sanitary industries. The company is based in Kaufbeuren and employs around 300 people.

www.ktbernt.de

In the Litho-Graphics method, a UV-curing covering varnish is applied in the area of the symbol. This can be done with different methods. In addition to a spray application such as lacquering, for example, printing with Tampoprint has proven to be a successful method.

Illuminated brush: brushed surfaces with surface light effect

In addition to an extended day-night design, car manufacturers are increasingly requesting brushed surfaces on the fascia panels and other components to achieve a noble, aluminum-like appearance. Kunststofftechnik Bernt has developed the Textured Plating Technology for this purpose. Here, injection molded parts are produced with a tool in which the visible side (often the nozzle side of the tool) is structured by laser processing in such a way that the resulting molded part receives a brush structure. However, when such a part is conventionally electroplated, the copper layer in particular provides a certain levelling of the structure. This is intentional with normal components, since slight surface defects and, for example, conjoinings are concealed, i.e. become less visible. However, brushed components look more artificial and not really brushed. In a coating process specially developed by Kunststofftechnik Bernt for this application, this levelling is reduced to a minimum, resulting in components that only a specialist can distinguish from components that are actually brushed.

With Illuminated Brush, lighting can now be combined with this technology. The use of lasers on the component has the decisive advantage that the brush structure can be illuminated over a large area by removing the electroless nickel layer in the direction of the brush structure. The process can be applied to the entire component as well as just to parts of it.

Litho-Graphics: curing symbols and graphics with laser

A further development of the proven laser process from Kunststofftechnik Bernt is pursuing two main goals. On the one hand, a process should be offered at lower cost and on the other hand, flexibility with regard to design and coloring should be increased. However, accuracy and edge sharpness should be at a similar level if possible. This has been achieved with the development of the Litho-Graphics process. In this method, a UV-curing covering varnish is applied in the area of the symbol. This can be done with different methods. In addition to a spray application such as lacquering, for example, tampon printing has proven to be a successful method. As far as accuracy and edge sharpness are concerned, this process cannot reach the level of laser technology by far. However, this is not necessary at all, as the UV coating is only cured with a UV laser exactly where the symbol is needed. Excess, uncured varnish is then cleaned off. On the cost side, the fact that the components can now be electroplated in one process and do not have to be discharged from the electroplating plant after pretreatment is a positive factor. This is due to the fact that the process described above can be carried out directly on the raw injection molding part. At the same time, it is also the laser in Litho-Graphics that ensures the flexibility, accuracy and edge sharpness of the process. Multicolor capability has now been added during the development of the process. In the printing process, up to four different colors can be applied in one step. In addition to the classic motifs such as the window regulator symbol, typical multicolored identification marks can now also be added, such as the manufacturer's brand symbols or flags that are translucent.

REACH: chrome (III) as a possible alternative to chrome (VI)

Since September 2017, chromium (VI) can only be used under very strict regulations and for a limited time. Current plans assume that authorization will be granted until at least 2024. Kunststofftechnik Bernt is already working intensively on alternatives. Since September 2019 all the technologies described above, as well as conventional components, have been available with a chrome (III) coating. The first components are already in series production.

Conclusion

Increasing demands on the design as well as stricter requirements by the legislator with regard to the choice of materials should ideally be met in electroplating by adapting the individual process steps and incorporating new technologies, even if these may initially mean a higher investment. Taking laser technology as an example, it is clear that the greater flexibility in processing achieved as a result can have a positive effect on the running costs and the final quality of the product. In addition, by combining already optimized processes, it is also possible to deliver additional functionality with high design and material quality. For example, 3K technology, brushed surfaces and different day and night design technologies can be combined well.

Author

Marco Läufle, born in 1987, completed his training as a process mechanic specializing in plastics and rubber technology in 2005. After a few years of industrial practice, he began further training as a technician in the field of plastics technology, which he successfully completed in 2010. He has been working for Kunststofftechnik Bernt as a project manager and key account manager since 2012. During this time, he has already set accents in the development and implementation of innovations. Since 2019, he has been exclusively responsible for process development and innovation.

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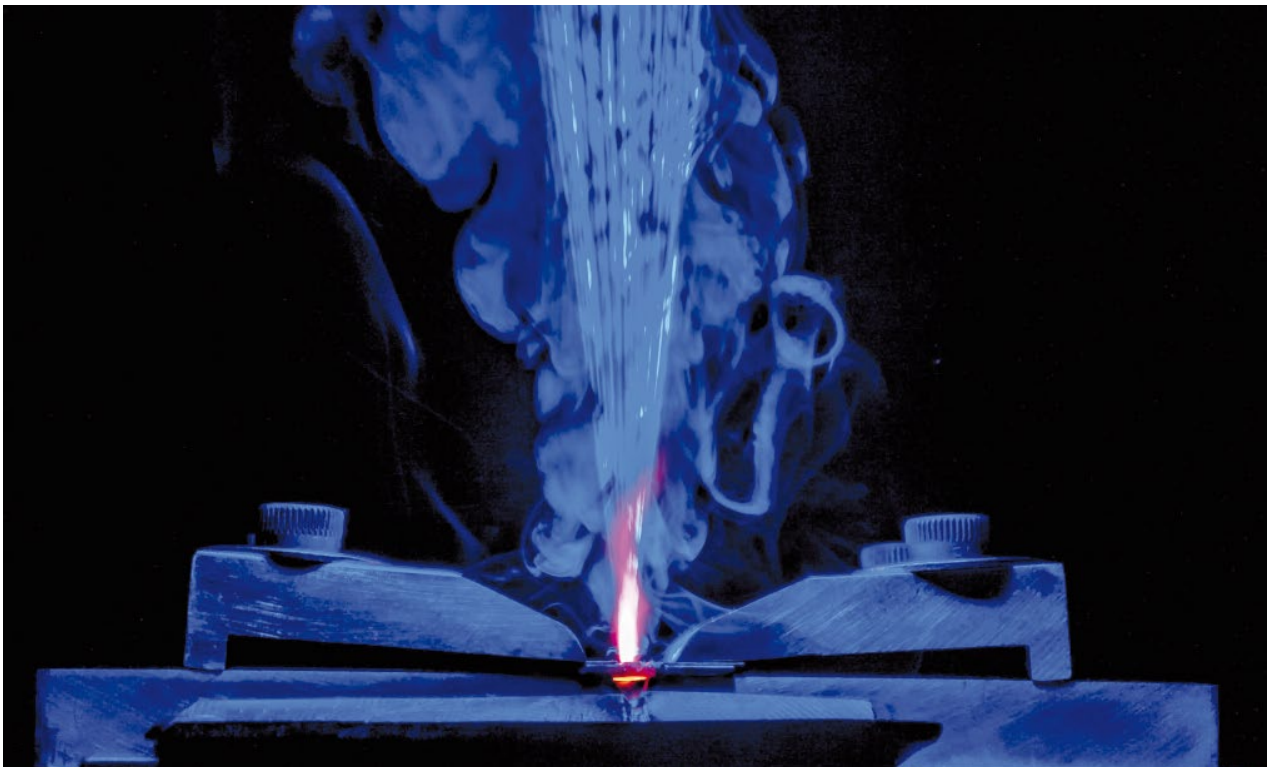
Blue Lasers Move Deeper Into Applications

Higher power and brightness enable new capabilities

Jean-Michel Pelaprat, Matthew Finuf, Richard Gleeson, and Mark Zediker



Source all images: Nuburu

In the few years that blue lasers have been on the market, they have demonstrated unprecedented materials processing capabilities. Blue lasers bring unmatched speed and quality to the welding of copper, aluminum, and other reflective metals, and those advantages are being applied to consumer electronics, battery fabrication, and e-mobility production. The latest improvements in power and brightness allow the blue laser to be seamlessly integrated into standard scanning systems, opening up an even wider range of applications.

The first industrially relevant blue laser was released in 2017. It quickly demonstrated its unique advantages in materials processing. Initial product offerings showcased the blue laser's unprecedented ability to weld copper both faster and better than alternative solutions, but relatively low power limited its potential applications. Now with a power of 1,500 watts and a beam parameter product (BPP) of 11 mm-mrad, the blue laser has reached a key milestone: for the first time, the brightness is high enough to be integrated with standard industrial scanning systems.

The adoption of the blue laser is driven by two primary characteristics: the fundamental physics of absorption, and laser design that delivers high power density. Copper absorbs blue light far better than it absorbs other wavelengths, both infrared (IR) and visible. That leads directly to performance advantages for materials processing. (See infobox: Blue Basics) But materials processing performance relies upon more than the choice of wavelength; it depends upon the power density delivered to the active site. (See infobox: Focus by Design)

Continuous growth of the blue laser's achievable power density has led to a corresponding growth in the range of applications it can address. Those applications span a range of industries from consumer electronics to battery fabrication to e-mobility and beyond. Each of these application spaces leverages both the fundamental physics of blue and the laser's design features to bring unprecedented productivity.

Consumer electronics

In 2014, the number of active mobile devices exceeded the global popula-

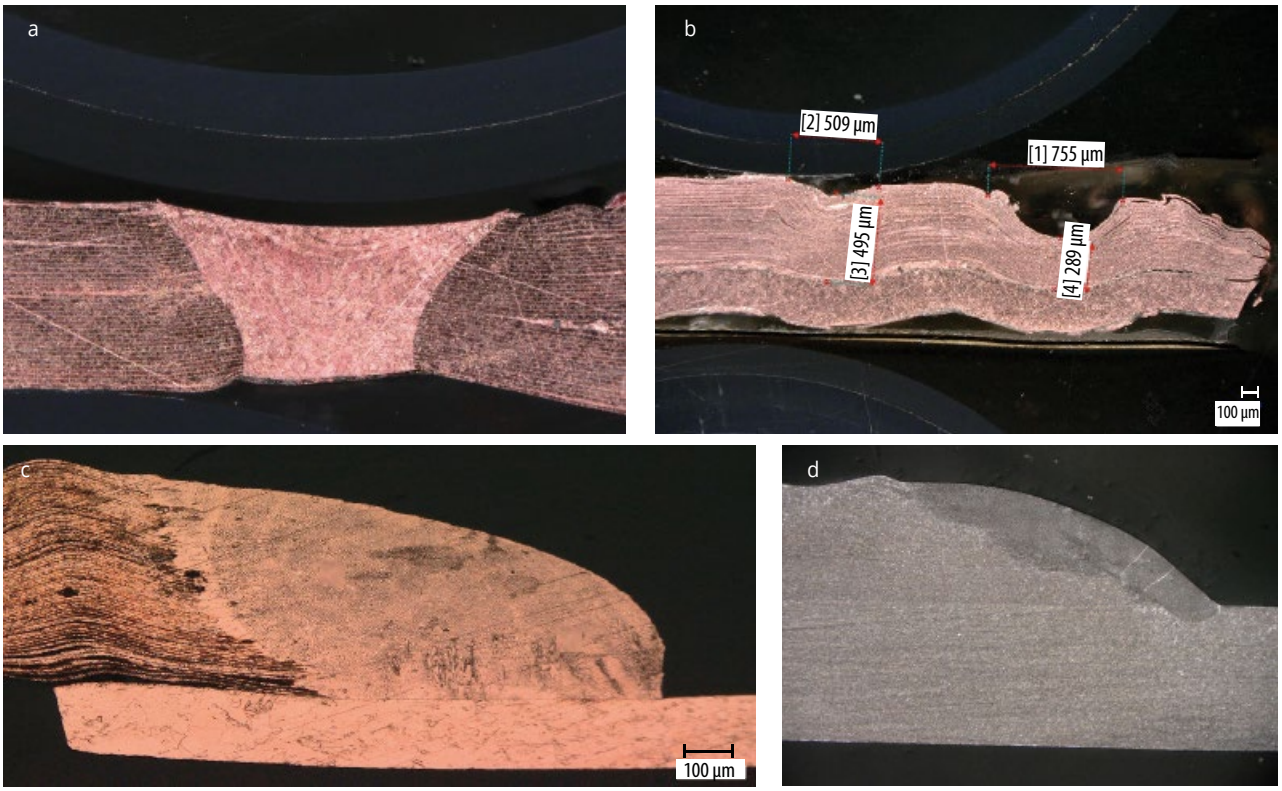


Fig. 1 The blue laser joins forty two 8-µm foils with no defects (a). In contrast an ultrasonic weld of a similar geometry (b). In a single operation, the blue laser welded seventy 8-µm copper foils to a 400-µm copper tab (c), and joined these forty 18-µm aluminum foils to a 600-µm tab.

tion [1]. Add in televisions, laptops, and other consumer products, and it is easy to see why the industry needs efficiency. These devices typically require the joining of copper-to-copper, copper-to-steel, or steel-to-steel. Although not typically requiring high power, these applications demand consistent, flat joints. A 200 W, 15 mm · mrad laser provides enough power to rapidly join these materials with the required uniformity.

Some consumer electronics production lines, however, streamline efficiency with scanning systems. A scanning system converts a change in angle – using mirror rotation, for example – into a change in position on the output side. 'F-theta' scanning lenses maintain beam quality across the field, but also introduce unavoidable beam expansion. That reduces power density, and the 200 W laser will no longer suffice.

The latest product release, a 1500 W, 11 mm-mrad blue laser, is the first blue laser capable of seamless integration with such scanning systems [2]. For example, when integrated with an industry standard 320 mm working distance scanner, with a 110 × 110 mm field, the blue laser yields a 400 µm spot with the power density required to rapidly produce defect-free welds.

Batteries

Growing emphasis on clean energy is driving the production of rechargeable batteries for dense and portable energy storage. According to analysts Benchmark Mineral Intelligence, lithium-ion battery production is on track to meet the needs of 39 million electric vehicles by 2029 [3]. These batteries come in different categories: cylindrical, pouch, and prismatic designs. Each is built from the same basic unit, a pair of electrodes separated by an electrolyte, sandwiched between two thin metal collector foils. Various joining operations can be necessary to connect (in order of thickness) foil stacks, foils to tabs, tabs to the exterior case, busbars, and the case joints themselves.

For example, a prismatic or pouch cell may require joining forty or eighty 8 µm thick copper foils together. Speed is key, because automated factories may produce hundreds of thousands of batteries each day, but defects reduce yield, so quality cannot be compromised. As shown in Fig. 1a, the blue laser joins forty-two foils with no defects, a dramatic improvement from ultrasonic joining, as seen in Fig.1b. The foils are then joined to a thicker tab, one or two hundred microns thick. Ultrasonic welding requires a separate welding head matched to the new dimensions. The

Company

Nuburu

Nuburu is leading the transformation to a world of high-speed, high quality metal machining and processing using a first-to-market class of high-power, high-performance blue lasers.
Nuburu technology breaks new ground by enabling radical gains in speed and quality in existing metal processes, as well as also unlocking a path to new designs for both conventional laser-metal machining and additive manufacturing (3D printing). Spatter-free copper welding enables a large number of new applications not addressable with infrared lasers.

www.nuburu.net

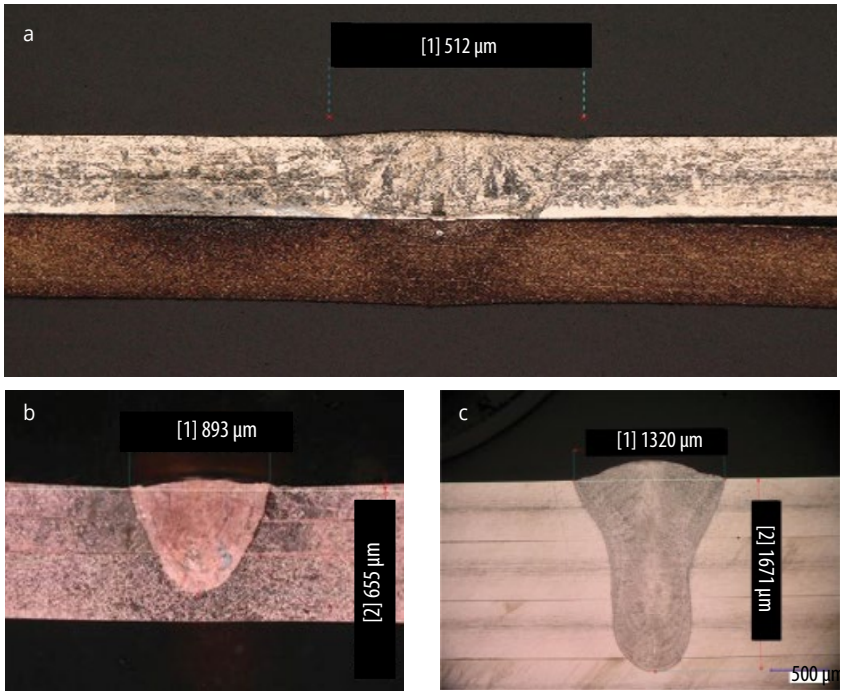


Fig. 2 Five hundred watts of blue laser power joins a variety of materials with no defects, including 0.3 mm copper to 0.3 mm stainless steel (a); 200 µm copper / 200 µm copper / 400 µm copper (b); and four 0.5 mm stainless steel plates (c).

blue laser has no such limitation and it doesn't even require two manufacturing steps, as seen in Fig. 1c and 1d where the laser connects foils and tabs in a single operation. The blue laser produces that same quality when welding aluminum.

The blue laser's speed and quality advantages also apply when joining tabs to stainless steel casing, done for cylindrical cells. The most recent product release even makes it possible to join mm-range thicknesses of copper – as in busbars – and mm-range thicknesses of stainless steel – as in battery casings. The range of possibilities is illustrated in Fig. 2a–c. Alternative methods, including resistance, IR laser, metal inert gas (MIG), tungsten inert gas (TIG), and ultrasonic welding, cannot match the blue laser's speed and quality. The same blue laser can do all those joining operations simply by adjusting process parameters, bringing both simplicity and reliability to the production line.

E-mobility

Electrical vehicles have already made impressive inroads into the market, but more is on the way. Bloomberg NEF predicts well over 100 million electric

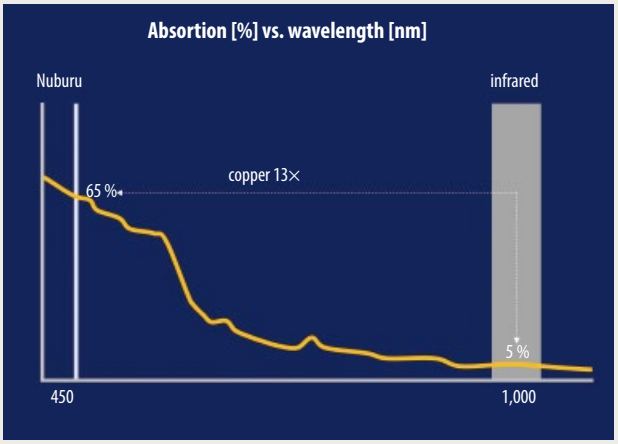
Infobox

Blue Basics

A material's optical properties are determined both by the electronic structure of a single element, and the manner in which electrons are shared among atoms in the material. That is, it depends on both the type of atom and the phase of the bulk material. Because solid copper absorbs only 5 % of IR, an IR laser must carry 20× more energy than actually goes into melting the copper. When the copper changes to liquid phase its IR absorption becomes much higher. The copper absorbs so much more of the IR energy that it vaporizes in tiny explosions, scattering particles around the joint, and leaving holes behind. The scattered particles are called spatter, and the holes are known as voids or perforations. Collectively, those defects can compromise the electrical and mechanical fidelity of a joint.

Using IR to weld copper is a tricky game of maximizing the power until the melt is initiated, then minimizing the power as quickly as possible to maintain the melt, then delivering maximum power a bit farther along. It's an impossible game to win; there's too wide a difference between the energy required to start the weld and the energy to maintain it.

With blue, that difference disappears. Copper absorbs blue light 13 times better than it absorbs IR, but just as importantly, liquid copper absorbs just about the same percentage as solid copper (see figure above). This is the foundation of the blue laser's unmatched combination of speed and quality. It also means the blue laser produces fast, high quality welds with a wide range of spot size, exposure time, and power. That wide process window makes it straightforward to accommodate different part geometries and thicknesses, and even addresses the difficult challenge of welding dissimilar materials.



Key Metals	Blue to IR Absorption Ratio
gold	66 ×
copper	13 ×
aluminium 1100	3 ×
nickel	1.5 ×
aluminium 1100	1.3 ×

Copper absorbs more than 13× more blue energy than IR, and 20 % more than blue than green.

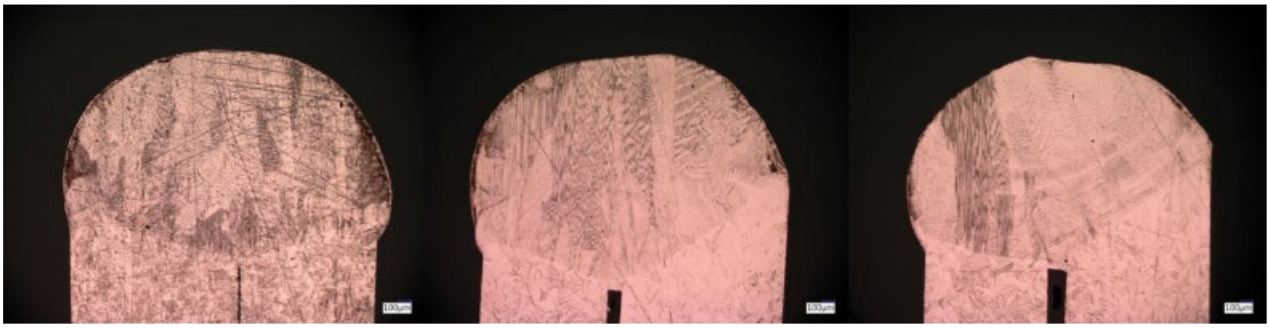


Fig. 3 Bar winding connections are essential for high-fill-factor electric motors, and the blue laser can produce clean hairpin welds such as these 1 mm / 2 mm copper joints.

vehicles will be on the road by 2030[4]. Batteries are one piece of the e-mobility picture, but only one piece. The most prominent other component is the electric motor itself.

Bar winding motors have become the de facto standard for electric vehicle drive trains. They replace standard wire winding, with a higher fill factor design that increases both electrical efficiency and thermal conduction. They are fabricated by inserting pre-formed copper wires into slots in the stator. The preform is more or less U-shaped, so when the wires are inserted they each leave two unconnected ends protruding from the stator.

All the protruding wires must be connected, and, again, speed and quality are equally important. For this application it is also important to minimize the heat-affected zone, as too much heat will degrade the insulation. As seen in Fig. 3, the blue laser welds the 1 mm × 2 mm joints quickly, with no defects, and little thermal impact to the assembly – all improvements over TIG or very high-power IR laser alternatives.

In addition to batteries and motors, sensors, power electronics, and lighting also all require rapid, high-quality metal joints. The wide process window of the blue laser allows it to be applied to each of these systems.

Blue skies ahead

In only a few years, the blue laser has demonstrated an unprecedented capability to rapidly produce high-quality copper joints. It has also demonstrated the same kind of performance for aluminum, stainless steel, gold, and other metals. The available output power has increased by an order of magnitude and the BPP for comparable power has improved by a factor of five. The GaN diodes at the heart of the blue laser are expected to follow the path of GaAs, just about doubling in efficiency. Combining that with an evolving system design leads to a roadmap of increasing capabilities.

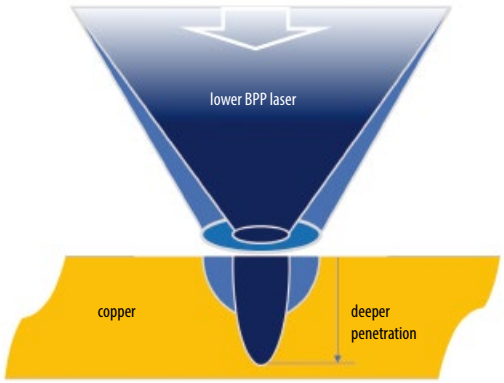
Capability alone, however, does not guarantee suitability. Any product looking for a place on the factory floor must exhibit other qualities: reliability, robustness, and value. The blue laser has already demonstrated an operational lifetime of 25,000 hours and counting. The diodes at its heart have an anticipated lifetime of 65,000 hours, so the system's reliability is not achieved by chance.

Infobox

Focus by Design

The processing advantage of the blue laser is founded on fundamental physics, but can only realized through system design. All materials processing applications depend upon the transfer of energy into a workpiece. The goal is to transfer enough energy into a target material to accomplish the task but not so much energy that defects creep in. It's a simple task, conceptually, but the simple concept hides a depth of possible complications. In welding, for example, at the same time as energy is being funneled into a location, thermal conduction is spreading the energy away. And within the liquid melt pool, fluid flow leads to an uneven distribution of energy. A wide process window helps to avoid defects, but the process must be maintained within that window. Power density is the key to controlling the process.

Power density is simply the power per unit area, and it is tempting to believe that a laser's power density can always be increased by bringing it to a tighter focus.



A lower BPP leads to a smaller spot size and a consequently higher power density. That results in deeper penetration and/or faster welding.

That is not the case. A laser's brightness cannot be increased beyond what's inherent in the laser. The laser spot can be enlarged indefinitely, but the smallest spot size is determined by the laser's initial beam parameter product, or BPP.

The BPP is the product of the beam radius and divergence half-angle, that is, roughly the beam size and the beam spread. The BPP cannot be improved by downstream optics, and it has a direct effect on achievable power density – and, thus, system performance. For example, consider the performance of two 500 W 450 nm lasers, identical except Laser A has a BPP of 60 mm · mrad while Laser B's BPP is 30 mm · mrad. As shown in the figure above, Laser B will penetrate almost twice as deep into copper, or penetrate to the same depth, but three to four times faster.

Robustness is also by design. It starts with the compact form factor; the laser fits in a small stand alone housing and the delivery optics are designed with the factory environment in mind. Should repair be necessary, the blue laser is designed for 'plug and play' module replacement. The efficient design makes the blue laser an economical choice as well.

After only a few years on the market, the blue laser has already demonstrated its value for applications in consumer electronics, battery fabrication, and e-mobility applications. Its flexibility and capability make it a good fit in a variety of fields. As the capabilities of the blue laser continue to expand, it is likely to find applications in aerospace, research facilities, healthcare, and other fields.

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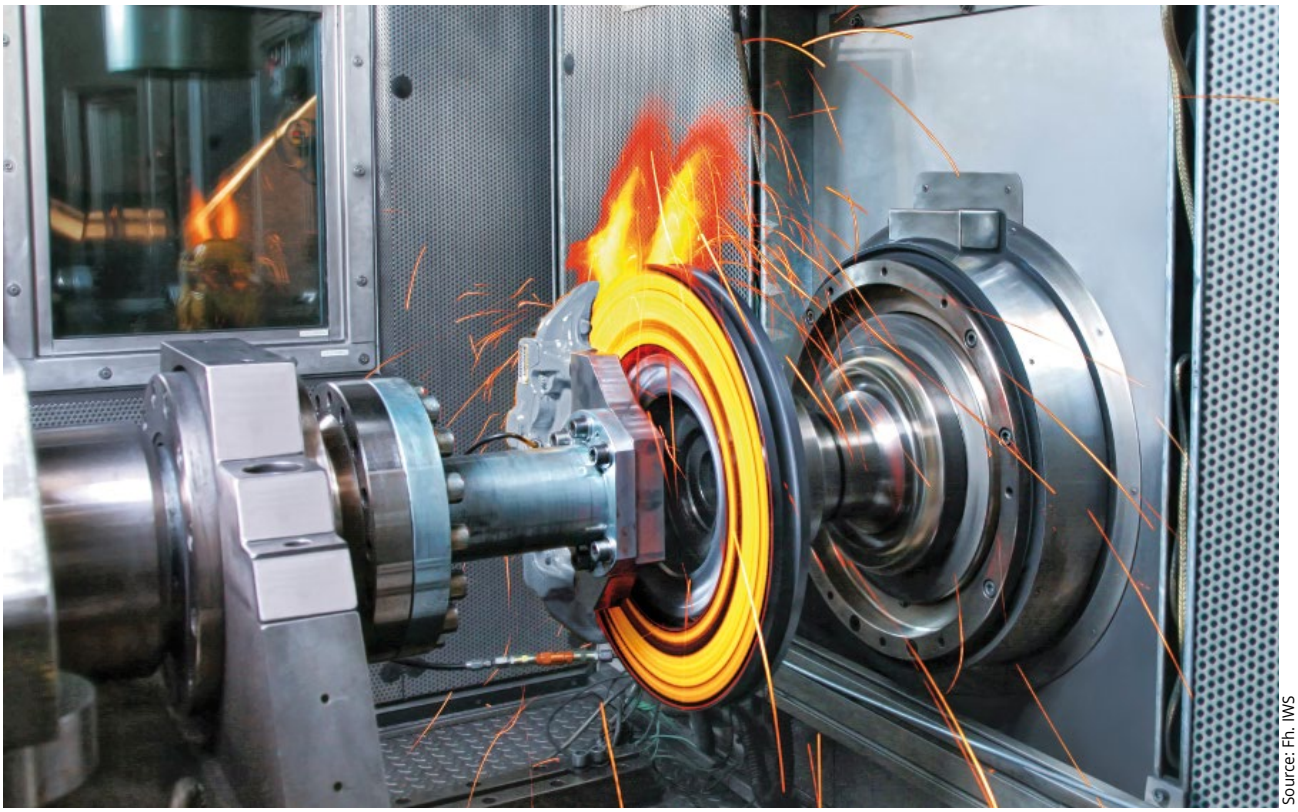
Less CO_2 and Fine Dust Emissions in Automotive

High-power laser cladding as a cost-effective rotor coating solution

Maria Barbosa, René Bischoff, Wilfried Strauß, Holger Hillig, Steffen Nowotny, Christoph Leyens



Source: Fh. IWS

There is increasing pressure on the automotive industry for further reduction of CO_2 and particulate (PM10, PM2.5) emissions. One of the main issues is the fine dust resulting from the wear of the brake disc/brake pads, which is considered to be a major source of non-exhaust traffic-related emissions, particularly in urban locations. Carbide coatings are the state-of-art solution for controlling rotor wear. The challenge of cost-effective serial production for automotive applications can be mastered by high power laser cladding.

Its high melting point, excellent thermal conductivity and heat storage capacity, and damping properties, combined with its ease of casting and machinability make gray cast iron (GCI) the material of choice for standard brake discs. Unfortunately it is also characterized by very poor corrosion and wear resistance, which not only considerably diminish its performance and service time, but also lead to extensive fine dust emissions that may have adverse effects on human health and the environment. Quoting from an EU report, brake wear contributes 16 – 55 % by mass of total non-exhaust traffic related PM10 emissions in urban environments, while on freeways this contribution is significantly lower (~3 % by mass) due to lower braking frequency [1].

Beside the investigation of alternative materials, the surface treatment of GCI brake rotors has presented itself as a promising solution to control the wear rate and, therefore, actively reduce the fine dust emissions. A literature review of different coating techniques and materials being applied to brake discs has been conducted by Aranke et al. [2].

One of these techniques is laser cladding

Laser cladding enables the deposition of feedstock materials with the aim of not only achieving a metallurgical bonding between substrate and coating but also simultaneously minimizing the mixing of elements contained in the substrate and feedstock [3].

During the process, the material is fed into the melt pool on the substrate

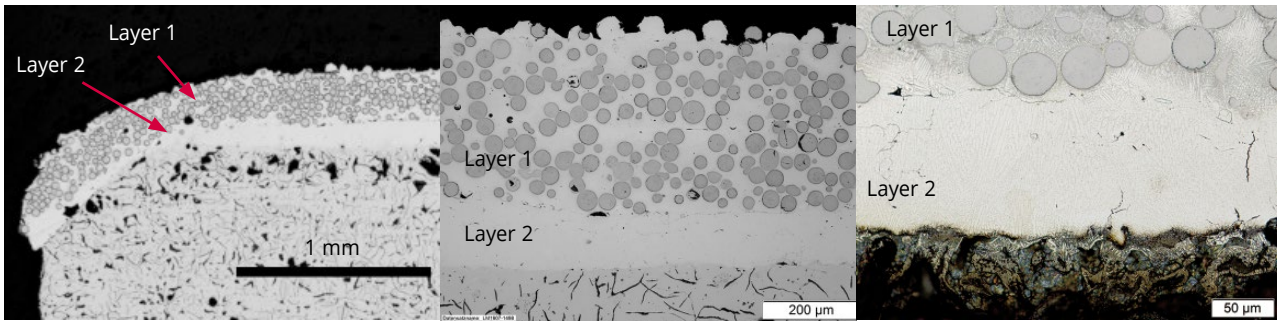


Fig. 1 Cross-section of a GCI brake disc coated with WC-316L. The coatings where deposited using an IWS high-power set-up. Layer 1: corrosion resistant coating of Inconel 625; Layer 2: wear resistant coating consisting of WC in a stainless steel matrix. Left: detail of the angled finishing zone, with a very homogenous coating result. Middle: high magnification micrograph showing the carbides well embedded in the metal matrix. Right: detail of the interface in etched condition. (Source: Fraunhofer IWS).

surface coaxially with the laser beam. The desired coating properties can be achieved by appropriate selection and control of processing parameters such as laser power density, beam diameter, travel speed, feedstock feeding rate, etc. Laser cladding has been used in industrial manufacturing for many years to precisely apply tailored coatings and three-dimensional deposits onto surfaces for repair as well as for the additive, layer-by-layer fabrication of high value parts.

For high volume mass production, of disc brakes for example, conventional laser cladding is unable to fulfill industrial cost targets. Therefore, two fundamentally different approaches have recently been developed to significantly improve the productivity of the cladding process:

- High-speed laser cladding [4–6], utilizing high laser energy densities to melt the powder particles, combined with rapid solidification of the melt pool, and
- High feeding rate laser cladding [7], combining low energy density with very high powder feed rates

The proper control of melt pool conditions is paramount to avoid decarburization and melting of carbide particles, while at the same time achieving high productivity and a robust coating processing window. The high productivity laser cladding process developed by Fraunhofer IWS Dresden has enabled industrial scale, high quality tungsten carbide (WC) coating deposition (Fig. 1). A diode laser (>15 kW) and a relatively large spot nozzle (>10 mm) combined with powder feeding rates in excess of 100 g/min provide homogeneous energy distribution and a stable melt pool. The process is insensitive to fluctuations, which makes it very attractive for serial production.

Additionally, the longer lasting melt pool allows the use of powders with higher and broader particle size distribution, significantly reducing the overall cost per kilo of the powder and, consequently, the cost per cubic centimeter of the coating. In addition, as a very efficient heat source, the diode laser provides a limited heat-affected zone, which is imperative for coating GCI as well as beneficial for disc brake performance.

GCI with lamellar graphite is a relatively challenging material to clad, not only due to a mismatch in the coefficient of thermal expansion, but also due to the higher affinity of carbon for absorption of the laser light, which leads to material sublimation and the formation of defects upon the interface. This can be overcome by appropriate pre-processing.

After the GCI brake disc surface has been prepared, a first layer of about 125 µm thickness of a corrosion resistant alloy, such as Inconel 625 or stainless steel, is applied. This coating must be crack-free to guarantee the corrosion resistance of the GCI base material during the harsh working conditions to which a brake is subjected during its life cycle. The second layer is the wear resistant top-coat, in this case a carbide material (WC, TiC or Cr_2C_3) in a stainless steel matrix, of about 200 µm is deposited. Here, the presence of a certain number of cracks is tolerable and even advantageous for the coating performance as it will allow compensation of the internal stresses induced by the high thermal cycle characteristics of the braking process. The vertical

Institute

Fraunhofer Institute for Material and Beam Technology IWS

The Fraunhofer-Institut für Werkstoff- und Strahltechnik IWS Dresden stands for innovations in laser and surface technology. IWS offers one-stop solutions ranging from the development of new processes to implementation into production up to application-oriented support. The fields of systems technology and process simulation complement the core competencies. The technology fields include PVD and nanotechnology, chemical surface and reaction technology, thermal surface technology, generation and printing, joining, laser ablation and separation as well as microtechnology.

www.iws.fraunhofer.de

Company

Fritz Winter Eisengießerei

The Fritz Winter Foundry has been a supplier and partner for the global automotive, commercial vehicle and hydraulic industry since 1951. The company develops and manufactures rough and finished part components such as brake discs, as well as complex system components, increasingly in a lightweight design.

www.fritzwinter.de

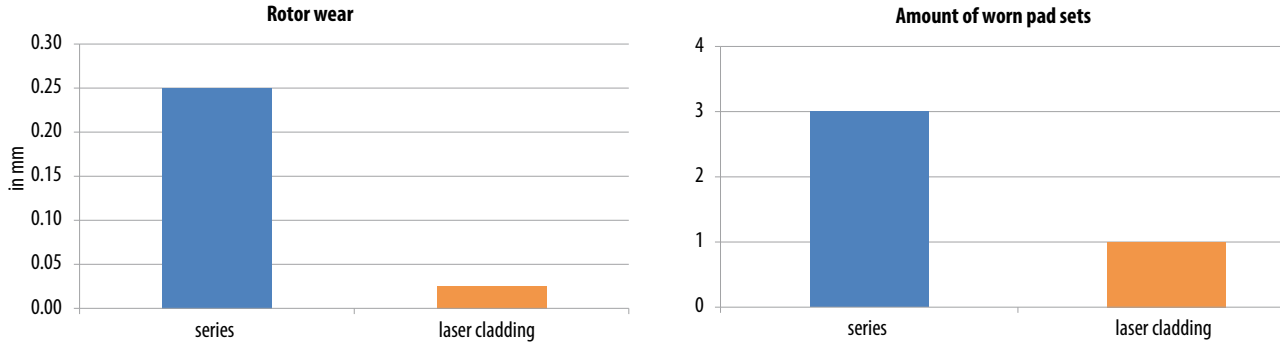


Fig. 2 Comparison of the performance of a standard brake disc with a coated one on the Dyno test. The left graphic shows the material loss (in mm) on the rotor surface and the graphic on the right the amount of pad sets used during the test.

Tab. 1 Dyno test procedure B08.02.12

Dyno	Brake Type	Rotor Type	Rotor dim.	Pad material	Compressibility K6
Edison	CBI 2×46	0901 Daimler	375×38	Galfer 5507-6	110-120

cracks increase the strain tolerance of the top coating which improves brake disc performance, provided that good adhesion is given, which is guaranteed by the metallurgical bonding through laser cladding.

Subsequently, the carbide layer is machined to the required dimensions of the friction ring. The different heat transfer coefficients of the materials composing the multilayer coating system will affect the heat dissipation during braking. A thermal barrier is created and more energy will go into the brake pad. Additionally, the brake pad quality should be adjusted to be able to absorb the increased temperature. It must also be ensured that the temperature input into the brake fluid does not reach a critical level.

When applying a carbide coating by laser cladding to the rotor and making the appropriate choice of braking pad material, the overall wear/performance of the friction system can be tailored by adjusting the volume ratio of carbide/matrix, which not only has a direct impact on the fine dust emission, but also on the braking performance.

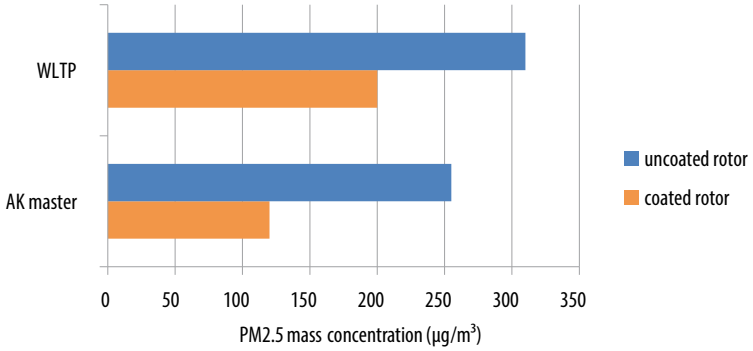
Test results

A test rotor coated with WC-410L by laser cladding was subjected to the dyno test rig (Tab. 1) and showed a significant reduction of the total wear of the friction pairing when compared to a non-coated specimen (Fig. 2).

An informative value for the reduction of fine dust is only possible to a limited degree from pure wear programs. In the respective state of wear, generating the PM10 and PM2.5 particle sizes must be considered. Fine dust measurements were carried out for the friction pairings mentioned above. The baseline of the test was the standardized WLTP program. A fine dust reduction of up to 60 % could be demonstrated on the test bench with the Fritz Winter coating and the developed surface (Fig. 3).

Outlook

Even assuming that a maximum of 25 % of the vehicle population is covered by electric vehicles by the year 2030, vehicles itself still will remain a cause of CO_2 emissions, which can be reduced by weight savings achieved by vehicle design. With regard to the brake disc, there are different options for lightweight construction, which can be significantly extended and explored by the existence of an appropriate friction surface such as the one presented here. Changing the material ratios in the composite layer will affect the overall heat transfer, which can be taken into consideration to redefine the thermal mass of the brake disc.



test	uncoated rotor	coated rotor
3x AK master	255	120
10x WLTP	310	200

Fig. 3 Comparison of fine dust emissions of an uncoated and a coated rotor (conducted at IUAT in Duisburg, Germany)

FEM simulations at Fritz Winter have shown a saving potential of 3 kg/disc (20 % reduction). A weight saving of up to 25 % is expected by coating optimization.

A further goal to consider when optimizing the carbide coating is to design the friction pair coating/braking pad in such a way that the fine dust particles, in particular PM2.5, are reduced to ten percent of those released by wear of a conventional combination.

Furthermore, the carbide coating provides the opportunity for optimization of the basic technical properties of the brake disc (e.g. damping and improved comfort) as well as an improvement of the reaction time of the braking pad when activated.

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Process video of a brake disc being coated using high-power high-speed laser cladding, HPHSLC:

https://s.fhg.de/hphslc

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Maria Barbosa obtained her PhD degree in materials engineering from the Technical University Dresden. She is the group manager of the thermal spray unit and the deputy manager of the thermal coating department where, together with her team, she explores different technologies of thermal spray and laser cladding to find tailored coating solutions.

Wilfried Strauß studied mechanical engineering at TU Darmstadt. He has been working in the developemt of braking systems since 1985. He has represented renown companies such as WABCO, Federal Modul Friction and, since 2017, Fritz Winter Eisengießerei GmbH, where he is responsible for advanced development.

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Measuring Wheel Movements at Speeds up to 155 MPH

Aicon automobile performance testing system equipped with high-speed cameras from Mikrotron

A BMW test vehicle equipped with the WheelWatch (Source all images: Mikrotron)

By incorporating high-speed EoSens GE GigE Vision cameras from Mikrotron into its WheelWatch optical measurement system, Aicon 3D Systems has set a new standard for non-contact monitoring of wheel motion in vehicle dynamics testing.

With a maximum speed of almost 500 frames per second, Mikrotron EoSens GE cameras feature a 1.3 megapixel CMOS sensor that captures resolution of 1280 × 1024 pixels with 90 dB dynamic range. As a result, the WheelWatch system is able to capture sharp, high-contrast images for critical analysis, even at driving speeds of up to 155 mph, including the accurate measurement of wheel parameters such as track, camber inclination, spring travel, clearance and steering angle.

The WheelWatch is used at the prototype stage in automobile development. Before a car gets anywhere close to serial production, prototypes have already covered millions of miles during testing. As part of this process, careful testing examines exactly how wheels behave in the event of extreme maneuvers. How do they handle bumps and wet roads? Do they remain stable during evasive maneuvers or when traveling at high speed? Do the wheel wells still provide enough room even when tackling sharp bends? These are the types of dynamic parameters that the WheelWatch captures for analysis.

A BMW test vehicle equipped with the WheelWatch

During testing, Mikrotron EoSens GE cameras are exposed to extreme forces like sudden accelerations, sharp steering maneuvers, and abrupt braking that would damage a standard camera. Equally challenging, the camera is expected to function during lengthy driving tests lasting several hours. Mikrotron EoSens cameras – featuring a fanless, shock- and vibration-proof design within a robust metal housing – proved up to the task, achieving long-term stability over hundreds of tests.

"We found the Mikrotron EoSens camera operates reliably, despite sometimes facing tough operating conditions," confirms Robert Godding, managing director of Aicon 3D Systems. "The camera always provided high-quality image data."

Simple installation

The system setup requires one Mikrotron EoSens GE camera be attached per wheel to enable it to fully capture the wheel and mudguard. Specially coded measurement targets are placed on the mudguard to identify the vehicle coordinate system. An adapter is also mounted on the wheel, featuring a unique pattern of dots.

Once installed, the camera acquires images of the wheel while simultaneously aligning itself with the surrounding mudguard, so it does not have to be kept stable. Vibrations and bumps do not have any effect on the data measured. The system recalculates its position continuously to achieve the measuring data, thereby achieving maximum positional accuracy of approximately ±0.1 mm and angular accuracy of around ±0.015°. Consequently, driving characteristics of the vehicle are not influenced by the measurement equipment, nor is steering motion restricted in any way.

The Mikrotron EoSens GE triggering function allows multiple cameras to be fully synchronized for simultaneous monitoring of several wheels or axles. Special optical targets applied to the prototype's fender define the vehicle coordinate system, while a lightweight carbon fiber wheel adapter is fixed to the wheel. The driver manually triggers the beginning and end of a measurement session.

The WheelWatch allows vehicle dynamics testing without mechanical connection between a sensor and the wheel.

For the measurement of wheel movements, one camera for each wheel is mounted so that the wheel and part of the surrounding fender is visible.

No other interaction with WheelWatch is required.

Up to four cameras can be synchronized with each other, as well as with other measuring sensors. For example, movements in the engine block can also be detected using additional cameras. Getting into tight spots within the engine block is made possible by the Mikrotron camera housing measuring only 63 × 63 × 47 mm.

Evaluating images in the camera

WheelWatch measurement images are assessed in the Mikrotron camera sensor using an FPGA image analysis processor before they are sent to a laptop inside the car via a GigE interface. Wheel target positions and target trajectories are available shortly after the image acquisition. In addition, WheelWatch computes all six degrees of freedom of the wheel in the vehicle coordinate system.

Mr. Godding considers the integrated FPGA technology to be a key camera performance feature: "Being able to use the built-in FPGA for our own image processing purposes was one of the reasons we opted for a Mikrotron camera."

The WheelWatch system can be deployed both on a test station as well as during drives on a test track. However, it is also ideal for other movement analyses such as:

- Door slam testing
- Examining the opening and closing behavior of doors, covers, windows
- Vibration analysis of components
- Robot rail measurement
- Machine control
- Error analysis in the production line (e.g. welding processes)
- Component behavior in wind tunnels or climatic chambers
- Collision analyses
- Material testing, structural analysis
- 6D positioning and alignment of individual points and rigid bodies.

*

Hexagon AB, a leading global provider of information technologies that drive productivity and quality across geospatial and industrial enterprise applications, acquired Aicon 3D Systems in 2016.

Software calibrates cameras and axles, determines reference points, calculates axle and wheel parameters and transfers data

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See, Recognize, Grasp

Industrial cameras optimize gripping processes of assembly robots

Stefan Waizmann

Asyril's flexible Asycube feeders, in combination with SVS-Vistek's EXO series cameras, provide a powerful bin picking alternative and increase the productivity of the robots used. (Source: Asyril)

The goal of the Swiss company Asyril is to improve the performance of assembly robots. It uses sophisticated image processing systems to facilitate the gripping of bulk material components by robots used in production, relying on an innovative idea and on industrial cameras from SVS-Vistek.

The attempts of various companies to realize the famous bin picking task could be seen at almost every automation trade fair in recent years i.e. the gripping of the pickup of randomly distributed components by a robot. Despite enormous progress in the field of robotics and image processing, this task still poses a great challenge. The reasons for this are obvious: before a robot can grip a component, an image processing system must first reliably recognize it, calculate its orientation, and then communicate the position and orientation of the gripping points to the robot. In conventional technology, this is still a slow, multistage process (recognition, gripping, correct depositing, gripping with correct orientation). If the components to be gripped are chaotically mixed up and partially concealed, the safe and fast gripping of individual parts often becomes a complex and slow process.

Asyril takes a new approach to this task which is frequently encountered in industry: the Swiss company builds fast, highly efficient feeding systems for pick-and-place robots using a trick that is simple at first glance but very innovative in detail. The bulk material objects lying next to and on top of each other in a box are guided via a feeding hopper to a vibration platform, where they are separated and placed in a position that allows easy access by the robot.

Vibration in three axes

The basic idea of the Swiss goes far beyond conventional mechanical systems such as vibrating pots, explains Asyril product manager Aymeric Simonin: "The special feature of our high-performance feeding systems is that the results of an integrated image processing system are used to control the platform vibrations to seperate the objects. The specialized vision system delivers the necessary data almost in real time, ensuring that the parts are isolated in a controlled manner and brought into a gripping position that is optimal for the robot. After separation by 'intelligent vibrations', the image processing system communicates the data of the position and orientation of the components to be optimally gripped to the pick-and-place robot, for which the job is then very easy. In order to optimize the speed of object detection, the system sends the information about the first detected, well-

Fig. 1 The vibration platform of the Asycube feeders enables controlled movement and separation of bulk material objects. (Source: Asyril)

placed components to the robot before the entire image is evaluated.

The technical basis for this procedure is flexible feeders called Asycube. Asyril developed this innovative, patent-protected 3-axis vibration technology itself, manufactures it in-house and uses it in its high-performance feeding systems. The high-quality actuators cause a platform to vibrate: this vibration can be controlled in terms of strength, frequency and duration, allowing the components to move quickly and accurately in the direction of desire on the vibration platform.

Economical image processing

The second core element of Asyril's flexible feeder solution is the integrated Smartsight vision system, which assesses the quality of the separation and determines the positions of the next optimally positioned parts with knowledge of the robot gripper's capabilities. "An economical design was also important to us for this part of the overall system," stresses Aymeric Simonin. The Swiss company therefore opted for several camera models from the EXO series with resolutions between 1.6 and 12 megapixels (after initial systems based on ECO cameras) from SVS-Vistek which, in addition to image acquisition, also take over control of the light and thus make an additional strobe controller obsolete. "This enabled us to reduce the hardware costs for the entire system and to operate incident and transmitted light with short flash times directly from the camera's power outputs," says Simonin, describing the image processing setup. The timings for light and exposure come directly from the camera, which controls the electrical processes and the integrated four-channel LED driver with its sequencer. Light, sequencer and camera are controlled via a single programming interface.

"Our technology is very flexible and is suitable for loose parts and components of all geometries with sizes ranging from less than 0.1 mm to 150 mm," says Simonin. "The feeders we use enable extremely gentle feeding of parts, which can be a decisive criterion for some applications."

Thanks to their modular design, Asycube feeders can be flexibly and quickly adapted to the properties of the objects. In addition to easily exchangeable hardware modules, this configuration flexibility is also ensured by easy-to-use, PC-based image processing, emphasizes Simonin. "When switching to other products, the advantages of a programmable feeder become particularly obvious: configuration is carried out very quickly via software and this saves expensive hardware setup times. This is a big advantage, especially in markets with very short product life cycles or small series."

Fig. 2 Asycube feeders are very flexible and suitable for extremely gentle feeding of loose parts and components of all geometries with sizes from less than 0.1 mm up to 150 mm. (Source: Asyril)

Companies

SVS-Vistek

As an innovative manufacturer of high quality industrial cameras for more than thirty years, SVS-Vistek GmbH – a member of the TKH Group – has acquired exceptional know-how in industrial image processing. We develop and produce a wide range of standard cameras as well as cameras with the highest resolutions, above-average image quality and all relevant interfaces in our own clean rooms at our headquarters in Seefeld near Munich: Quality Made in Germany!

www.svs-vistek.com

Asyril

Asyril SA – a member of the Nivalis Group – develops, produces and markets high-performance flexible feeding systems for parts and components from 0.1 up to 150 mm in size. Its patented 3-axis vibration technology and intelligent control system are easy to integrate and allow for optimized speed, accuracy and flexibility. Asyril's key competencies and extensive know-how encompass all three sub-domains of modern parts feeding systems: vibration technology, industrial vision and precision robotics.

www.asyril.com

Excellent partners

For the realization of the Smartsight vision system that is integrated into the Asycube feeders, Asyril works together with Fabrimex from Volketswil in Switzerland who, as partners of SVS-Vistek, add their innovative camera technology to tailor-made optical solutions from a single source. Asyril's development enables robots to access individual parts or bulk materials more quickly, leading to considerable increases in efficiency. Our roots are in the Swiss watch industry with its high demands, but the advantages of our technology have now also proven themselves in many other markets, such as the automotive, medical and electronics industries," says a delighted Simonin. "With Asycube Smartsight, we can offer users a fast alternative to the still slow, complex bin picking task and thus increase the productivity of the robots used.

Fig. 3 The core of the image processing system used in the current Asycube feeders is a camera from SVS-Vistek's EXO series. (Source: SVS-Vistek)

The advantages of material feeding through the innovative Asycube solutions have previously been paying off in other ways: at the Motek trade fair in Stuttgart at the end of 2018, Asyril was awarded a prize in the 'components for handling and assembly' category.

Author

Stefan Waizmann has gained more than 15 years of international experience in service and system integration in the post-production business after his master degree in photo engineering. His main focus was on scanning and film recording with specialization in color spaces. This was followed by stations in the development and product management of novel scanners based on CCD line sensors. In Germany he has worked in technical support, as a product manager and is currently at SVS-Vistek in technical marketing for industrial cameras.

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In Colladon's Footsteps

Water jet laser evolution MMXX – applying modern IR fiber lasers to cut challenging applications

Jens Gaebelein and Jeroen Hribar

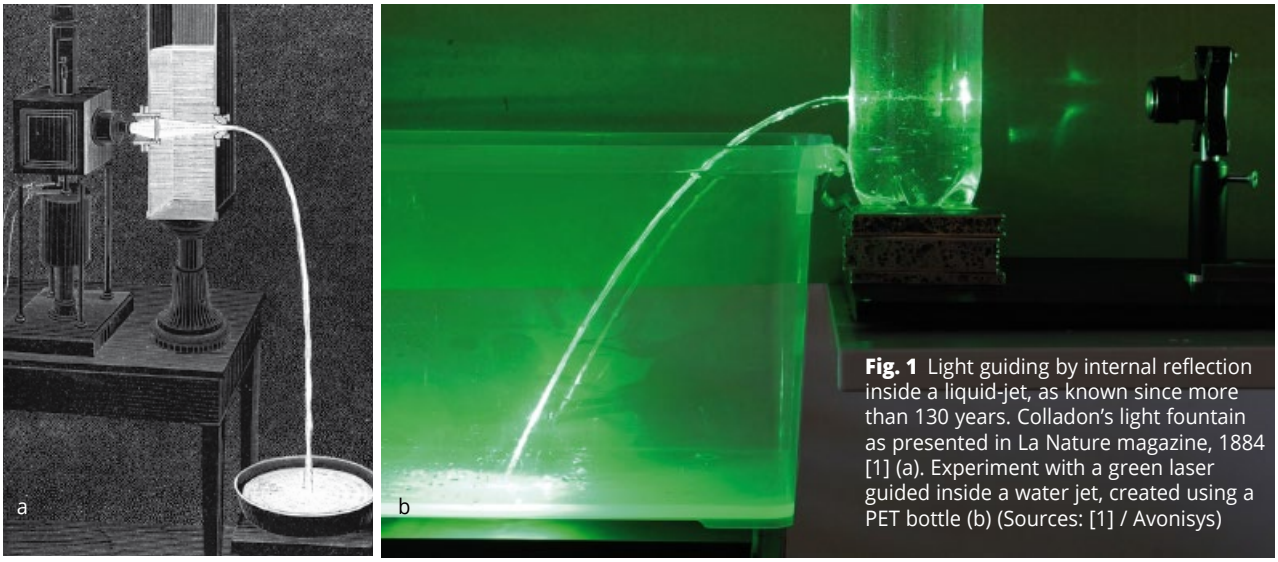

Fig. 1 Light guiding by internal reflection inside a liquid-jet, as known since more than 130 years. Colladon's light fountain as presented in La Nature magazine, 1884 [1] (a). Experiment with a green laser guided inside a water jet, created using a PET bottle (b) (Sources: [1] / Avonisys)

The first real water jet guided laser was developed and applied in the mid 1980's, using a Nd:YAG laser. Today, a new generation of water jet guided laser technology enables reliable use of modern high-power IR fiber laser sources.

The light guiding capability of a liquid jet was demonstrated by Daniel Colladon in a very illustrative manner more than 130 years ago [1]. He used a lens to focus light from a light source through a reservoir of water into a water jet that was generated by a nozzle. The light propagated through the bent water jet into a second reservoir by internal reflection inside the water jet (Fig.1a). The physics behind Colladon's experiment apply in exactly the same manner today, also for coherent light sources. Avonisys wanted to demonstrate that the core principle behind the water jet guided laser is not rocket science. A simple PET bottle was used to generate a bent water jet into which a beam from a diode pumped green laser was coupled. As can be seen in Fig.1b, the laser light is guided perfectly inside the bent water jet. The exercise was taken even one step further and the PET bottle setup was used vertically to actually cut a piece of thin sheet metal (Fig. 2) to show that essentially any non-turbulent water jet is capable of guiding significant amounts of laser energy for the purpose of material processing – in this case a 50 W diode-pumped, green nanosecond laser.

Almost exactly 100 years after Colladon showcased the internal reflection principle inside a water jet, the first real water jet guided laser was developed and applied in the mid 1980's by Aesculap-Werke [2] and Sander et. al. [3] from the municipal hospital of Munich Harlaching, both in Germany. Up to 95 W power from a 1.06 µm Nd:YAG laser was guided and transmitted through a water jet coaxially flown around a 600 µm optical fiber.

Recently, Avonisys has developed, patented [4, 5, 6] and commercialized a new generation of water jet guided laser technology that enables reliable use of modern high-power IR fiber laser sources. It makes use of today's highly robust and powerful fit-and-forget fiber laser technology. It enables Avonisys to couple significant laser power into very small water jets of just 0.05 mm or 0.03 mm diameter. In a typical application for example, 100 – 135 W (1.5 – 3 kW peak power) is coupled into a tiny

Company

Avonisys

Avonisys develops, builds and sells laser systems based on its proprietary water jet laser technology. Avonisys laser systems are designed to deliver robust performance for demanding applications, while keeping operation simple and maintenance procedures fast and cost effective. Around its core technology Avonisys holds over 20 patents and patents pending, which include unique features such as a high-power laser coupling method, an air jet protection system and an easy-maintenance laser coupling unit design.

www.avonisys.com

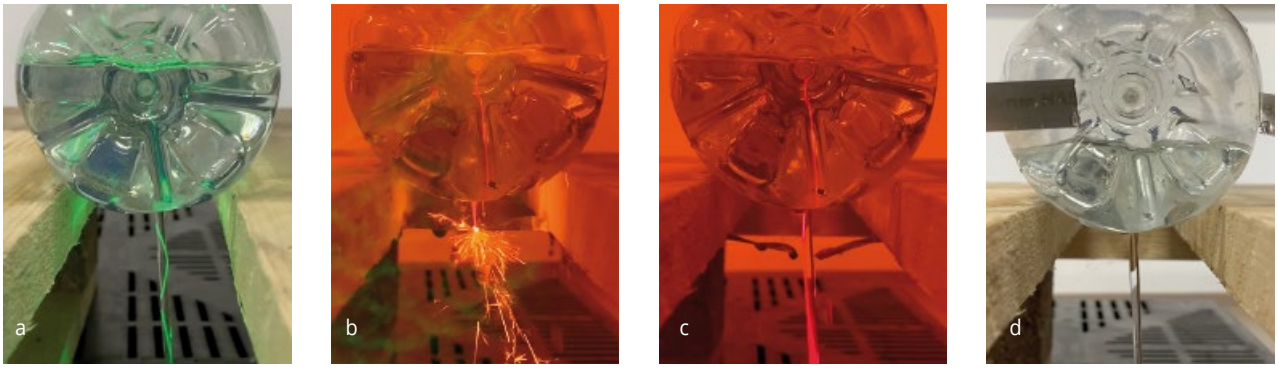

Fig. 2 Cutting through a 0.03 mm piece of sheet metal using a PET-bottle water jet laser. Green laser guided by total internal reflection inside a 4 mm diameter water jet. Reflection points inside the jet can be clearly seen (a). 50 W laser power applied to cut through the sheet metal – red color from laser safety glass, cutting sparks visible) (b). Metal sheet after cutting through with the laser guided inside the water jet (c–d).

0.05 mm water jet. With 51 – 70 kW/mm^2 this is 150 to 200× more compared to the energetic density applied by Sander et. al. (≈330 W/mm^2). A key aspect for using IR fiber lasers is coupling the laser focus cone as deep as possible into the stable laminar portion of the water jet (Fig. 3) while at the same time avoiding the introduction of significant energy into the nozzle orifice. The exact coupling point is calculated based on the laser focus cone angle as well as the nozzle geometry [5] and can be precisely set using a high-resolution focus Z-drive that was developed specifically for this purpose.

Another important feature is the so-called air jet [4]: a mechanically spaced-apart air shield that protects the water jet against disturbances such as back spray occurring when drilling deep microholes and in directional turning points when cutting small high-aspect features. It also keeps the laser processing area dry, even inside workpiece cavities and thus prevents the process from 'drowning' (Fig. 3). Instead, it maintains a perfect air-to-water jet interface for laser energy being guided towards the work piece by internal reflection.

Today, Avonisys sets the benchmark in terms of high aspect ratio cutting capability with a water jet-guided laser and achieves cutting kerfs with an aspect ratio of up to 400 : 1. An extreme example is shown in the form of an aluminum cube in which we cut square holes of only 1 × 1 mm but 18 mm deep (Fig. 4f). Apart from realizing such non-round holes in the first place, the fascinating aspect is that the process also removes the 1 × 1 × 18 mm pins from these bores as good parts. This is possible due to the system design that mitigates disturbances of the water jet in an effective way and provides a quasi dry cutting area. When Avonisys developed the system, the team was not so interested in generating the longest water jet possible but instead forming the most stable water jet possible. With the same system configuration, the developers are able to cut a broad range of materials and material thicknesses, which is very interesting not only for job shop companies. To illustrate the specific and forgiving behavior of our technology, the exact same laser parameters and cutting nozzle were applied to process a set of different materials, thicknesses and cutting geometries. (Tab. 1).

Cutting results typically display a wire EDM-like smooth (sub)micron finish,

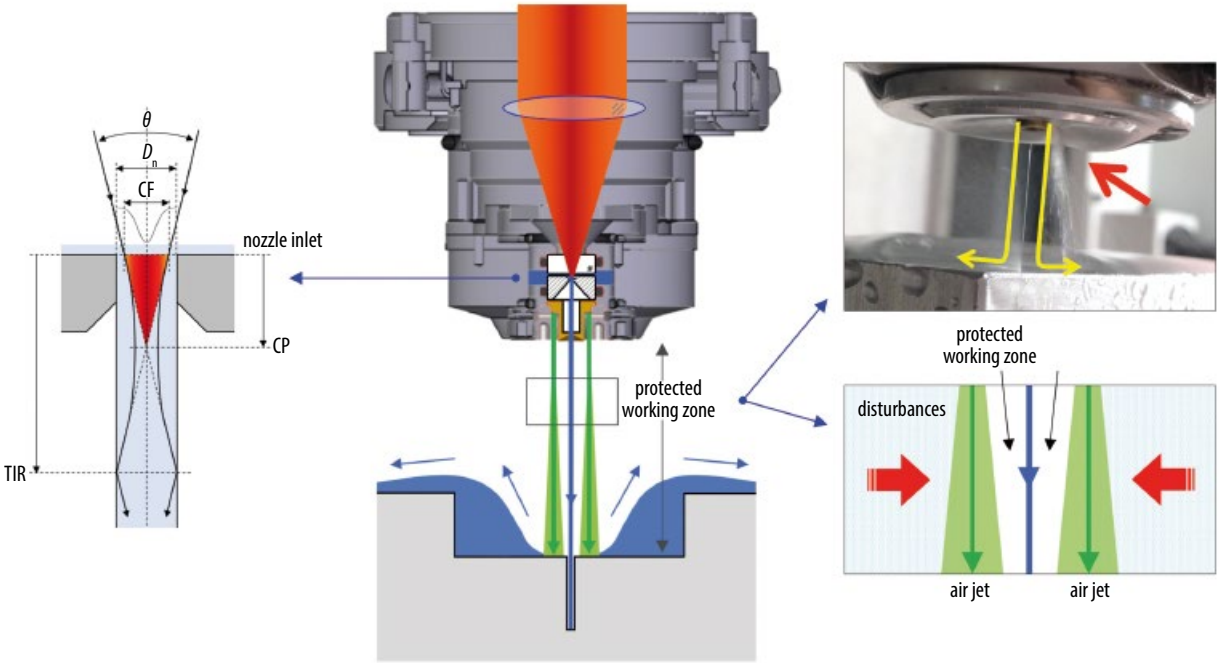

Fig. 3 Working principle of Avonisys water jet laser technology. The calculated and precise coupling point is far below the nozzle inlet plane to ensure internal reflection starts in the stable laminar area of the water jet. An air jet module creates a protected working zone for the water jet as well as a quasi dry working area on the work piece for stable and efficient laser processing.

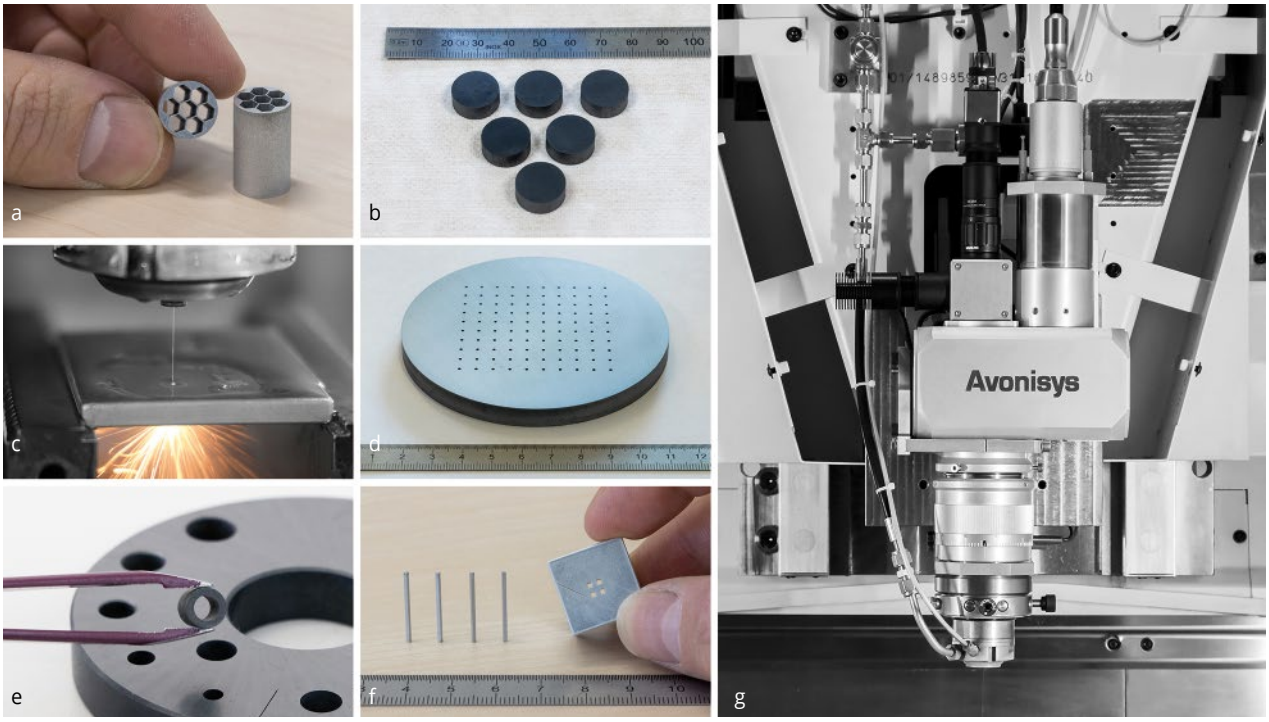

Fig. 4 Machining examples: 3 mm hexagon in 18 mm aluminum (a). Ø 15 × 5.5 mm boron carbide chip cutting (b). Drilling Ø 0.8 × 5 mm in Inconel (c). 100 × Ø 1.0 × 8 mm in silicon (d). Ø 3 × 8 mm hole in silicon carbide (e). 1×1 mm square holes in 18 mm aluminum (f). Avonisys LJFK45 series water jet laser head inside a 5-axis CNC-machine (g).

Material	Cutting/Drilling Feature		Time
Al	3 mm hexagon, 18 mm deep	(Fig. 4a)	5m30s
B_4C	Ø 15 x 5.5 mm chip cutting	(Fig. 4b)	6m55s
Inconel	Ø 0.8 mm hole, 5 mm deep	(Fig. 4c)	1m30s
Si	Ø 1.0 mm hole, 8 mm deep	(Fig. 4d)	0m55s
SiC	Ø 3.0 mm hole, 8 mm deep	(Fig. 4e)	4m30s

Tab. 1 Example of machining different materials, all with different geometries, yet all with the exact same laser and process parameters.

yet with faster process speeds, without a starting hole. The process is also useable on non-conductive and hybrid materials. The company received valuable feedback from existing and new customers who appreciated the technology first-hand, and also valued seeing it in action in a series of detailed videos on the Internet.

Meanwhile, Avonisys has deployed the process in various countries, e.g. Switzerland, Germany, Korea and China, and received very positive feedback that, as well as the cutting performance, the user-friendly system design and quick maintenance features are also valued.

DOI: 10.1002/phvs.202000033

[1] *D. Colladon:* La Fontaine Colladon, La Nature magazine, pages 325-326 (2nd half year 1884), image in the public domain
[2] *W. Wrobel:* Aesculap-Werke AG, Patent DE3643284C2, Verfahren und Vorrichtung zum Schneiden eines Materials mittels eines Laserstrahles (December 1986)
[3] *R. Sander* et. al.: Städtisches Klinikum München Harlaching, An Nd:YAG laser with a water-guided laser beam – a new transmission system, Gastrointestinal Endoscopy **34** (1988) 4, 336-338
[4] *J. Gaebelein, J. Hribar:* Patent US103078-64B2, Methods and systems to keep a work piece surface free from liquid accumulation while performing liquid-jet guided laser based material processing (December 2013)
[5] *J. Gaebelein, J. Hribar:* Patent US8859988B1, Method for coupling a laser beam into a liquid-jet (May 2014)
[6] *J. Gaebelein, J. Hribar:* Patent US10022820B2, Methods and apparatus to perform a liquid-jet guided laser process and to simplify the maintenance thereof (December 2013)

Authors

Jens Gaebelein has broad and four decade-long experience in both industrial production as well as advanced engineering environments. At Avonisys, Gaebelein is in charge of system design and process development. He is co-founder of the company and has been with Avonisys since 2013. He holds a degree in production engineering from the university of Dresden, Germany.

Jeroen Hribar has twenty years experience in technical design as well as the marketing of advanced optical products, such as metrology equipment and material processing devices. He is co-founder of Avonisys, has been with the company since 2013 and is in charge of project development as well as optical system design. He studied applied physics at the university of professional education in Heerlen, The Netherlands.

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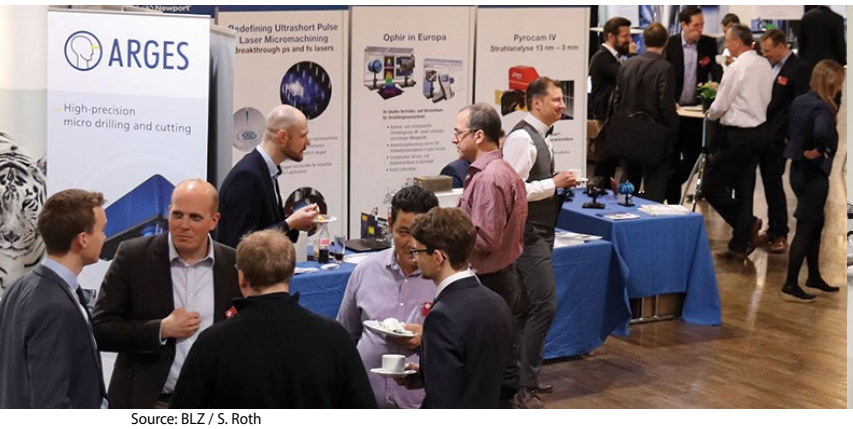

Source: BLZ / S. Roth

Source: W3+ Fair 2019 Rheintal / FLEET Events

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SIAF Guangzhou & Asiamold 2020
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www.spsinchina.com
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September 15 – 18, 2020
EPHJ 2020
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Photonics Technology Enables Smart Production

Review: LASER World of PHOTONICS CHINA 2020, 3 – 5 July, Shanghai, China

As the annual high-end event for the global optoelectronics technology industry, and the front-runner of optoelectronics exhibitions in 2020, Laser World of Photonics China served as a gathering of the leading brands and their new products, technologies and solutions, and showcased the future trends and prospects of optoelectronics technology in modern manufacturing environments. With an exhibition space of 53,060 square meters, the trade fair attracted nearly 819 exhibitors. With strict safety guidelines in place, the trade fair received 57,135 professional visitors during the three days.

Dr. Reinhard Pfeiffer, deputy chairman of the board of Messe München, on the success of the trade show: "Thanks to the strong commitment of all partners and exhibitors Laser World of Photonics China 2020 was held successfully. The safety and hygiene concept of Messe München ensured the restart of Asia's leading trade show for this key technology in China."

Source: Messe München

Reopening industry finds opportunities in hardship

The Covid-19 epidemic has had a major impact on the global economy. However, China fortunately has made initial progress in its prevention and control, laying a foundation for the gradual restoration of economic activities. The laser industry has also been gradually revitalized as companies resume daily operations and production. The Chinese laser industry has entered a period of rapid development in recent years, benefiting from China's support of intelligent manufacturing and the expanding application market.

Wang Youliang, director of the Laser Processing Committee, China Optical Society, mentioned: "The year 2020 is indeed very special. After ten golden years of development, the laser industry in China is entering a period of transition. Coupled with the impact of the Covid-19 epidemic, the challenge we are facing is unprecedented. However, the challenges can mean crisis, but they can also be opportunities."

Exhibitors from the laser, infrared, optics and other industries have made contributions to the fight against the Covid-19 epidemic with IR thermal imaging body temperature screening technology, IR temperature measurement, and anti-counterfeiting laser marking technologies which are essential in the reopening of businesses. The trade fair, together with China's laser optoelectronics industry, has established a comprehensive procurement and supply system that covers the upstream and downstream of the industry. While promoting the vigorous development of the Chinese manufacturing industry, the trade fair also attracted German and Japanese pavilions to present their advanced technology and applications in optoelectronics and related industries.

The next Laser World of Photonics China will return to the Shanghai New International Expo Center on March 17 – 19, 2021.

https://messe-muenchen.de/en

Online Conference Format Attracts 130 Participants

Review: EMVA Business Conference, 26 June 2020

The first ever virtual interactive EMVA Business Conference received an overwhelmingly positive response to the online format, adopted this year as a consequence of recent Covid-19 travel restrictions.

In a unique approach to combine webinar and personal online meeting functions, close to 60 face-to-face video meetings were booked during the conference breaks by the participants to bilaterally discuss business opportunities. A traditional feature of previous business conferences, this opportunity to directly interact with other conference participants was highly appreciated, as expressed by the statement of Christian Offermann, Kowa Optimed Deutschland, Germany: "Attending the seminars was made very easy. Personal interaction at 1:1 meetings was a great idea and enabled good discussions." Arwyn Roberts of Surface Inspection added: "Very well done! A major undertaking under difficult circumstances but a great success! I always get great value from EMVA events and this was no exception."

The conference organizers were thrilled about the way this unique online conference concept, necessitated by the global pandemic, was adopted by the industry. "We not only happily donate the income, from ticket sales for this event to the WHO Covid-19 Solidarity Response Fund. In addition, we will also soon enable access to the presentations given in the Vision Knowledge Section on our website" says EMVA General Manager Thomas Lübkemeier. He added with regard to classic conference setup: "While we are delighted with the highly positive feedback to this online event, we are also really looking forward to our next physical Business Conference which is scheduled to take place 10 – 12 June 2021 in Sofia, Bulgaria."

www.emva.org

Preview: Fakuma 2020

13 – 17 October 2020, Friedrichshafen, Germany

Expert visitors will gain an overview of all modern plastics technologies from 13 to 17 October 2020 when roughly 2000 exhibitors present their companies in Friedrichshafen at the 27th Fakuma international trade fair for plastics processing.

As an industry and technology barometer for injection moulding, Fakuma is the first port of call where innovations involving materials, machines, peripherals, processes and simulation are concerned. Visitors are provided with a comprehensive overview of all plastics technologies: injection moulding, extrusion technology, thermoforming and 3D printing. As a working event for established practitioners, Fakuma is consistently aligned to the process sequence in the field of plastics processing. Exhibitors and expert visitors are able to discuss concrete projects directly with each other on an equal footing.

Fakuma will occupy all available hall space in the modern exhibition center at Lake Constance. 1,933 exhibitors from 40 countries and nearly 48,000 expert visitors from 126 nations came to Lake Constance in 2018. Trade fair promoters P. E. Schall have announced that this important technical event for injection molding will be even more international in 2020. All leading companies in the field of industrial plastics processing will meet here for an exchange of technical ideas and experience.

Digitalization, connectivity, extended process integration and system solutions for equipment and peripherals have arrived at plastics processing machines as well. Theoretical or planned digital transformation options that were only recently still on the drawing board will be on show in reality at Fakuma 2020.

Efficient use of resources, sustainability, environmental protection

Of course Fakuma also deals with the issues of environmental protection, sustainability, efficient use of resources and circular economy. Climate concerns, difficult plastic waste situations and the negative image of plastics are promoting the need to implement economical and gentle production processes and to implement effective, broad-ranging recycling management. It will only be possible to master the plastic waste problem at a global level by means of higher recycling rates and improved efficiency in waste management. Factual clarification and a differentiated discussion with all parties involved in the value chain is necessary in this regard. Fakuma 2020 will be a highly interesting and indispensable platform that will showcase technology trends for environmentally compatible production, the use of recyclates and more efficient injection molding processes.

www.fakuma-messe.de

Preview: EuroBLECH Digital Innovation Summit

27 – 30 October; EuroBLECH 2020 postponed: new date: 9 – 12 March 2021, Hanover, Germany

The decision to postpone the fair was taken after extensive conversations by Mack Brooks Exhibitions with all exhibitors and partners over recent weeks and months who have expressed their preference not to hold the show in October, in view of the ongoing Covid-19 crisis. Uncertainties around travel restrictions to maintain the truly international character of the Euroblech event were also a concern to many participants.

As part of a recent series of industry surveys, the participants of Euroblech indicated their requirement to network and conduct business in order to pave the way for the recovery of the industry following the Covid-19 pandemic. Euroblech will therefore offer a virtual hub for the global sheet metalworking industry in October: "Following feedback from our exhibitors and visitors indicating the need to participate in an event, even if not in a physical form, we will organize a Digital Innovation Summit taking place from 27 to 30 October, our planned event slot. This Digital Innovation Summit will provide our exhibitors with a platform to demonstrate their latest machines and solutions and to arrange virtual meetings with international visitors. We believe it is our duty to assist the industry through these extraordinary times by offering a marketplace this year as a platform for innovations and a starting point for the recovery of the industry", said Nicola Hamann, managing director of Mack Brooks Exhibitions.

The Euroblech Team will communicate closely with customers and partners over the coming weeks and months and thanks their exhibitors, partners, suppliers and visitors for their support during this challenging time. Further information on the Digital Innovation Summit containing details on the Online Presentation Theatre for exhibitors, video on demand options and matchmaking facilities, will be available shortly.

Every two years, this large sheet metalworking technology exhibition attracts top industry professionals from all over the world. The show targets specialists at all management levels in small and medium-sized companies as well as large enterprises from all key industry sectors. Featuring an enormous number of live machine demonstrations, Euroblech is renowned with international sheet metalworking professionals as an important event to find smart solutions and the right machines, equipment and materials for their companies. A total of 56,307 international trade visitors attended the previous show.

www.euroblech.com

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LOGO?

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