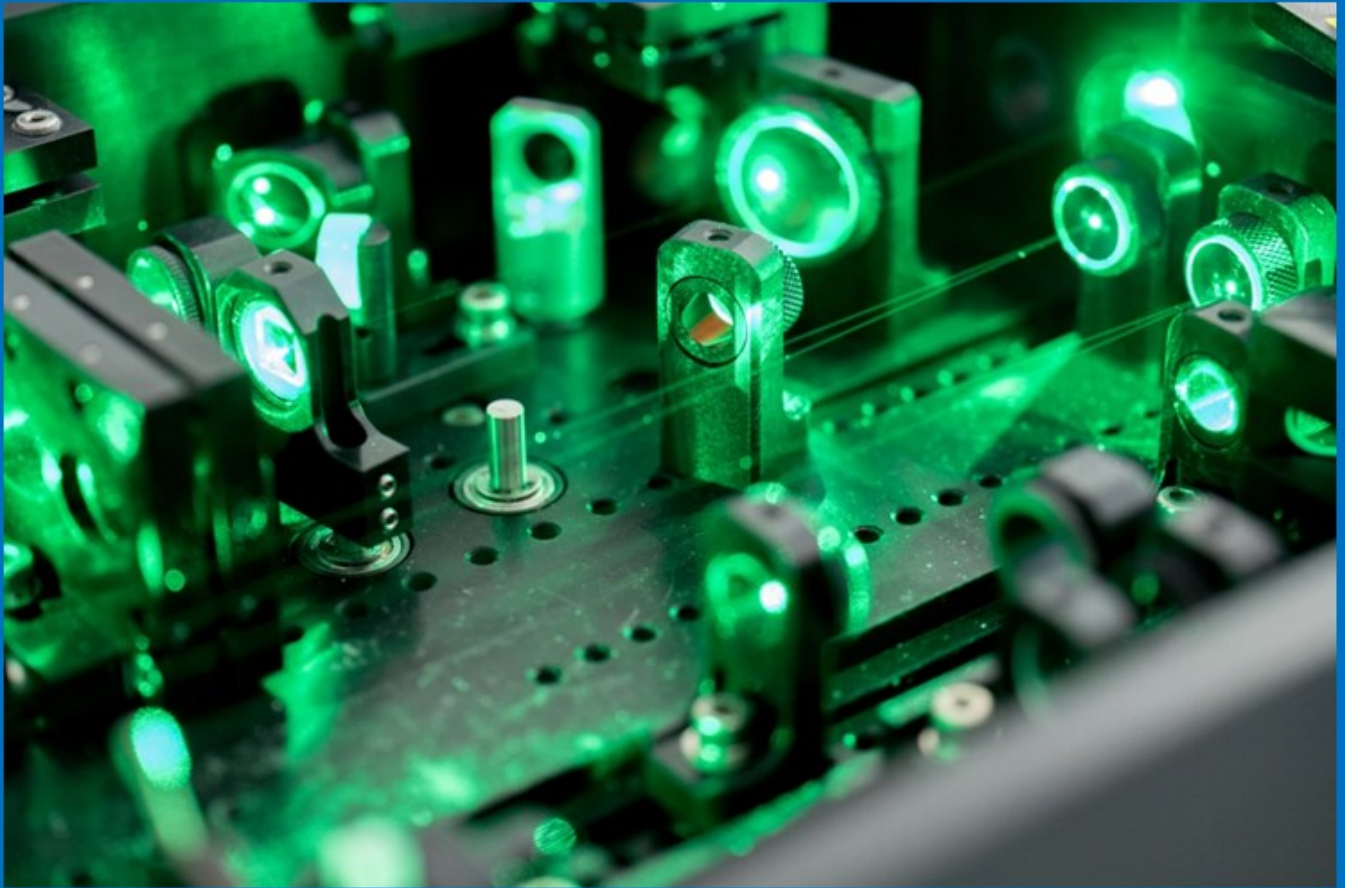




Photonics: Technology for a Greener Future



Photonics Is Everywhere

Photonics is the science of harnessing light to benefit humankind. Behind this definition lies a broad range of applications. And yet people rarely recognise how many photonic technologies are involved in their daily life.

Are you reading this text on a screen? A display is made of millions of pixels, each one is a light source which will be activated in real time to produce images in a fraction of second. Displays are photonic devices! Digital cameras catch light and allow us to capture millions of images of a professional, medical, or personal nature. How did you receive this document? Through the Internet? This document travelled as infrared light through a fibre optic network.

But photonics is far more. Light is fast, precise and clean – three unique properties that make photonics the technology of tomorrow's solutions - while reducing the energy consumption of our data-driven lives. In fact, photonics is at the heart of many remarkable innovations in nearly every market.

Photonics is everywhere and is a key technology that enables all industries to become more effective, more productive, and far more energy efficient.



Environmental

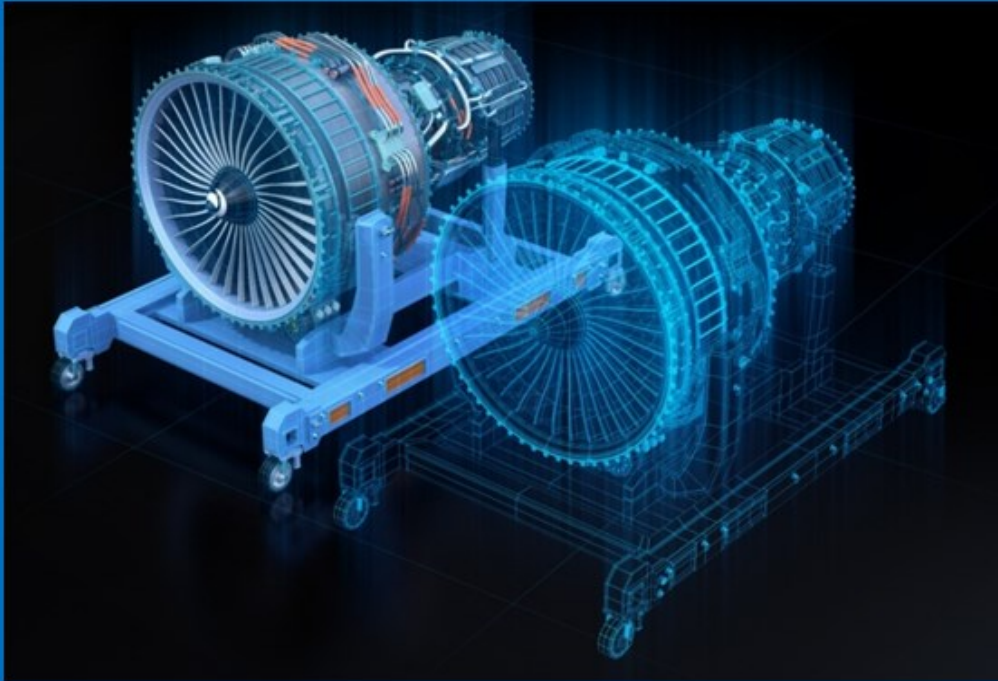


Global warming and its consequences, air pollution in urban areas, water scarcity, the death of beehives or the future of plastic particles in oceans are just a few of the issues that pose immense challenges to science and the future viability of our planet.

As a science of complex measurement, photonics is particularly well suited to monitor the environment and is most often the sole solution. Photonics is the "eye", providing the unique means to monitor Planet Earth from satellite imaging to sensors and fibers capable of active monitoring of water and air pollution.

But the photonic industry also provides solutions. Solar farms have already saved millions of tons of greenhouse gas emissions. The energy consumption for lighting in Europe has dropped consistently since 2010, thanks to the replacement of old light bulbs by more efficient, low-energy lighting. The need for a cleaner and safer future is undeniable. Improving wind turbine efficiency, sorting waste, remediating pollution, bacteria and viruses without using chemicals are just some of the ways that photonics can bring about a greener planet.

Industrial manufacturing



Major transformations are underway in the way goods are manufactured. Referencing precise product specifications, components are built to accurately mirror the design in order to create an exact “twin” of the design. This results in improved yields, higher quality manufacturing, less material waste, *and* enhanced revenues.

Digital Twin manufacturing is made possible through photonics. Realtime feedback is provided by photonic cameras, photonic sensors, and optical imaging systems. Information is shared in real time via high speed optical and 5G networks. And thanks to 3D laser measurements, the shape and dimensions are precisely controlled.

Photonics makes the new era of Digital Twins, and other future manufacturing processes, a reality for the new standard of advanced manufacturing. Less waste, improved quality, precise power control, and more efficient manufacturing are a direct result of photonics-enabled Digital Twins.

Consumer products

Smartphones and laptops are the iconic devices of digitization. But they cannot operate without displays, sensors and cameras. Thanks to the fast miniaturization process of photonic components, many new functions are now available on chips, such as night and 3D vision or gas sensing which will make smartphones much more versatile.



Photonics is also the core technology of augmented or virtual reality devices and many other wearable products.



Industrial Lasers

Cutting, drilling, welding, cleaning, melting, micromachining, marking and dicing, the versatility of lasers is amazing. There are many different types of lasers for hundreds of applications which are now essential in factories. Lasers also provide greener production through less material waste, faster processes, lower maintenance, and greater energy efficiency.

Lasers are especially critical for the Semiconductor industry at many steps of production including etching, wafer inspection, and the detection of defects.

For the last 10 years, lasers have also enabled 3D printing techniques. Initially used for prototyping, these machines now provide tremendous flexibility in the production phase and can manufacture plastic, metal and even ceramic components that were never possible using traditional processes.

And Precision Laser Micromachining utilizes ultra fast laser pulses and can be used for texturing, creating bacterial resistant surfaces, and incredibly fine detail - from small coins to high end vehicles.



Healthcare



Photonics has revolutionized healthcare in our time. From the oxygen saturation finger-clip optical sensor, to minimally invasive surgery, and even improved cancer detection, photonics has had an incredible impact on medicine, biology and our life expectancies.

Today, almost all diagnostic equipment in laboratories use photonics. Even the familiar PCR test used to diagnose COVID-19 is read through photonic equipment, as well as the now ubiquitous body temperature scanners utilizing photonic sensors.

A key field where photonics has made an extraordinary impact is surgery. Endoscopes enable non-surgical inspection and treatment of many organs in the body. Utilizing miniaturized optical components, it is now possible to examine tissues, detect diseases and tumours, and repair organs. Lasers travelling through endoscopic fibres can cut or heal with less scarring, less pain and greater precision. Additionally, an increasing number of advanced diagnostic photonic instruments are integrated into endoscopic probes. Although widely used today, this revolution is still in its infancy.



Communication



The World Bank recently stated that "by 2022, yearly total internet traffic is projected to increase by about 50 percent from 2020 levels, reaching 4.8 zettabytes, equal to 150,000 GB per second. The growth in global internet traffic is as dazzling as the volume." The hidden backbone of the digital world is fibre optics fed by lasers and other photonic components. Fibre optic networks are crossing continents and oceans. And industries race to meet the exponential demand of data traffic.

5G telecommunication networks are a critical element to support ever increasing bandwidth requirements. Utilizing Photonic Integrated Circuits (PICs), which are a photonic / semiconductor "sandwich", PICs provide higher bandwidth – with far lower power consumption. Increasingly used in data centers and satellites, as well as other non-telco applications, PICs are the future of miniaturized, high-speed processing in multiple applications – including all communications.



Transportation

Huge investments are being made for developing autonomous vehicles: cars, trucks, planes, taxis, boats, trains, drones and robots. To become autonomous, these vehicles need to perceive their environment by means of laser sensors, cameras, and LiDAR. It is the combination of Photonic technologies and AI that make autonomy possible.



Photonics companies offer far more than the sensors that support Autonomous driving. Headlights are now smart systems with new laser or LED light sources, integrating many new embedded sensors that help illuminate potential hazards while eliminating the glare to oncoming cars. New designs in automotive interior lighting are enabled by photonic components and systems. And precision micromachining enables special designs for headlights and lenses, as well as the auto body.

But photonics companies also develop tools for greener transportation systems. Testing fuel or hydrogen for optimizing engines, monitoring exhaust emissions and decongesting roads, all support a safer, greener environment.



Photonics Industry Outlook

With a higher start-up success rate than for most industries, and growing far more rapidly than other technologies, many sensors, systems, and components are emerging that are faster and more miniaturized. A new industry has emerged that rivals the exponential growth of the semiconductor industry.

Between 2014 and 2019, the global *non-photonic microelectronics* market grew from € 336 bn to € **412 bn**. However, by comparison, the global photonics industry has grown geometrically over the past 15 years. The global photonics market was worth € **733 bn** in 2019 and is expected to reach approximately € 1,000 bn by 2025. This is a fast-growing industry compared to other high-tech industries.

Photonics Category	CAGR 2020-25
Consumer Products	17.4%
Environmental	20.8%
Healthcare	10.8%
Industrial Products	15.3%
Lasers	11.3%
Sensors	10.4%
Telecom	8.5%
Average CAGR	13.5%

Source: EPIC forecasts for the constituents in the Solactive EPIC Core Photonics Index

Photonics: Technology for a Greener Future



- Photonics represents a growing opportunity for optical components and systems in high-speed data communications, medical technology, advanced sensing, imaging and consumer safety.
- On the consumer side, Photonics applications permeate nearly all aspects of our daily activities and facilitate making our lives easier and safer.
- Photonics is also enabling the ongoing evolution of manufacturing processes which positively impact the environment by using less energy and natural resources while also improving efficiencies and reducing costs.
- Lastly, Photonics provides a direct solution to the environmental crisis by enabling greatly reduced energy and water consumption while eliminating most of the material waste associated with traditional manufacturing processes.



"We may not know what the future looks like, but we are certain that photonics will lead us there"

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