PHOTONICS NEWS

LASER COMPONENTS USA, Inc. Magazine #41 ▪ 07|18 laser-components.com

Emotions Measured in the Movie Theaters

Laser Welding for Functional Clothing

Maya City Explored with LiDAR

New Products

UPCOMING EVENTS

SPIE Optics+Photonics
San Diego, CA
August 19–23, 2018
Booth 527

IR WORKshop
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November 12–13, 2018

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Content

Technologies in Service of Leisure

Product News

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LASER COMPONENTS USA, Inc.
116 South River Road, Building C
Bedford, NH 03110, USA
Phone: (603) 821 7040
Fax: (603) 821 7041
www.laser-components.com
info@laser-components.com

Bringing the Maya's Back to Life

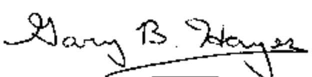
Summer vacation is made up of multiple activities. It can include a trip to the movies, a visit to a foreign land, swimming, biking, or hiking. Technology has been used one way or another to enhance your fun or learn more about our interactions with the earth and environment.

A popular vacation destination like the Maya civilization site, was once not discovered and a lot was unknown before the introduction of modern day technology. These are now places we can enjoy and explore more, for example, with the help of LiDAR (Light Detection and Ranging) technology as it reveals hidden places through dense vegetation.

With our continuation in advancing new technology and our ability to analyze data using smart tools, this aids us in making decisions for the future. In addition, our new ways of looking at the world through the eyes of technology are helping us to continue to improve current daily activities and entertainment. It makes you wonder what disruptive technology will be used thousands of years from now, like we did with the Maya civilization up till now.

We owe it to our communities to take this knowledge and pay it forward so that others can continue to learn and appreciate our modern-day technologies. We can harness it and use it to our advantage for future generations to come.

Sit back, relax, and enjoy!
Sincerely,



Gary Hayes
CEO/General Manager, LASER COMPONENTS USA, Inc.

LOST & FOUND

When you go on a journey, you hope for an extraordinary experience. The allure of distant countries lies in their exotic land-scapes, unfamiliar customs, and remains of long-forgotten advanced civilizations. Historical sites such as Angkor Wat, Machu Picchu, and Tikal (see photo) have proven to be real tourist magnets – and not all secrets of the past have been revealed yet. Today, laser technology provides archaeologists with information of which they were previously unaware. Just recently, new discoveries about the Maya have caused a sensation. ➔

Secrets in the Rainforest

New Insights into Ancient Cultures

Mexico and Central America are becoming increasingly popular tourist destinations. Crowds are not only drawn to the beaches of Acapulco and Cancun, but the old residential and cultural sites of pre-Columbian high cultures also attract millions of visitors to the region every year. The best known are the Aztecs, who ruled large areas of central Mexico at the time of the Spanish conquistadors. Relatively speaking, a lot is known about the Aztec culture – albeit mostly from the point of view of the conquerors. The Maya, who inhabited the densely-forested mountains and plains of what is now Mexico, Guatemala, Belize, El Salvador, and Honduras, seem much more mysterious to us. Unlike the Aztecs, their heyday was long past when the first Europeans set foot in the region. Everything we know about them today, archaeologists and anthropologists have laboriously compiled over the last 150 years from the remains of cities abandoned long ago. No wonder, then, that every discovery reveals new insights into the Mayan people.

Impenetrable Rainforest

Everyone has seen pictures of the temples and pyramids of Tikal. But if you have not visited it yet, it is hard to imagine how big the ruins really are. The national park in which it is located covers an area of 575 km^2. Most of it is covered in dense rainforest. Compared to the surrounding Mayan biosphere reserve, however, this is only a small blob. This huge nature reserve in the northern part of the province of Petén covers 21,000 km^2. Together with the adjacent biospheres in Mexico and Belize, this results in an impenetrable and protected rainforest the size of Brandenburg.

It has long been suspected that the dense vegetation hides further remains of Mayan civilization, but the search for them has proven difficult. In the days of Alexander von Humboldt, when researchers still struggled through the thicket with a machete, it was often pure luck when they came across old buildings. Many a ruin may have gone undiscovered because an expedition missed it by just a few hundred meters. Of course, more state-of-the-art methods have been available for a long time; for example, aerial photos. However, even photos of the region do not reveal much more than a dense ceiling of treetops. It was not until the application of laser technology that it was possible to look through the trees.

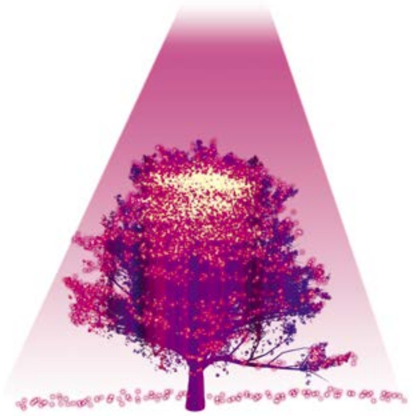
Complex Aerial Measurements

Light detection and ranging (LiDAR) uses laser light to measure distances. When the laser pulse hits an obstacle, the reflected light is detected by a detector. The exact distance to the obstacle can be calculated from the time between the emission of the pulse and the arrival of the returning light, which is referred to as time of flight (ToF) in technical jargon. This principle is familiar to every DIY enthusiast who has measured his home with a laser rangefinder before. This technology is also used in obstacle detection during autonomous driving or with self-piloting drones (see Photonics News #38, pp. 3–8). One of the great advantages of LiDAR is its high resolution: Compared to other technologies, laser-based systems operate with very short wavelengths and can, therefore, record considerably more details.

To create a digital elevation profile, the laser scans the landscape from an airplane or helicopter. Several thousand pulses are sent every second. In addition to LiDAR, two other technologies are used to determine the exact elevation profile: A satellite-supported GPS constantly records the exact geographical position of the aircraft so that the LiDAR measurements can be located later on the map. This happens in all three dimensions because the exact flight altitude naturally has a crucial influence on the ToF result. In addition, an inertial measurement unit (IMU) – essentially a gyroscope – measures the various angles of inclination of the aircraft since these directly influence the path length of the reflected laser beam.

Trees Are Essentially Removed

In trees and other plants, an effect occurs that is particularly useful in laser cartography. Unlike buildings or rocks, leaves do not reflect all light. One part penetrates the leaves and continues to move towards the ground until it hits the next "obstacle" and so on. Thus, it can happen that the same light pulse is reflected several times – each time with lower intensity and of course with continuously increasing ToF. All these reflected signals can be assigned later to the original pulse. The result is a three-dimensional image of the tree – or even of an entire forest.



Avalanche Photodiodes and Pulsed Laser Diodes for LiDAR Measurements

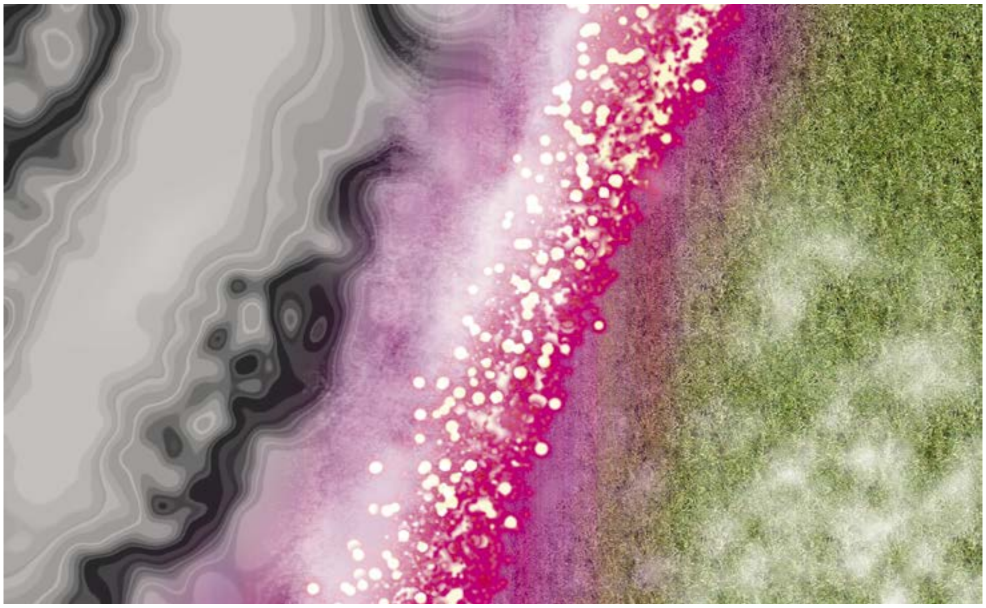
WEB US41-951

Pulsed laser diodes in the near IR range are commonly used in LiDAR cartography. Avalanche photodiodes (APDs) detect the reflected laser pulses. At our facilities in Canada and the USA, we manufacture both components in order to equip LiDAR systems for a wide variety of applications – not just archaeology.

Using complex algorithms, a computer can virtually remove vegetation from the landscape profile identified. What remains is a detailed model of the bare floor. The Maya researchers were surprised at how much new knowledge they were able to gain from the LiDAR data. The surface structures showed that hundreds of years ago houses, high roads, and fields once existed where the rainforest now grows. Until recently, it has been assumed that the hinterland of the Mayan cities was sparsely populated. Now the archaeologists know better: The metropolises were closely interlinked.

New Discoveries Everywhere

Not only in Central America does laser technology provide new insights into the past. On Glauberg in Hesse, archaeologists were of the opinion that they had already discovered all traces of its millennia-old settlement history. LiDAR investigations proved them wrong: They accounted for about a dozen potential sites. Approximately half of them have now been examined – all of which were burial mounds. Their colleagues in Guatemala are far from that. They must first evaluate and analyze all data. It, therefore, remains very exciting. ■



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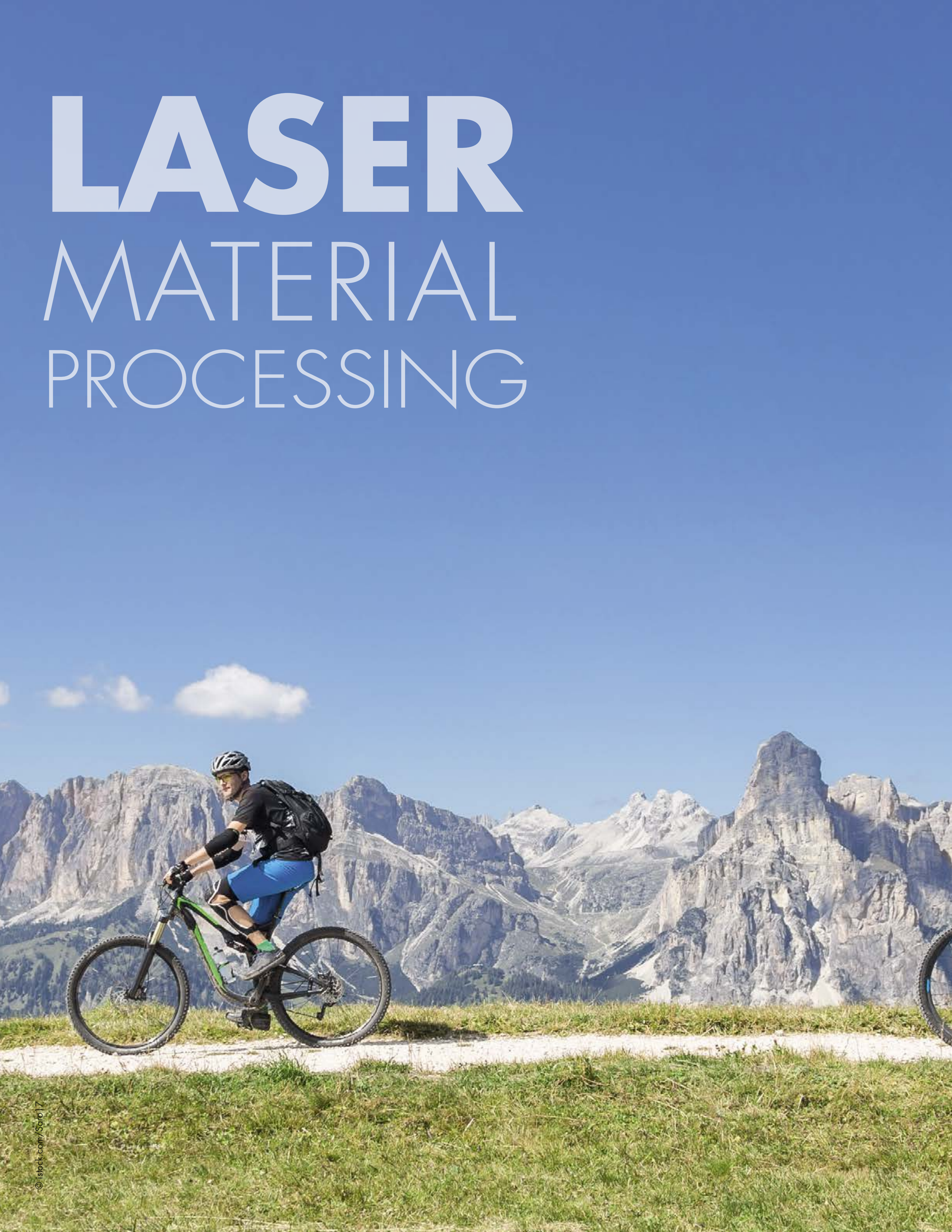
LASER MATERIAL PROCESSING



Innovative Processing of Apparel

Flat and Low-friction Seams via Laser Welding

Machine sewing, hot-air welding, and ultrasound are well-known procedures applied in the finishing of clothing. Laser welding is a completely new technology used in the clothing industry. The Swiss company Leister Technologies AG is developing this market to industrial maturity. Promising garment prototypes are already being produced. We spoke to project manager Frederike Lehmeier about this new process. "Compared to ultrasonic welding, laser-welded seams have an undamaged fabric surface; melting points are not visible on the surface. Adhesive material is not required either," she explained the advantages.

Continued on page 012 ➔

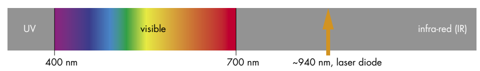
Laser welding is therefore particularly interesting for functional clothing: the seams can be extremely flat, elastic, and therefore skin-friendly. A so-called seamless effect can be achieved because the outside of the materials to be welded is not damaged. This technology is based on laser transmission welding, in which fiber-guided diode lasers are used in the near IR (NIR) range.

Laser transmission welding requires working with a laser-transparent and a laser-absorbing material. These two materials are joined exclusively between both material layers. Another possibility is the use of exclusively transparent materials; in this process, absorbers are partially applied to the positions to be welded.

The basic rules of laser welding:

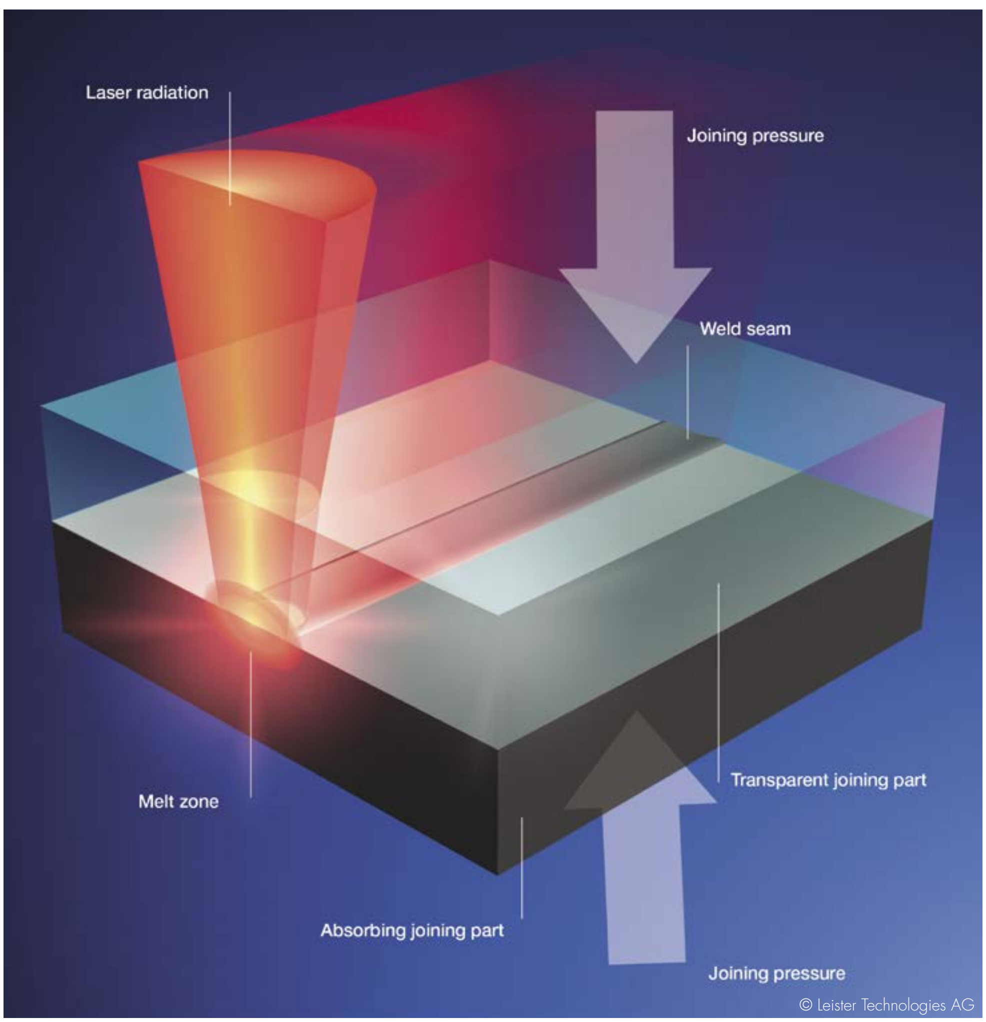
1. Transparency and absorption are required

A laser transmission weld requires a transparent and an absorbent textile when lasers with a wavelength of 940 nm are used.



2. Welding same with same

In laser welding, thermoplastic materials are joined together. During the welding process, laser radiation is absorbed by plastic and converted into heat. Thermoplastics are plasticized in the joining zone and joined under pressure.



In order to achieve a connection with high strength, similarly-typed thermoplastics should primarily be used. Practically speaking, this means, for example, that polyester can only be welded with polyester and polypropylene only with polypropylene.

Working with the same materials has a positive ecological impact on a subsequent recycling process and is becoming important for increasingly sustainable production in the textile and clothing industry.

Materialization

Materials tested to date in the textile and clothing industry include single-layer elastic and non-elastic knitted and woven fabrics, spacer fabrics, nonwoven materials, membranes between 10 μm and 25 μm, and multi-layer textiles (laminates). The chemical basis is largely polyester articles and, for knitted fabrics, polyamides and polypropylene articles.

In addition to polyester products, polyurethane-based materials can also be welded. The low foreign fiber content of a material type (e.g., elastane) does not significantly influence the laser welding process and the seam quality as long as they have laser-transparent properties.

Many of the textile materials available on a standard basis have laser-transparent properties. It is more difficult to use materials with sufficiently high absorption; they usually have a dark shade. Working with absorbent and transparent materials is often accompanied by a two-tone appearance.

If this is not desired, purely transparent materials can also be processed together "using a trick:" Either mostly liquid, NIR-absorbing pigments (absorbers) are introduced or additional absorbent materials are used.

Leister Technologies AG is developing two machine concepts for processing textiles.

A two-dimensional cutting and welding system for the clothing industry will be available as early as 2019. This laser system is based on a vacuum table and can draw in up to three layers of material. Welding and cutting is carried out completely automatically, and different tool heads are applied for each process step. Globo Optic is used for laser welding. The cutting process is performed using a knife tool, which can be selected depending on the material being processed. An inkjet printing head can be integrated on an optional basis to print absorbers on transparent textiles.

In 2020, a continuously manually-operated laser sewing machine will be available as a standard product for shaping seams. In this development, laser technology is integrated into the mechanical engineering process that is well known in textile and clothing technology. This operation is carried out for the user with the help of a similarly familiar methodology. Machine designs and dimensions, as well as the classification as laser class 1, allow positioning in a conventional production line. ■

Application Fields and Seam Shapes

Low-friction, flat, and flexible laser welds are ideal for garments that come into contact with the skin. This increases the wearing comfort of underwear, swimwear, sportswear, and fitness clothing – an enormous benefit for sweaty athletes who wish to enjoy the highest wearing comfort! This has been successfully tested in practice.

Two main seam shapes are used for textiles.

Seam shapes for two-dimensional connections are used, for example, for attaching pockets but also for decorations, reinforcements, or fixing insulating materials to outer fabrics. This technology can be particularly interesting for the continuously growing wearables market if sensors and other technical components are incorporated directly into the clothing.

Three-dimensional, shaping seams are used, for example, for overlapping seams, hemming seams or the welding of strip materials.

Outlook

Laser welding yields a new joining technology for clothing, textile products in medical technology, and technical textiles. Manufacturers and brands in the textile and clothing industry have a high need for innovation and differentiation in a highly competitive market. This development takes into account innovative laser technology.

Leister pioneered the development of textile-specific laser machines. We are working on making the sophisticated processing of textiles industrially accessible by means of suitable machines. ■

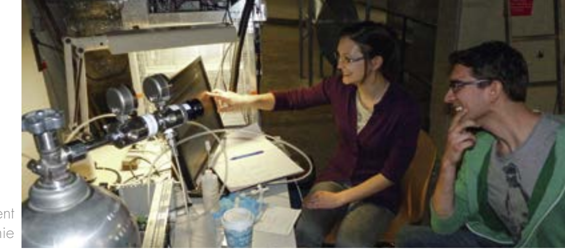
F. Lehmeier, project manager of prototype testing

Detailed view of an appliquéd pocket

Something's in the Air

Exciting or Funny?
Using Spectrometers to Measure Moviegoers' Feelings

Does a thriller smell different than a comedy? Of course not; after all, olfactory cinema has not yet been invented and emotions are created by images and sounds. However, it is now known that plants and insects pass on information via chemical sub-stances. So, why wouldn't humans do the same as well? Scientists from the Max Planck Institute for Chemistry and the Johannes Gutenberg University of Mainz have investigated this question. For this purpose, they have chosen a place where many people feel the same feelings simultaneously: the movie theater. ➔



In school, we learn that the oxygen we inhale is converted into carbon dioxide in the body. Generally speaking, this is correct; however, our breath also contains other substances (i.e., so-called volatile compounds). Eight hundred seventy-two of these substances are now known to scientists, some of which are produced by physiological processes in the body. This knowledge is used to measure changes in the body; for example, how the organism reacts to physical activity or certain foods. Strong emotions also trigger biochemical processes in the muscles, nervous system, and blood circulation. Prof. Jonathan Williams and his team from the Max Planck Institute for Chemistry in Mainz wanted to find out whether these reactions can be detected in the air we breathe.

100 Gases in 30 Seconds

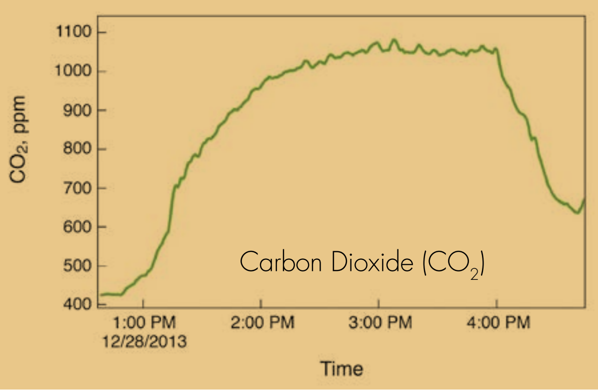
A movie theater offers the ideal setting for this project, especially because all viewers react to the film at the same time. This means that the measured values can always be assigned to a specific scene. In addition, the theater halls are continuously ventilated: fresh air enters through openings under the seats, and the "used" air escapes through ventilation openings in the ceiling. Scientists installed several mass spectrometers at the openings and were thus able to measure the concentration of around 100 different volatile compounds at 30-second intervals. The continuous circulation also has the benefit that the composition of the air quickly returns to a normal level after the movie. This makes it easy to compare the results of successive measurements later on.

IR Spectroscopy for CO_2 Measurements

WEB US41-922

Scientists at the Max Planck Institute used proven IR spectroscopy to measure the carbon dioxide concentration in the cinema auditorium. Like other gases, CO_2 absorbs certain wavelengths of the IR spectrum. If the air is irradiated in the IR spectrum, a sensor can precisely determine the CO_2 content based on the absorption behavior. The sensors are matched to the absorbed wavelength of 4.265 µm.

Due to continuous air circulation, the CO_2 curve established in theaters takes the classic shape of a "shark fin." The concentration in the air rises steeply after the start of the movie until it settles at around 1000–2400 ppm. As soon as the audience leaves the theater hall, it quickly sinks again and approaches the starting value. ■



Your contact:
Jim Dell: +1 603 821 7040
dell@laser-components.com

Over the course of one and a half months, the values were measured in two theater halls of a multiplex cinema in Mainz. During this period, films of various genres were shown: in addition to the usual comedies and action films, horror and children's films were also shown; and even a ballet performance was among them. The spectrograms of the individual curves were so charac-teristic that the researchers could often see with the naked eye which film was involved. In particular, exciting and funny scenes are clearly recognizable by the measurement curves.

Exciting and Funny Curves

"When the heroine fought for her life at the height of one of the action films, the values of carbon dioxide and isoprene in the exhausted air always rose significantly," explains Williams, "at each and every showing." This is important because this is the only way to produce reproducible (i.e., scientifically reliable) results. Isoprene is known for being released through muscle activity. One explanation for the increase in isoprene concentration in a seated audience could be that moviegoers get tense, restless, and breathe faster during exciting scenes.

The fact that the clearest measurement results were achieved for "tension" and "humor" could be related to evolution. Certain substances are released from the body to signal to others that increased attention is required ("tension") or that it is time to relax ("humor"). The findings of the study can be advantageous in various areas. In medical breath gas analysis, for example, it is possible to determine whether a patient is in a stress situation and whether the results could be falsified. For audiovisual media such as commercials, films, and video games, the reaction of the test audience can be better evaluated by air measurements. ■

New Products

Compact Measuring Device

Determining Wavelengths Exactly

WEB US41-028

The WaveEye is a particularly compact and versatile wavelength measuring device for cw or quasi-cw lasers between 450 nm and 950 nm. The measurement data is available with a data rate of 1 kHz without a warm-up delay. It can be used for an optical input power range between 0.1 µW and 1 mW. The digital measured value output is carried out via a USB connection, which also serves as a power supply. In addition, the wavelength information is available as a voltage of up to 4.096 V at the analog output. The WaveEye is particularly easy to operate via comfortable software or simple serial text commands.

Due to its small size, the WaveEye is suitable as an OEM component for a variety of applications (e.g., in tunable lasers or as part of a larger measuring device). ■

Carol Howard +1 603 821 7040
howard@laser-components.com

New Conversion Screens

Optimized Performance and Resolution

WEB US41-051

Our range of conversion screens is constantly being optimized and expanded to cover as many application areas as possible. These three new versions are currently being added:

- **LDT-007BN** for low-power Nd:YAG lasers converts IR radiation of 700 nm to 1400 nm into visible red light of 654 nm.
- **LDT-1064CN** made of resistant ceramic is suitable for high-power IR lasers (900 – 1100 nm) up to 200 W/cm². The area of 60 x 40 mm can be used up to the edge.
- **LDT-1064N** offers a particularly large area of 50.8 x 50.8 mm and can also make the invisible radiation of IR lasers (800 – 1700 nm) with larger diameters visible as green light (530 nm).

All screens are ready to use immediately and do not have to be activated. Upon request, we will be happy to supply you with a sample to test the screens in practical applications. ■

Kelly Child +1 603 821 7040
kchild@laser-components.com

New Line of Differential Pyroelectric Detectors

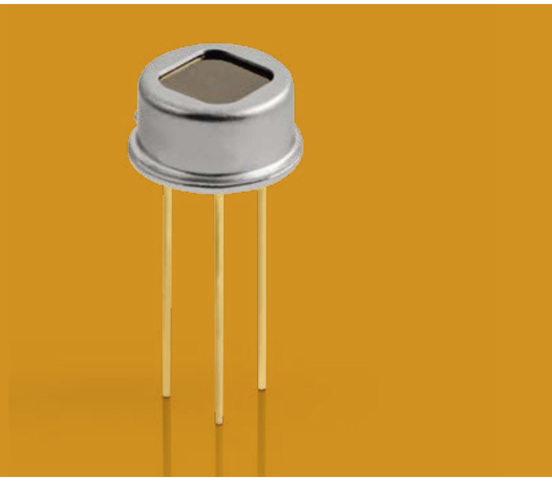
Plug-and-Play Version with an Integrated Two-Stage Amplifier

WEB US41-9220

With our differential pyroelectric detectors, the charge carriers on the top and bottom of the chip are able to be amplified separately for the first time. This causes the detector signal to double while the background noise only increases by a factor of 1.4. This patent-pending idea can significantly increase the sensitivity of IR analyzers. The separate signal outputs make the detector insensitive to interference currents.

For better implementation in existing systems, we now also offer a version with a classic 3-pin housing. Both signals are fed into a differential amplifier in the housing. For the user, the detector looks normal at first glance: a single supply (i.e., only one signal output). The difference is evident in the application: The signal-to-noise ratio is around 50% better than with conventional high-end models. ■

Jim Dell +1 603 821 7040
dell@laser-components.com



For Clean Air

Detectors Now Available with IR Filters for Measuring NO_2

WEB US41-087

Particularly since the diesel scandal, everyone has been talking about the concentration of nitrogen dioxide in the air. While carbon compounds are routinely measured using the NDIR method, the search for standard IR detectors with filters for NO_2 measurements has been pursued in vain. To detect nitrogen oxides, usually electrochemical or UV processes are used. In engine development, laser-based IR processes are employed.

LASER COMPONENTS has established itself in recent years as the manufacturer of pyroelectric detectors with the broadest range of standard bandpass filters. It is therefore only logical to expand this leading product range: We now offer pyroelectric detectors with narrow-band IR filters for NO_2 measurement (filter option V) upon request. The filter specifications were developed in close cooperation with users.

This makes it possible for manufacturers of NDIR exhaust gas measuring benches to ex-pand their devices by an additional IR measuring channel and to dispense with alternative methods. Two further innovations from LASER COMPONENTS are very helpful in this context: Firstly, the gas humidity can also be measured using NDIR with the help of the "M" filter. Secondly, NO_2 measurement is without a doubt challenging and we therefore recommend the use of the latest and best detector generation – our differential pyroelectric detectors. ■

Susan Wells +1 603 821 7040
wells@laser-components.com

Optical Fibers with Ball Lenses

Expansion of Technology in the Field of Fiber Optics

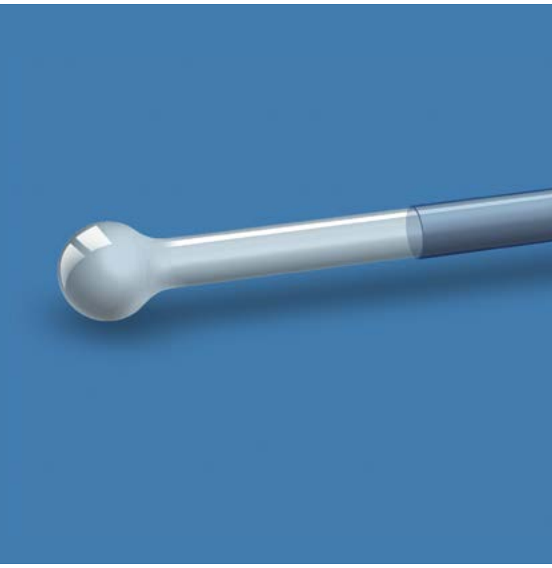
WEB US41-014

Ball lenses are used in fiber optic technology to optimize the illumination characteristics of the fiber. Depending on the geometry of the light source, these lenses are used to focus or collimate light. This is why they are used in endoscopes and other medical applications, for example. The rounding of the ball lens also reduces the risk of injury during examination.

Upon request, LASER COMPONENTS can melt ball lenses onto the end surfaces of silica fibers in various diameters. The fiber geometry must be taken into account here as a basis. Our technology supports fiber diameters of 200, 365, 400, 550, and 600 µm. Of course, you can also order assembled fibers with ball lenses as a finished OEM product from us.

All fibers are processed and sterilely packed according to ISO 13485. Thus, they meet all hygiene requirements for medical technology. ■

Huyen Vu +1 603 821 7040
hvu@laser-components.com



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