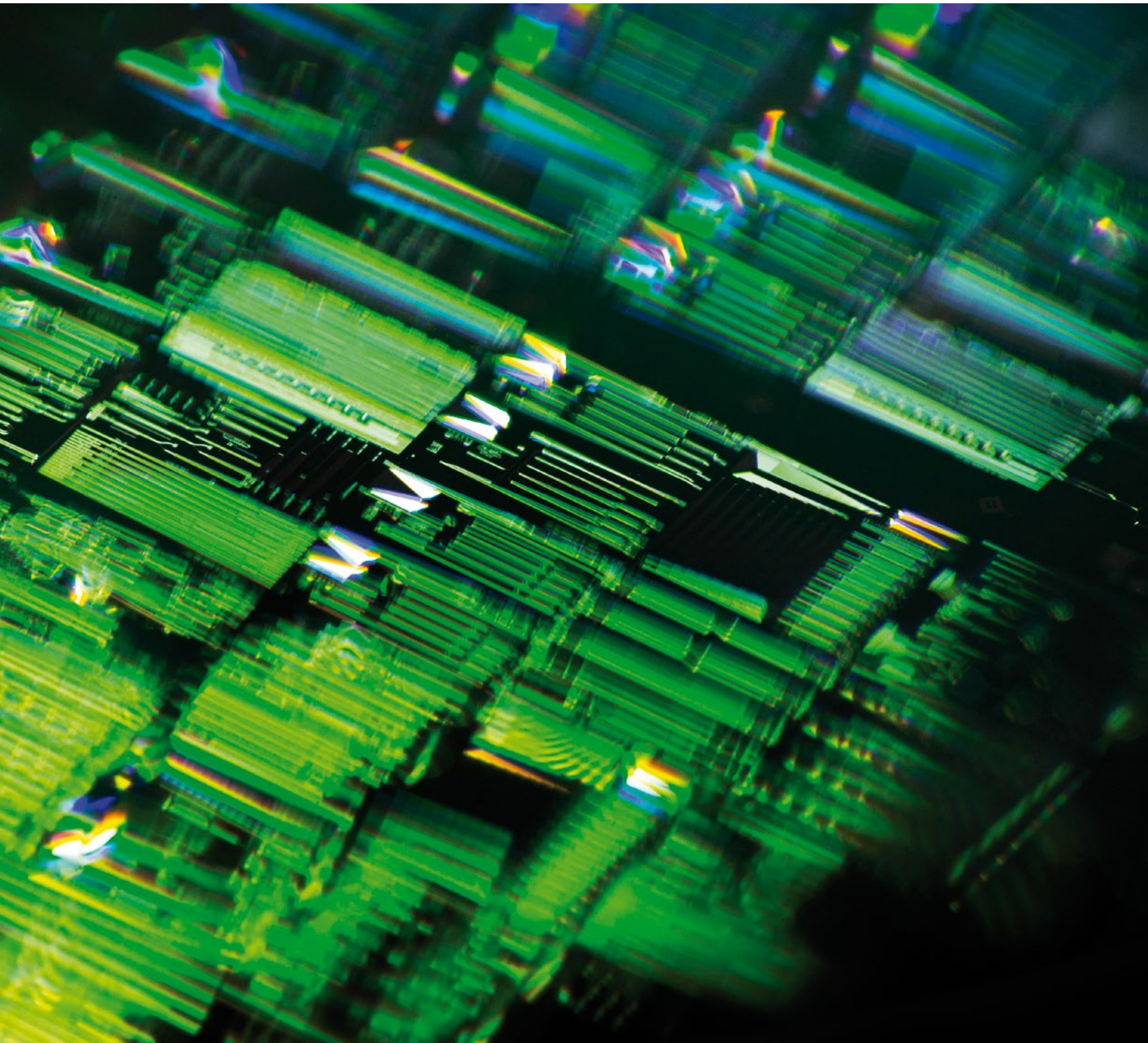
INTEGRATED PHOTONICS IN THE NETHERLANDS

Application Notes on Integrated Photonics



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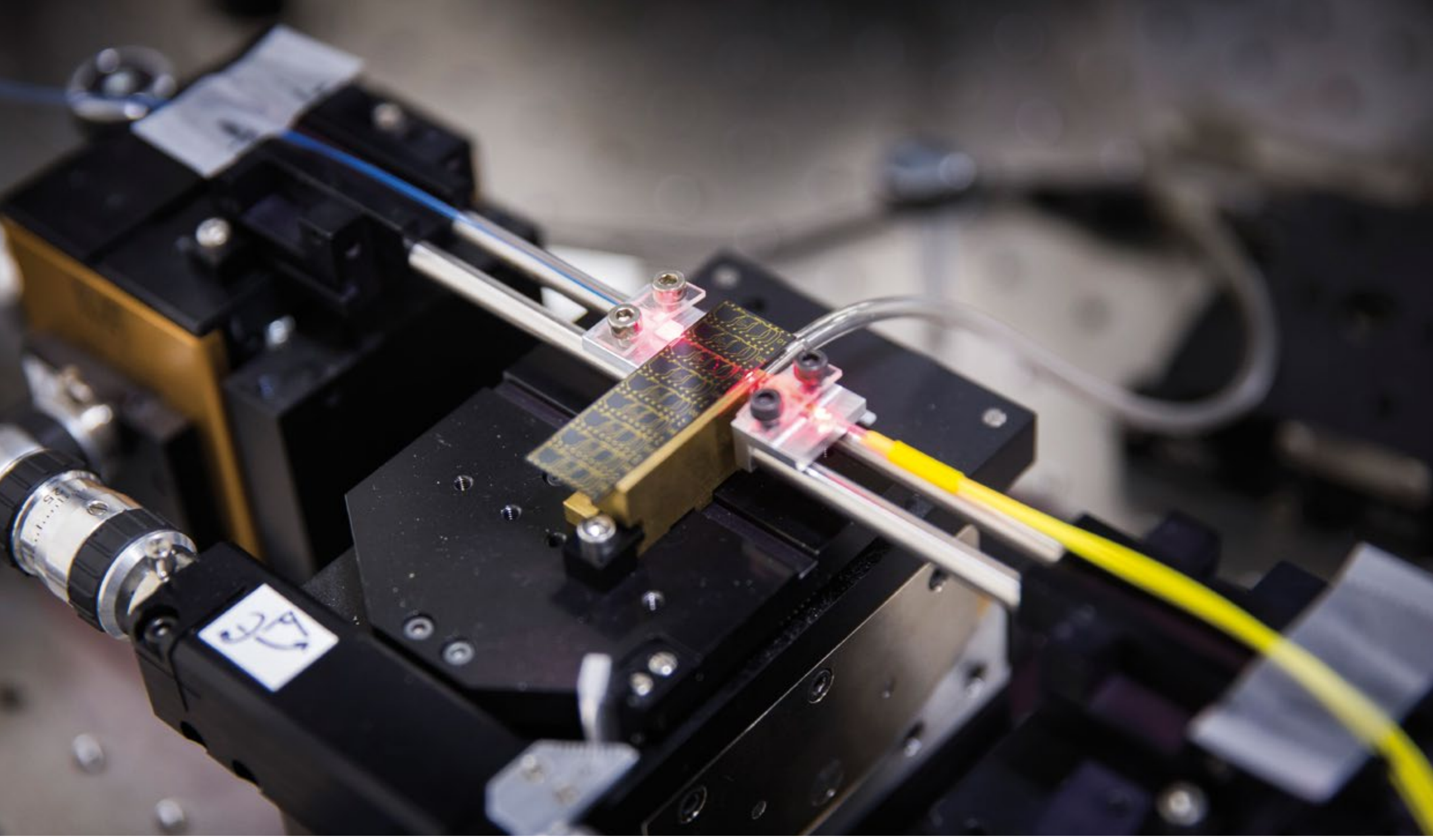


A TROLLEY FULL EQUIPMENT ON A POSTAGE STAMP

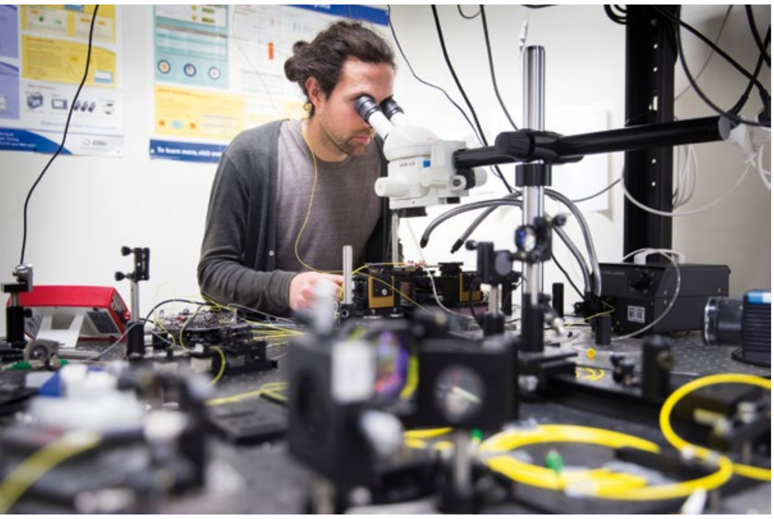
Introduction

Optical Coherence Tomography (OCT) is a relatively new method of examining living tissue, which uses light instead of needles and incisions. Current OCT systems are rather cumbersome and involve a trolley laden with equipment being pushed through the hospital. This makes the current systems also too expensive and unwieldy for a family doctor to carry out a quick check. The Academic Medical Centre of the University of Amsterdam (AMC), among others, is working towards miniaturazing the trolley by using integrated optical circuitry.

OCT, the optical analogue of ultrasound imaging, provides high resolution imaging of living tissue to a depth of 1-3 millimetres. Because light is used, the depth information of the back-scattered light is obtained by low coherence interferometry. Currently, two methods are used, both based on the fact that the depth information from back-scattered light can be obtained by detection of the wavelength encoded interferometric signal. One method makes use of a broadband laser light source of which the back-scattered light is detected by a spectrograph equipped with a detector array. In the other method, the complexity of the system is the use of a fast scanning laser source, which bombards the tissue with light at successive wavelengths. At the detector, the wavelength information of the interferometric signal is decoded in time.

Bulky lab equipment

In both cases the lab equipment is particularly bulky. Classic optical building blocks, such as lenses, diffraction gratings, interferometers and mirrors expand the size of the equipment. Couldn't it all be made smaller, more portable and less expensive? Couldn't the equipment, in some cases, be reduced to the size of a pocket book or even a postage stamp?
Yes, that must be possible, according to the AMC, Twente University, the Technical University of Eindhoven and the companies Lionix, XiO Photonics and VTEC. In a year's time they aim to demonstrate an OCT set-up approximately ten times smaller. This size reduction is enabled by the use of small, integrated, optical circuits, in which items such as optical wave-guides are incorporated. These photonic integrated chips manipulate light on a much smaller scale than lenses, mirrors and prisms.



No more glass fibre cables

The consortium was already successful in integrating a spectrograph in a chip the size of 3-6 cm^2. A further success was the integration of a laser source that emits light at various frequencies in quick succession. In fact, the consortium's aim is to transport and manipulate the light as much as possible within the integrated optical circuitry itself. Glass fibre cables are only needed to transport light to and from the circuitry.
The real challenge is to develop a measuring device with optical chips that can be stuck onto tissue like a plaster, which would completely eliminate the need for glass fibre cables.
The consortium's approach opens up a whole treasure trove of possibilities for alternative applications. With a spectrograph on a chip and the other building blocks currently in development, a technology such as fluorescence scanning literally loses mass.

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CSI

Fluorescence scanning is not only used to identify tumours but it is also an invaluable tool in crime scene investigations. In an ideal world, the technology would be so portable and inexpensive that a forensic detective could carry out blood spatter research and fingerprint analysis on site. The age of a fingerprint is currently determined through the use of substantial measuring equipment. In the future, perhaps, all that will be needed is a small device in the detective's pocket.

'The consortium was already successful in integrating OCT on a chip'

Thinking outside the box

Miniaturisation would also relieve the burden on overstretched hospitals. In the near future, family doctors might be able to investigate skin blemishes themselves. And industries could also benefit from the technology; for example, in the detection of particle movements in liquids, for which bulk methods are currently employed. And then there are numerous applications which no-one has yet imagined, e.g. measurements in places that are currently inaccessible to imaging equipment. Over the coming years, thinking outside the box will undoubtedly bring new possibilities to light.

Fields of application:

- Medical Industry
- Life Science Industry
- Forensic Industry

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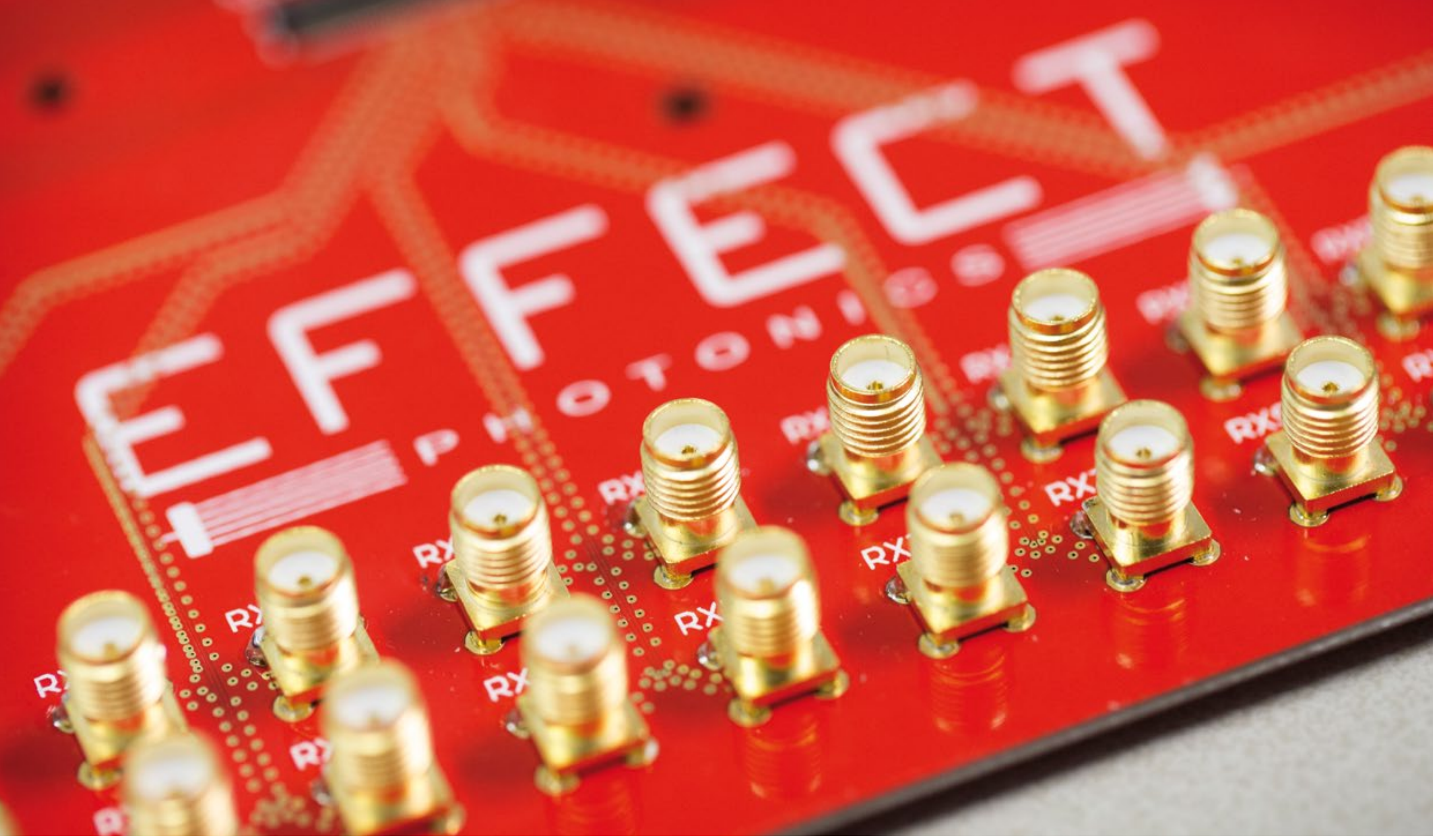


ACCESS TO INFORMATION AT OUR FINGER TIPS

Introduction

We all love watching the latest House of Cards on our cellphones or tablets, navigating the streets of Barcelona while listening to music through our apps – preferably without any delays or hiccups. With all this new, mobile technology in our hands, our thirst for fast connections and lots of data has grown exponentially. But data technology is reaching its limits. What we need is nothing short of a revolutionary innovation that is able to deal with more data at the speed of light.

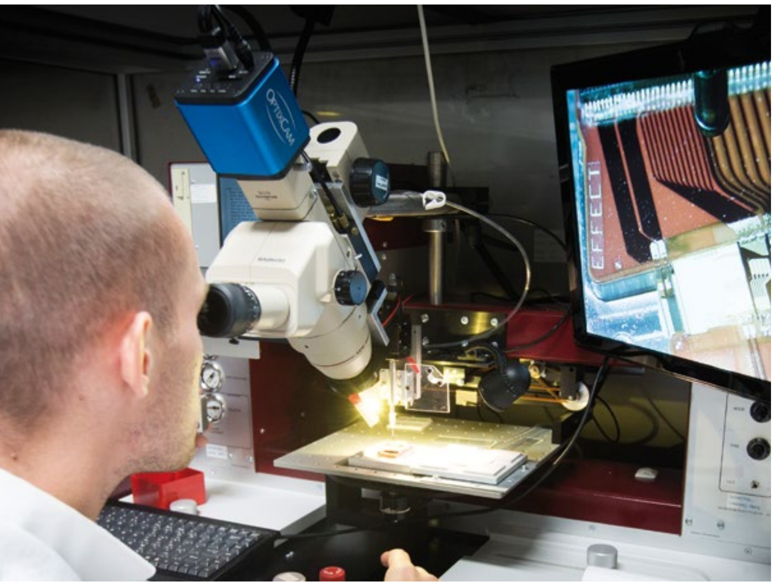
Some 50 years ago, optical fibers were the answer to our growing need for fast data. They span from country to country, crossing the oceans and forming the largest piece of man-made infrastructure that exists on our planet today. By using Wavelength Division Multiplexing (WDM), telecommunications companies worldwide were able to quickly expand the capacity of their networks through the use of different wavelengths of laser light that feed lots of separate signals over a single strand of optical fiber. Thanks to these inventions and immense technological innovations in our computers, mobile devices, and new applications, within a few decades our need for even faster data rates continue.

On-demand and IoT

Unfortunately, the capacity of the current generation of optical devices hasn't kept pace. Not only on-demand video streaming is to blame, but also the development of 'The Internet of Things' and advanced machine-to-machine communication will demand more stable, secure, yet inexpensive solutions. This is where integrated photonic chips play an important part; optical chips that can send and receive multiple light signals simultaneously, all within the same physical size as a chocolate bar.

Optical System-on-Chip' technology

In 2010, EFFECT Photonics, a spin-off from the Technical University of Eindhoven (TU/e), saw a strong market need to bring its 'Optical System-on-Chip' technology to market in order to meet the soaring demand for bandwidth in cell towers and between data centers. EFFECT Photonics develops and delivers highly integrated optical components based on InP (Indium Phosphide), the material of choice for combining efficient laser light sources, waveguides, modulators, amplifiers, and photo-diodes used in optical communication systems throughout the world. In 2013 they started building a demonstration model for this Dense Wavelength Division Multiplexing (DWDM) optical system based on integrated photonics, working closely with their customers such as data centers and telcos to define their requirements.



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More condensed, energy efficient and cost-effective

Each photonic chip can handle huge bandwidths of data in a far more condensed, energy efficient and cost-effective way than current optical devices. EFFECT Photonics' current design improves the port density by a factor of 5 while lowering operational costs by up to 40%. Due to the exponential growth in data in the forthcoming years by a factor of 10, experts foresee a huge rise in energy demand from data centers and telecommunication services. Our current energy use while surfing the Internet already makes up 5% of all energy consumption worldwide, by 2020 this will be 20%. EFFECT Photonics' 'Optical System-on-Chip' technology might just be the tipping point for Obama's Climate Change Plan to succeed.

> 'This is where integrated photonic chips plays an important part'

Taking micro-photonics to a serious macro-economic business

EFFECT Photonics is scaling up and opened a second facility in the United Kingdom, Torbay in 2015. Scaling up to manufacture in volume can be a complex challenge, however, EFFECT Photonics has set out to design for low cost manufacturing from the very beginning. Working together with several photonic innovators at their doorstep, like the TU/e and SMART Photonics, EFFECT Photonics is taking micro-photonics to a serious macro-economic business.

Fields of application:

- Data communication industry
- Telecommunication industry
- High Tech industry
- ICT Industry

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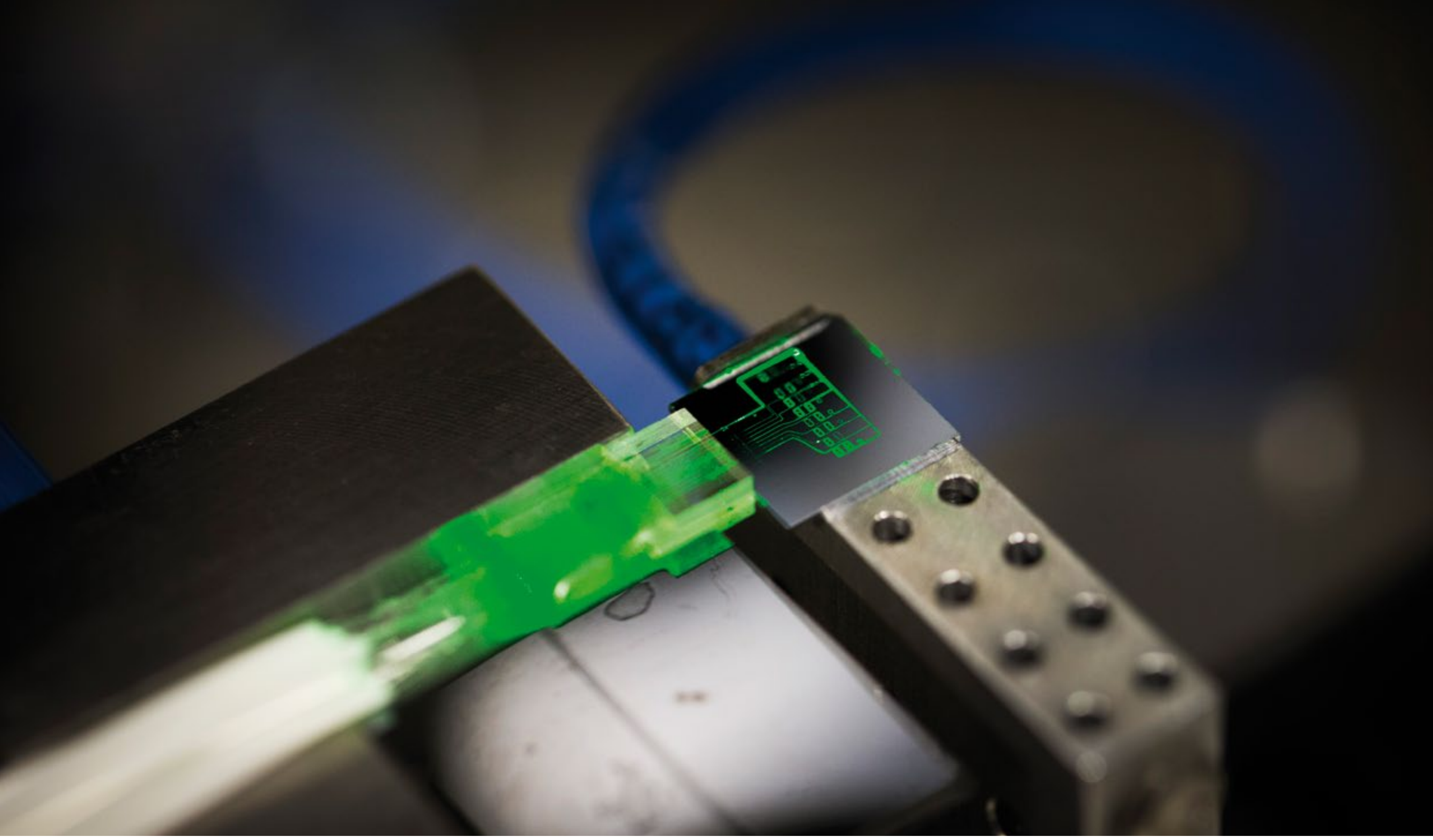


VISIBLE LIGHT CHIP RULES THE WAVES

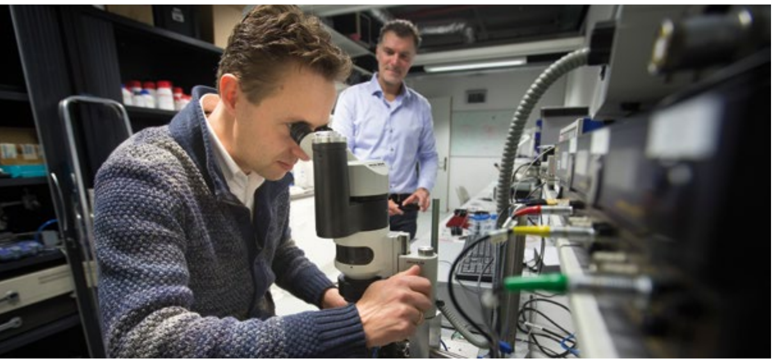
Introduction

Measurements are essential to the production process in many industries. Take the food industry, for example, in which pathogens and other substances that do not belong in food must be identified and removed in time to avoid possible food scandals. Or consider farming, for which light, air, water and fertiliser must be combined in the correct proportions to produce an optimal harvest. Just think of the possibilities if a sensor technology could be developed that is not only extremely compact but can also perform various complex measurements simultaneously and real-time and on-site.

Many sensors make use of light. Because light and matter is a beautiful combination; certainly when it comes to organic matter. Current equipment makes use of expensive lasers and analytical software. This equipment is often very large and consists of bulky components, lots of lasers, glass fibre, prisms and microscope lenses. The development of integrated optics has made chip technology possible based on light, which is accompanied by substantial cost reductions and introduction into arrays and matrix sensors.

From infrared to visible light solutions

Nowadays there are three main platforms available to produce standardized solutions for integrated chips, being Silicon Photonics (Si), Indium Phosphide (InP) and TriPleX™. All three platforms are applicable for infrared (IR) light, which is logical as the traditional applications can be found in telecom and data communications. Contrary to Si and InP, the TriPleX platform is also applicable for visible light. Especially for sensing applications this is very beneficial as IR based sensors have only limited applications and are difficult to manufacture, due to their expensive (and still frequently used) large components. Also for applications such as microscopy, people have a strong preference for visible light, as they are used to work with visible light only. This means that almost all new applications developed in this field have to be based on visible light. An additional advantage of visible light sources and detectors is that despite the sometimes very low cost due to very small size, the quality can still be very high, making them ideally applicable to, for instance, a disposable design. LioniX, based in Twente, the Netherlands, designs, develops and manufactures customised 'visible light' chips. Chip designs are either completely tailored to customers' needs or are based on standard elements in a design library.



Multi Project Wafer (MPW) runs

The latter option offers each customer the possibility to design their own chips and to participate in one of the company's Multi Project Wafer (MPW) runs. This considerably reduces the price per run for each client. The LioniX brand of integrated optics technology is called TriPleX™ and allows for medium and high index-contrast waveguides with low channel attenuation, especially for visible light.

Micro ring resonator

The company has also developed a micro ring resonator: a microscopically small, flat disc in which visible light is trapped. Even though the light is trapped in the ring, it remains in contact with the outside world and the light is able to engage in sensor activity, both in liquids and in air. It is possible to place various rings on a single surface, creating a multi-sensor. The typical diameter is 50-100 micrometres, which means that hundreds of rings can fit on a chip only one square millimetre in size. All these rings can be driven by one light source only and read out by a very small detector array, which is very interesting for a whole range of sensor applications. Sensor applications are not only important for our food safety; the medical world is also interested in taking measurements using multiple parameters. Blood, saliva, faeces: taken together, these measurements help to form a complete picture of a patient's condition. This, in turn, supports a better and quicker diagnosis and analysis. Current measuring equipment is often expensive, large and complex. If we want to switch to equipment capable of taking synchronised measurements, which is inexpensive to read and even disposable, photonic integrated chips are the solution. The advantages of visible light pave the way for designing this disposable, miniaturised chip.

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> **'Advantages of visible light pave the way for disposable chip'**

Building a neural network of rings

A sensor must be sensitive to multiple external influences. Each ring therefore receives a special coating which is sensitive to a single application. Platform technology makes other specific measurements possible by using multiple rings. And all of this takes place on a surface area of just one square millimetre. Because the light intensity inside the ring is enormously high, extremely sensitive measurements are possible. No light is lost and the ring resonator is also, therefore, extremely energy efficient. The goal is to develop a very inexpensive chip that is extremely effective and capable of measuring more, and more complex, data simultaneously and in a much shorter time. By equipping multiple rings to perform multiple applications, a kind of neural network is created from which researchers, doctors or farmers are able to extract much more information. By combining rings, each of which produces a small amount of information, a complete picture can be formed.

Fields of application:

- Agriculture Industry
- Food Industry
- Medical Industry
- Health and Life Science Industry

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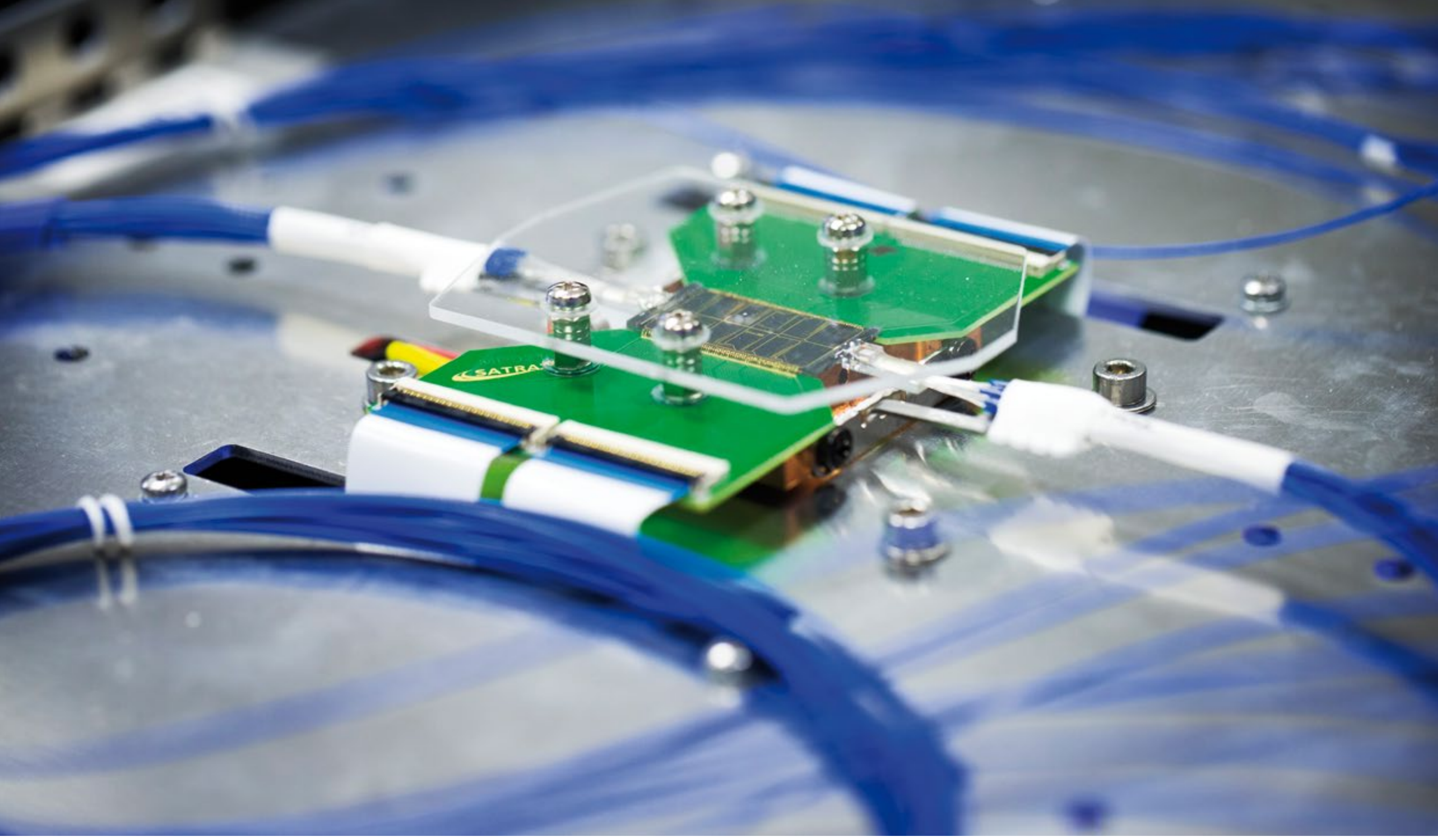


REVOLUTIONS IN ANTENNAS AND 5G NETWORKS

Introduction

In the world of antennas, high-frequency radio and data traffic, work is proceeding at a pace on, among others, the introduction of 5G wireless networks in 2020. According to Satrax, a company based in Twente, the Netherlands, light is the answer to the increasing demand for higher data frequencies and bandwidths. The company develops antenna plates in which integrated photonic circuits play an essential role. But these chips are also leading to revolutionary developments in other fields.

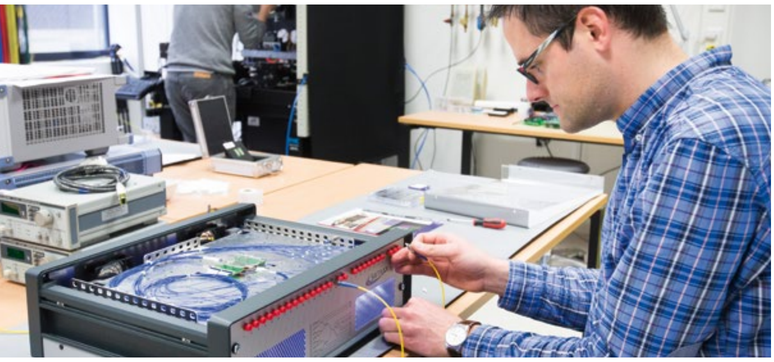
In response to the increasing demand for high-frequency bandwidths, capable of transmitting large amounts of data in short times, light offers a better solution than electronics. Bringing radio signals into the optical domain via beamforming technologies, processing them and transforming them back into radio frequencies, no longer requires time-consuming, and power consuming high speed electronics. The processing could be sped up by a factor of 1,000 to 1 million when performed in the optical domain.

Free space optics

The networks and modules that make this possible today are based on free space optics and require bulky discrete components such as lasers, detectors, modulators and large glass-fibre cables. This results in a cumbersome, large and inefficient solution, which is also very expensive and therefore unattractive for mass production. For this reason Satrax has developed an optical chip-platform which includes tuneable delays, phase shifters and filters that are integrated through the use of CMOS manufacturing techniques. Satrax is able to confine light signals in optical ring resonators to achieve tuneable delays, which are key-functionalities to create a broadband beamforming modules for phased array antenna plates.

Integrated Microwave Photonics

Integrated Microwave Photonics makes it possible to incorporate those optical ring resonators on the optical chip. Not only is the functionality and robustness of the antenna improved but, at the same time, weight, costs and energy consumption are reduced. Independent of the desired frequency, Satrax can design larger or smaller directional antennas from several modules of individual antenna plates.



Demonstrating broadband reception

Satrax works with chip manufacturers SMART Photonics, which manufactures InP chips with lasers, modulators and detectors and LioniX who fabricates TriPleX™-chips with the optical beam-forming network. This InP-TriPleX™-chip-platform ensures processing of light on a small scale without leading to large signal losses. The first prototypes were produced in 2006-2010, thanks to the support of the then government's Point One programme, among others. The first optical chips were connected to an antenna in 2008 to demonstrate broadband reception for Radio Astronomy applications. All of the functions normally associated with the electronic domain are now possible by means of light.

Disruptive technology

This so-called disruptive technology of photonic integration, and particularly the combination of different chips to one integrated chip-platform, can be applied to various industries and used in a variety of applications. The chip can be integrated in data and telecoms applications, prototypes for satellite communication, antennas in the roofs of self-driving cars and in the next generation of (plate) antennas for base stations which enable high capacity and dynamic coverage for mobile communication. Furthermore, light reflections also provide images of surroundings in relation to objects, distances and differences in speed. Here light, LiDAR, is used as alternative for radar.

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'All of the functions normally associated with the electronic domain are now possible by means of light'

Aviation, space and medical applications

The development of photonic beamforming technology is also of interest to the aviation and space sector. In 2014 Satrax participated in an ESA satellite communication project with Airbus Defence & Space. A satellite currently serves an entire continent with a single beam for the whole of Europe, for example. The new technology makes it possible for multiple, independent, signal beams to be transmitted to various European countries at the same time. Frequencies can be re-used: the beam-forming chip was designed to handle up to 36 bundles simultaneously. Moreover, the size and weight of the beamforming module was more than 1000 times smaller than the currently used conventional technology of RF waveguides. Furthermore, the technology has possible applications in MRI scanners where beamforming is also applied. The optical chip would make the scanner much smaller (and therefore more patient-friendly), would speed up the processing of data and would allow the generation of greater amounts of more complex data.

Fields of application:

- Data and Telecom Industry
- Aerospace Industry
- Automotive Industry
- Life Science and Medical Industry
- Data Security Industry (Cryptography)

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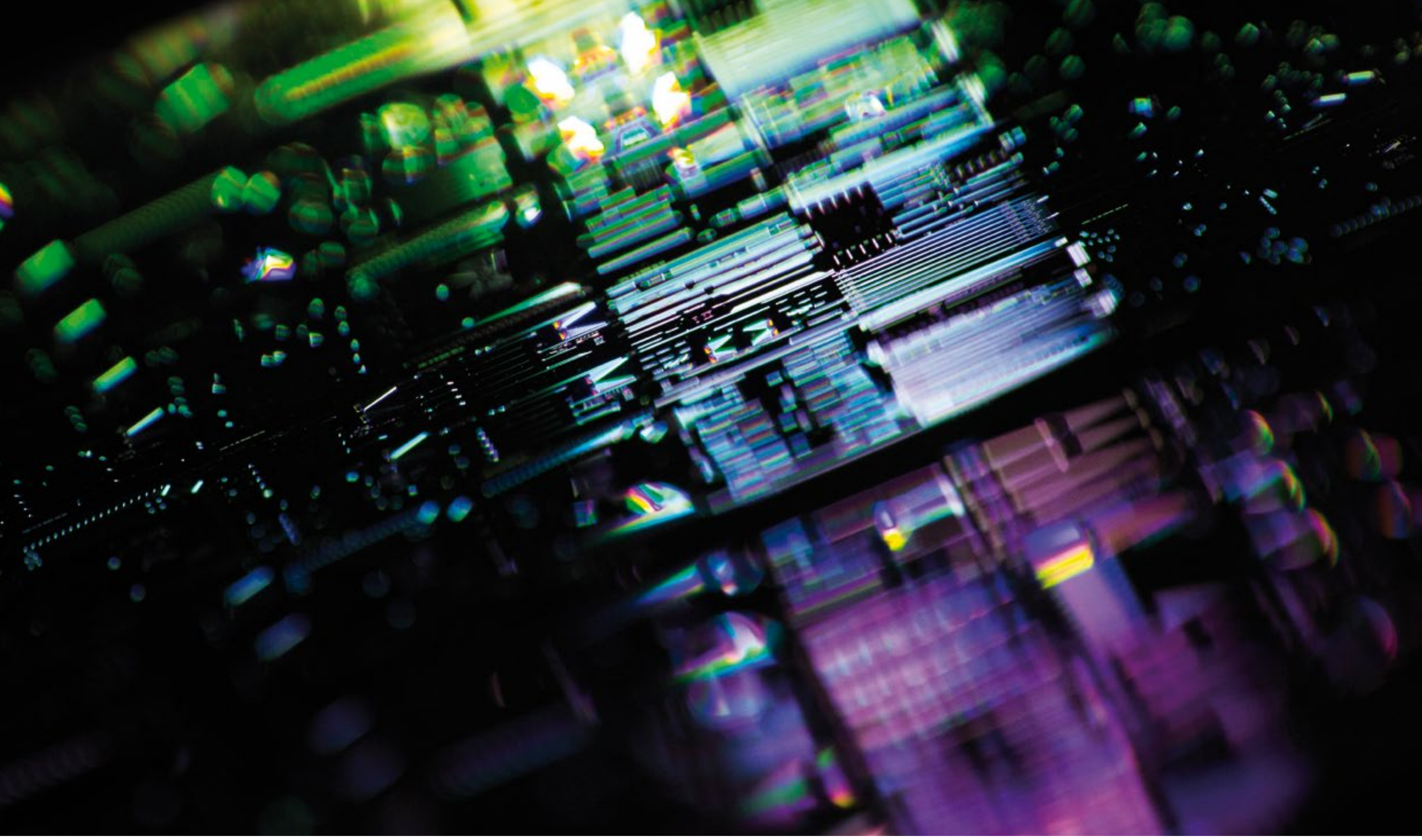


IT ONLY NEEDS TO BE IMAGINED

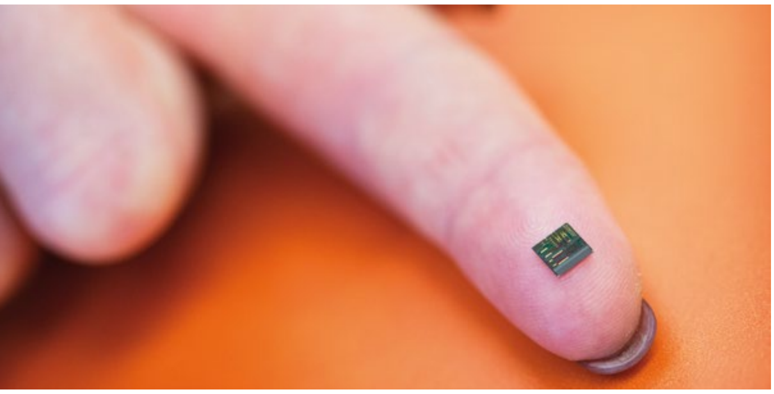
Introduction

A few years ago chip manufacturer SMART Photonics, in Eindhoven began to produce integrated photonic chips with the potential for diverse applications in a wide range of industries. In high-tech industries sectors such as data and telecom, the medical sector and aviation, integrated photonics offer many advantages and new functionalities compared or in addition to existing solutions.

Like semiconductors, photonics has become a mature industry, and with the introduction of integrated photonics new inventions, business sectors, studies and maybe even disruptive products, like smartphones, may be expected. Taking a similar development path as the semiconductor industry, SMART Photonics provides integrated photonics using the generic technology as its basis; it brought the industry on the verge of making breakthrough developments. Up to then, for each chip a new process needed to be developed, tested and manufactured. SMART Photonics was in 2013 the first to commercially introduce Multi Project Wafers (MPW) as a low threshold vehicle to bring this technology onto the commercial market.

More energy efficient and lighter than standard optical measurement equipment

Two years ago the first chips that could replicate existing functionality on a single chip rolled off the first MPW run wafers. The company produced the chips for incorporation in measuring equipment, replacing the previous shoebox of free standing optical components and sensitive, not to mention expensive, materials. The first run produced a chip 18 square millimetres in size with greater functionality, able to take measurements with many times more accuracy and many times more robust than conventional measuring equipment. This chip can be incorporated in aircraft and helicopter wings or in ships' hulls. It is non-sensitive to light, air and vibrations, while being more energy efficient and lighter than standard optical measurement equipment.



A smartphone for self-diagnosis

The company also produced a chip with support from the IOP programme, in partnership with Radboud university Nijmegen and TU Eindhoven, which delivered a chip for a breakthrough technology: trace gas analysis. This allows the level of e.g. methane in a person's breath to be measured, through which the presence of diseases can be traced. The laser used for this is smaller than 10mm^2. Thanks to this enormous reduction in size, a large piece of equipment, which functions in a completely different way, can now be replaced by a single chip. The technology is many times more inexpensive than the larger equipment and, in the future, could easily be incorporated into a handheld device or maybe even a smartphone for self-diagnosis. Similar sensoring methodology can also be applied to the oil & gas industry, for example for detecting gas at the bottom of an oil well, and thus avoiding the creation of sparks, drilling can be made much safer and explosions can be avoided.

Building blocks in a design kit

Thanks to the research carried out over the past 15 years, integrated photonics makes it possible to combine all the building blocks in a design kit to produce extra and new functionalities. The description of the building blocks in the design kit includes an additional abstraction level to the design. Designers do not need to know the ins- and outs of the technology, but can make a design on a functional rather than a physical level. Anyone who understands the functions of the individual building blocks and has the imagination to see new possibilities can have their 'idea on a chip' made by SMART Photonics. Designs for any sector, from the medical sector, sensors, data and telecoms to aerospace, can be converted into the required process steps. SMART Photonics provides the expertise, the equipment and the environment. In 2015 the company opened its own clean room in order to offer specific solutions to clients, while ensuring stability and continuity; perhaps the most important characteristics of mass production. After three years, the first clients are now moving towards mass production. That is to say, the design is reasonably stable and the chips are now progressing from the concept or test phase towards the pre-production phase.

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'SMART Photonics provides integrated photonics using the generic technology as its basis'

Next step: mass production

The next step is to approach various markets. They need to imagine applications that would make life or production simpler, faster, more intelligent, cheaper and more energy efficient. The infrastructure to produce the chips already exists; an inexpensive testing procedure is available and if the design works, the next step into mass production is relatively simple. For SMART Photonics it is no longer a question of whether revolutionary innovations can be made using integrated photonics, but when. It is possible. It only needs to be imagined.

Fields of application:

- Health and Life Science Industry
- Agricultural Industry
- Automotive and Aerospace Industry
- Data and Telecom Industry

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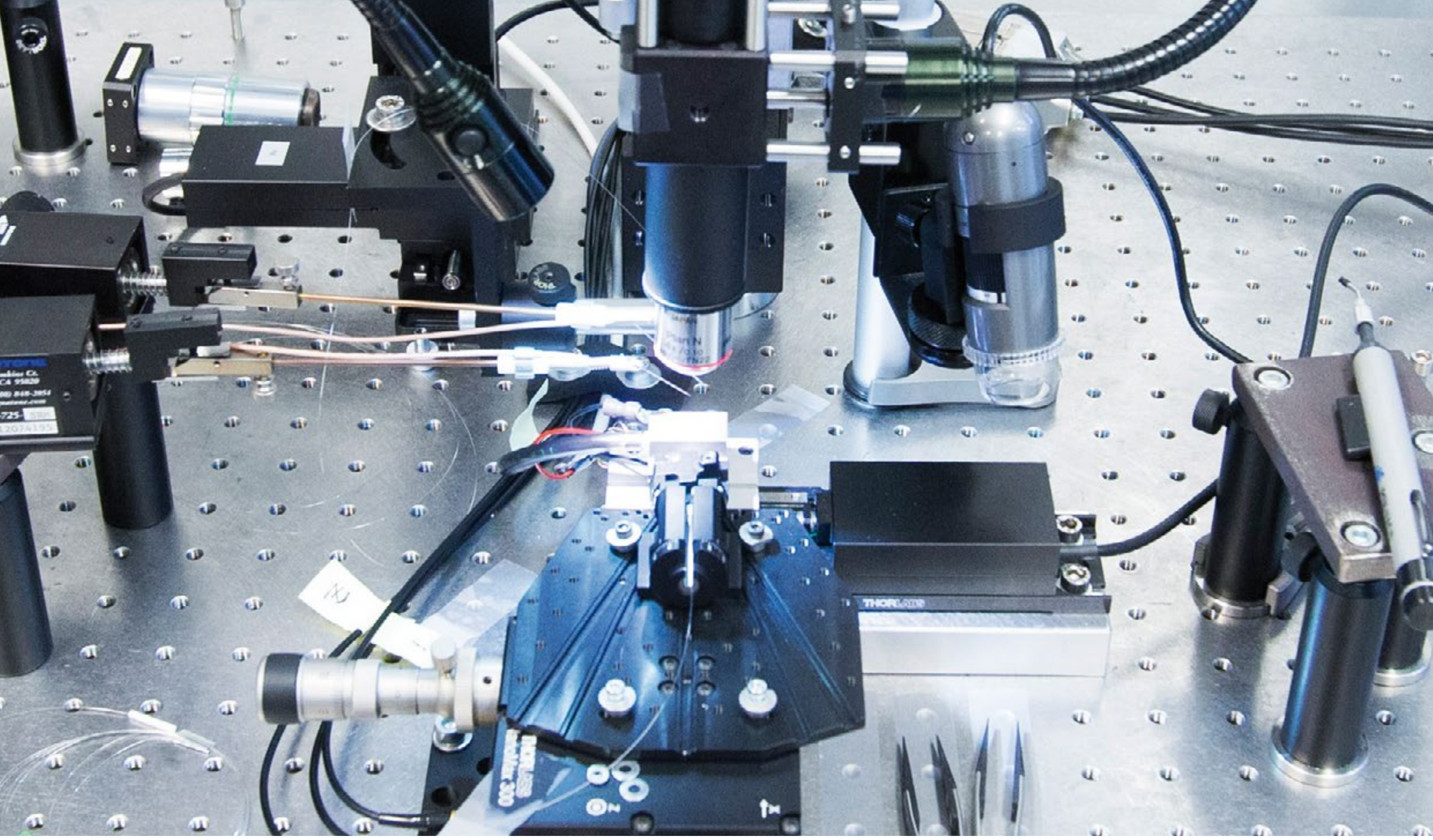

MEASURING 30,000 TIMES MORE ACCURATE

Introduction

From the aerodynamics of aircraft wings to micro-vibrations in the high-tech industry: a wide range of industries have a pressing need for extremely accurate measurement systems. Technobis, based in Alkmaar, the Netherlands, develops just such measurement systems. Thanks to Integrated Photonics Technology, their measurement accuracy and reliability has increased considerably. It is now possible to take measurements just 50 nanoseconds apart, 400,000 times faster than a hummingbird's wings, which flap 50 times per second.

Fibre optic sensors form the basis of integrated measurement equipment for instance incorporated in biopsy needles, aircraft and crash-dummies. As a fibre becomes stretched, it is possible to measure extremely accurately the change in wavelength (colour) of the light passing through it. Spectrometry and Interferometry are the physical concepts at the heart of the measurement equipment developed by Technobis to analyse the deformation of the optical fibres.

A few square millimetres

Technobis designs and builds technological platforms based on Photonic Integrated Circuits or optical chips. Previously the company worked with standard optical measurement systems. The disadvantage of these systems is that they are relatively large. While the 'old' solutions were a few square centimetres in size, the integrated photonics chip takes up just a few square millimetres. This compressed technology also allows for a much smaller chip casing while delivering far greater stability, both thermally and mechanically. This allows much smaller changes in wavelength to be measured, which would be undetectable to conventional measurement equipment.

Measuring strain differences of less than a millimetre over 1000 kilometre

Impressive improvements in measurement performance have been realised. Conventional measurement equipment is able to measure strain to an accuracy of 0.1%. With Integrated Photonics it is possible to take measurements 30,000 times more accurately. High-tech companies such as ASML have a pressing need for virtually vibration-free equipment which means that they have to use extremely sensitive sensor systems to achieve this. Thanks to the increased stability of Technobis' measurement systems it is now possible to take wavelength shift measurements of less than a femtometer, i.e. measuring strain differences of less than a millimetre over 1000 kilometre. In addition, the equipment is much more precise in collecting falsifiable and verifiable measurements.

Little space? No problem

The system's applications range is also vast in the field of extrinsic measurements. For aerospace and automotive industries it is of particularly importance taking measurements where little space is available, such as on the ribs of crash test dummies. At a speed of 20 kHz, it is possible to take a measurement every 50 microseconds. If a collision takes place in 20 milliseconds, the many measurements acquired will form a detailed impact and crash profile. Damages and impact effects in composites structures in aerospace and space can now be made visible by taking high frequency measurements with devices that endure the strict environments. Composite material is light and strong but damage is often invisible externally. The frequency behaviour of the composite structure changes as it is damaged and is only measurable thanks to the small size and performance of Integrated Photonics. There is no practical and affordable solution thinkable with conventional equipment.

> **'The equipment is much more precise in collecting falsifiable and verifiable measurements'**

Aircrafts and flight performances

The shape definition and design of morphing structures can be measured by fibre optic sensing technology in aircraft wings, with the objective of improving the performance and maintenance of aircraft, to ultimately make flying itself more cost effective (better flight performance and lower maintenance costs). Measurement equipment for these applications must be as inexpensive and small as possible, while using as little power as possible. With the introduction of Integrated Photonics, operational and energy costs can be reduced by as much as a factor of 10 and the same applies to the dimensions of chip casings.

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Fields of application:

- Aerospace industry
- Automotive industry
- Maritime industry
- Defense industry

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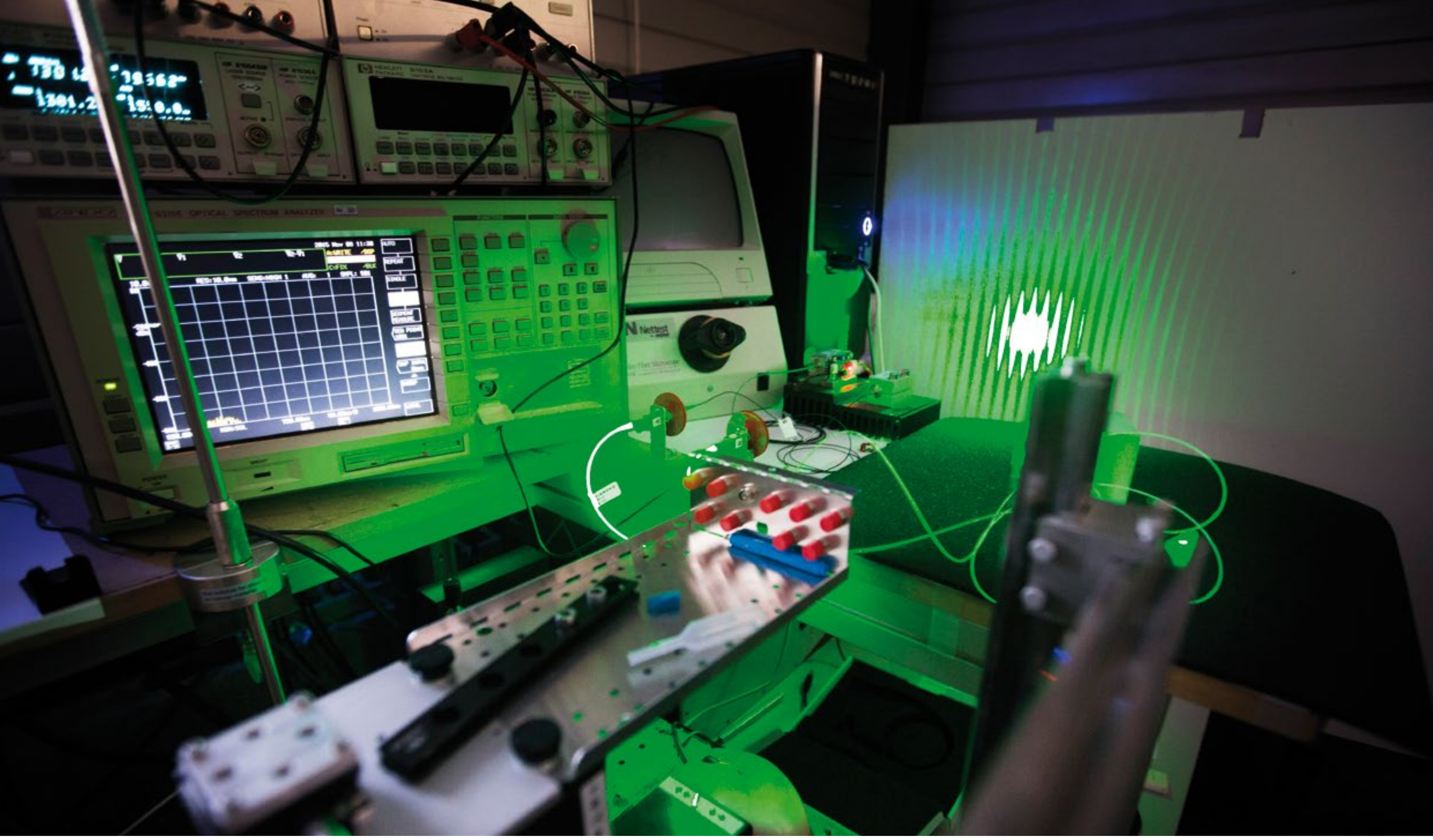


HALF A LABORATORY ON A PICNIC TABLE

Introduction

Highly economical, very inexpensive and much smaller; these are the key characteristics of optical chips. By employing optical circuitry, measuring systems that currently fill half a laboratory can be reduced in size to fit on a picnic table or even slip into a jacket pocket. XiO Photonics has been working with light-manipulating chips for years. The company, based in Enschede, the Netherlands, has a whole library full of solutions based on photonic building blocks and produces applications for the medical and food industries, as well as for Life Sciences, among others.

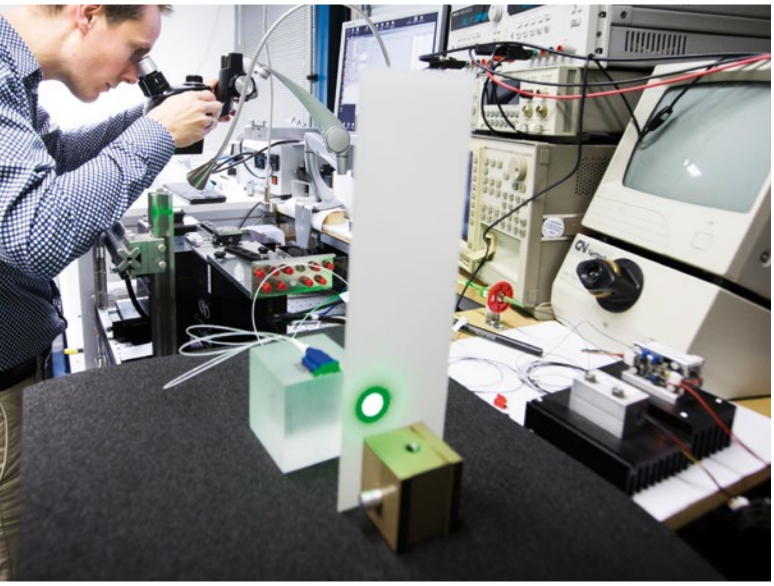
XiO Photonics recently helped a company to find a solution for a relatively complex measurement set-up. A special biosensor with a blood sample was lit from four sides in succession. In order to do this, the company switched between four laser sources. One of the chips from XiO Photonics' library has since replaced three of the four laser sources. The chip is linked to a single laser source and incorporates an optical switch, which acts as a kind of traffic warden. It decides which turn-off the laser light should take. The chip's four outlets are linked to the biosensor, so that the light falls on the blood sample from the correct angle at the right time.

A tiny chip stabilises the laser light

The measurement set-up is shrunk even further through the use of another application that XiO Photonics is keen to highlight: a tiny chip that stabilises the laser light simply by placing it behind the laser source. This is currently achieved elsewhere in the world through the use of a large box of electronic equipment. The changes described above make the measurement set-up more user-friendly, portable, robust and precise.

Beneficial to life science

This approach illustrates a fundamentally different method of thinking in terms of the transportation of light from the source to the place it is needed by the researcher or technician. This can be of benefit to life science researchers, doctors or bio-physicists. Take, for example, confocal microscopy; a decades-old technique that uses a laser source to obtain a pinpoint-accurate 2-D or 3-D image from a sample of tissue or food substance. The light from the laser source(s) is often still manipulated in the classic way, using components such as lenses, prisms and semi-transparent mirrors. These kinds of components are also used to combine or split laser beams. The path from the laser source to the sample is therefore long and circuitous, while the measuring equipment is space- and power-consuming. The equipment is often highly sensitive to vibration and relocation is usually not an option.



Miniaturisation is key

These limitations in the light delivery path barely apply when using integrated circuits, for instance in confocal or fluore-scence microscopy. Miniaturisation is the key word: all of these components can be integrated in chips with a surface area that's a hundred times smaller. The chips are able to mani-pulate laser beams, for example by changing their course, focusing them, combining them or even splitting them. One product that XiO Photonics has developed is a plug-and-play box that can combine up to eight different wavelengths and can be linked to other optical components using glass-fibre cables. This can be a very complex operation using mirrors and prisms. Manipulating light using simple, connectable chips makes confocal microscopy more robust, precise, smaller, more

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mobile and therefore more user-friendly than conventional techniques. Basically, virtually any microscopic technique, such as endoscopy or fluorescence scanning, can be miniaturised in this way.

'A tiny chip that stabilises the laser light simply by placing it behind the laser source'

Improving head-up display in cars

XiO Photonics is also currently carrying out research into improving the head-up display in cars, a technology that has become increasingly commonplace. The gauges and meters in the dashboard are projected onto the windscreen making driving safer, since drivers can keep their eyes on the road at the same time. The technology behind this is also largely based on integrated optics. The gauges and meters are split up into coloured pixels, which consist of combinations of red, green and blue. Each pixel is converted into a laser beam containing a certain amount of red, green and blue. The laser beams are projected onto the windscreen in quick succession, pixel by pixel, by means of a rotating mirror and electronic components. This technology eliminates the need for a lens, since the image on the windscreen is always in focus.

Make an impact

Yet it remains to make an impact. Current systems are hybrid: they combine red, green and blue laser beams with mirrors and prisms. By using a beam combiner on a chip, such as the one developed by XiO Photonics, the projection system can be much smaller, cost effective and robust.

Fields of application:

- Life Science industry
- Medical industry
- Biotech Industry
- Automotive Industry

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