Technical applications of optics This article needs additional citations for verification. Please help improve this article by adding citations to reliable sources. Unsourced material may be challenged and removed.Find sources: "Photonics" – news · newspapers · books · scholar · JSTOR (April 2013) (Learn how and when to remove this message) Dispersion of light (photons) by a prism Photonics is a branch of optics that involves the application of generation, detection, and manipulation of light in the form of photons through emission, transmission, modulation, signal processing, switching, amplification, and sensing.[1][2] Even though photonics is a commonly used term, there is no widespread agreement on a clear definition of the term or on the difference between photonics and related fields, such as optics.[3] Photonics is closely related to quantum electronics, where quantum electronics deals with the theoretical part of it while photonics deal with its engineering applications.[1] Though covering all light's technical applications over the whole spectrum, most photonic applications are in the range of visible and near-infrared light. The term photonics developed as an outgrowth of the first practical semiconductor light emitters invented in the early 1960s and optical fibers developed in the 1970s. The word 'Photonics' is derived from the Greek word "phos" meaning light (which has genitive case "photos" and in compound words the root "photo-" is used); it appeared in the late 1960s to describe a research field whose goal was to use light to perform functions that traditionally fell within the typical domain of electronics, such as telecommunications, information processing, etc.[citation needed] An early instance of the word was in a December 1954 letter from John W. Campbell to Gotthard Gunther:Incidentally, I've decided to invent a new science — photonics. It bears the same relationship to Optics that electronics does to electrical engineering. Photonics, like electronics, will deal with the individual units; optics and EE deal with the group-phenomena! And note that you can do things with electronics that are impossible in electrical engineering![4]Photonics as a field began with the invention of the maser and laser in 1958 to 1960.[1] Other developments followed: the laser diode in the 1970s, optical fibers for transmitting information, and the erbium-doped fiber amplifier. These inventions formed the basis for the telecommunications revolution of the late 20th century and provided the infrastructure for the Internet. Though coined earlier, the term photonics came into common use in the 1980s as fiber-optic data transmission was adopted by telecommunications network operators.[citation needed] At that time, the term was used widely at Bell Laboratories.[citation needed] Its use was confirmed when the IEEE Lasers and Electro-Optics Society established an archival journal named Photonics Technology Letters at the end of the 1980s.[citation needed] During the period leading up to the dot-com crash circa 2001, photonics was a field focused largely on optical telecommunications. However, photonics covers a huge range of science and technology applications, including laser manufacturing, biological and chemical sensing, medical diagnostics and therapy, display technology, and optical computing. Further growth of photonics is likely if current silicon photonics developments are successful.[5] Photonics is closely related to optics. Classical optics long preceded the discovery that light is quantized, when Albert Einstein famously explained the photoelectric effect in 1905. Optics tools include the refracting lens, the reflecting mirror, and various optical components and instruments developed throughout the 15th to 19th centuries. Key tenets of classical optics, such as Huygens Principle, developed in the 17th century, Maxwell's Equations and the wave equations, developed in the 19th, do not depend on quantum properties of light. Photonics is related to quantum optics, optomechanics, electro-optics, optoelectronics and quantum electronics. However, each area has slightly different connotations by scientific and government communities and in the marketplace. Quantum optics often connotes fundamental research, whereas photonics is used to connote applied research and development. The term photonics more specifically connotes: The particle properties of light, The potential of creating signal processing device technologies using photons, The practical application of optics, and An analogy to electronics. The term optoelectronics connotes devices or circuits that comprise both electrical and optical functions, i.e., a thin-film semiconductor device. The term electro-optics came into earlier use and specifically encompasses nonlinear electrical-optical interactions applied, e.g., as bulk crystal modulators such as the Pockels cell, but also includes advanced imaging sensors. An important aspect in the modern definition of Photonics is that there is not necessarily a widespread agreement in the perception of the field boundaries. Following a source on optics.org,[3] the response of a query from the publisher of Journal of Optics: A Pure and Applied Physics to the editorial board regarding streamlining the name of the journal reported significant differences in the way the terms "optics" and "photonics" describe the subject area, with some description proposing that "photonics embraces optics". In practice, as the field evolves, evidences that "modern optics" and Photonics are often used interchangeably are very diffused and absorbed in the scientific jargon. Photonics also relates to the emerging science of quantum information and quantum optics. Other emerging fields include: Optoacoustics or photoacoustic imaging where laser energy delivered into biological tissues will be absorbed and converted into heat, leading to ultrasonic emission. Optomechanics, which involves the study of the interaction between light and mechanical vibrations of mesoscopic or macroscopic objects; Optomics, in which devices integrate both photonic and atomic devices for applications such as precision timekeeping, navigation, and metrology; Plasmonics, which studies the interaction between light and plasmons in dielectric and metallic structures. Plasmons are the quantizations of plasma oscillations; when coupled to an electromagnetic wave, they manifest as surface plasmon polaritons or localized surface plasmons. Polaritonics, which differs from photonics in that the fundamental information carrier is a polariton. Polaritons are a mixture of photons and phonons, and operate in the range of frequencies from 300 gigahertz to approximately 10 terahertz. Programmable photonics, which studies the development of photonic circuits that can be reprogrammed to implement different functions in the same fashion as an electronic FPGA A sea mouse (Aphrodita aculeata),[6] showing colorful spines, a remarkable example of photonic engineering by a living organism Applications of photonics are ubiquitous. Included are all areas from everyday life to the most advanced science, e.g. light detection, telecommunications, information processing, photovoltaics, photonic computing, lighting, metrology, spectroscopy, holography, medicine (surgery, vision correction, endoscopy, health monitoring), biophotonics, military technology, laser material processing, art diagnostics (involving infrared reflectography, X-rays, ultraviolet fluorescence, XRF), agriculture, and robotics. Just as applications of electronics have expanded dramatically since the first transistor was invented in 1948, the unique applications of photonics continue to emerge. Economically important applications for semiconductor photonic devices include optical data recording, fiber optic telecommunications, laser printing (based on xerography), displays, and optical pumping of high-power lasers. The potential applications of photonics are virtually unlimited and include chemical synthesis, medical diagnostics, on-chip data communication, sensors, laser defense, and fusion energy, to name several interesting additional examples. Consumer equipment: barcode scanner, printer, CD/DVD/Blu-ray devices, remote control devices Telecommunications: fiber-optic communications, optical down converter to microwave Renewable Energy: Solar power systems Medicine: correction of poor eyesight, laser surgery, surgical endoscopy, tattoo removal Industrial manufacturing: the use of lasers for welding, drilling, cutting, and various methods of surface modification Construction: laser leveling, laser rangefinding, smart structures Aviation: photonic gyroscopes lacking mobile parts Military: IR sensors, command and control, navigation, search and rescue, mine laying and detection Entertainment: laser shows, beam effects, holographic art Information processing Passive daytime radiative cooling Sensors: LIDAR, sensors for consumer electronics Metrology: time and frequency measurements, rangefinding Photonic computing:[7] clock distribution and communication between computers, printed circuit boards, or within optoelectronic integrated circuits; in the future: quantum computing Microphotonics and nanophotonics usually includes photonic crystals and solid state devices.[8] The science of photonics includes investigation of the emission, transmission, amplification, detection, and modulation of light. Photonics commonly uses semiconductor-based light sources, such as light-emitting diodes (LEDs), superluminescent diodes, and lasers. Other light sources include single photon sources, fluorescent lamps, cathode-ray tubes (CRTs), and plasma screens. Note that while CRTs, plasma screens, and organic light-emitting diode displays generate their own light, liquid crystal displays (LCDs) like TFT screens require a backlight of either cold cathode fluorescent lamps or, more often today, LEDs. Characteristic for research on semiconductor light sources is the frequent use of III-V semiconductors instead of the classical semiconductors like silicon and germanium. This is due to the special properties of III-V semiconductors that allow for the implementation of light emitting devices. Examples for material systems used are gallium arsenide (GaAs) and aluminium gallium arsenide (AlGaAs) or other compound semiconductors. They are also used in conjunction with silicon to produce hybrid silicon lasers. Light can be transmitted through any transparent medium. Glass fiber or plastic optical fiber can be used to guide the light along a desired path. In optical communications optical fibers allow for transmission distances of more than 100 km without amplification depending on the bit rate and modulation format used for transmission. A very advanced research topic within photonics is the investigation and fabrication of special structures and "materials" with engineered optical properties. These include photonic crystals, photonic crystal fibers and metamaterials. Main article: Optical amplifier Optical amplifiers are used to amplify an optical signal. Optical amplifiers used in optical communications are erbium-doped fiber amplifiers, semiconductor optical amplifiers, Raman amplifiers and optical parametric amplifiers. A very advanced research topic on optical amplifiers is the research on quantum dot semiconductor optical amplifiers. Photodetectors detect light. Photodetectors range from very fast photodiodes for communications applications over medium speed charge coupled devices (CCDs) for digital cameras to very slow solar cells that are used for energy harvesting from sunlight. There are also many other photodetectors based on thermal, chemical, quantum, photoelectric and other effects. Main article: Optical modulator Modulation of a light source is used to encode information on a light source. Modulation can be achieved by the light source directly. One of the simplest examples is to use a flashlight to send Morse code. Another method is to take the light from a light source and modulate it in an external optical modulator.[9] An additional topic covered by modulation research is the modulation format. On-off keying has been the commonly used modulation format in optical communications. In the last years more advanced modulation formats like phase-shift keying or even orthogonal frequency-division multiplexing have been investigated to counteract effects like dispersion that degrade the quality of the transmitted signal. Photonics also includes research on photonic systems. This term is often used for optical communication systems. This area of research focuses on the implementation of photonic systems like high speed photonic networks. This also includes research on optical regenerators, which improve optical signal quality.[citation needed] Main article: Photonic integrated circuit Photonic integrated circuits (PICs) are optically active integrated semiconductor photonic devices. The leading commercial application of PICs are optical transceivers for data center optical networks. PICs fabricated on III-V indium phosphide semiconductor wafer substrates were the first to achieve commercial success;[10] PICs based on silicon wafer substrates are now also a commercialized technology. Key Applications for Integrated Photonics include: Data Center Interconnects: Data centers continue to grow in scale as companies and institutions store and process more information in the cloud. With the increase in data center compute, the demands on data center networks correspondingly increase. Optical cables can support greater lane bandwidth at longer transmission distances than copper cables. For short-reach distances and up to 40 Gbit/s data transmission rates, non-integrated approaches such as vertical-cavity surface-emitting lasers can be used for optical transceivers on multi-mode optical fiber networks.[11] Beyond this range and bandwidth, photonic integrated circuits are key to enable high-performance, low-cost optical transceivers. Analog RF Signal Applications: Using the GHz precision signal processing of photonic integrated circuits, radiofrequency (RF) signals can be manipulated with high fidelity to add or drop multiple channels of radio, spread across an ultra-broadband frequency range. In addition, photonic integrated circuits can remove background noise from an RF signal with unprecedented precision, which will increase the signal to noise performance and make possible new benchmarks in low power performance. Taken together, this high precision processing enables us to now pack large amounts of information into ultra-long-distance radio communications. [citation needed] Sensors: Photons can also be used to detect and differentiate the optical properties of materials. They can identify chemical or biochemical gases from air pollution, organic produce, and contaminants in the water. They can also be used to detect abnormalities in the blood, such as low glucose levels, and measure biometrics such as pulse rate. Photonic integrated circuits are being designed as comprehensive and ubiquitous sensors with glass/silicon, and embedded via high-volume production in various mobile devices. [citation needed] Mobile platform sensors are enabling us to more directly engage with practices that better protect the environment, monitor food supply and keep us healthy. LIDAR and other phased array imaging: Arrays of PICs can take advantage of phase delays in the light reflected from objects with three-dimensional shapes to reconstruct 3D images, and Light Imaging, Detection and Ranging (LIDAR) with laser light can offer a complement to radar by providing precision imaging (with 3D information) at close distances. This new form of machine vision is having an immediate application in driverless cars to reduce collisions, and in biomedical imaging. Phased arrays can also be used for free-space communications and novel display technologies. Current versions of LIDAR predominantly rely on moving parts, making them large, slow, low resolution, costly, and prone to mechanical vibration and premature failure. Integrated photonics can realize LIDAR within a footprint the size of a postage stamp, scan without moving parts, and be produced in high volume at low cost.[12][13] Main article: Biophotonics Biophotonics employs tools from the field of photonics to the study of biology. Biophotonics mainly focuses on improving medical diagnostic abilities (for example for cancer or infectious diseases)[14] but can also be used for environmental or other applications.[15][16] The main advantages of this approach are speed of analysis, non-invasive diagnostics, and the ability to work in-situ. Nano-optics OP-TEC Optronics/optoelectronics Organic photonics Bio-inspired photonics Photonics mast (on submarines) Photonic radar European Photonics Industry Consortium IOWN Global Forum

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"Tracking active groundwater microbes with D2 O labelling to understand their ecosystem function". Environmental Microbiology. 20 (1): 369–384. Bibcode:2018EnvMi..20..369T. doi:10.1111/1462-2920.14010. ISSN 1462-2920. PMID 29194923. S2CID 25510308. Retrieved from " Skip to main content University of Washington Research Innovation Get Involved Prospective Students Industry Alumni Give to UW ECE Job Openings Diversity, Equity, & Inclusion (DEI) Contact Us UW ECE alumna Thy Tran (BSEE '93) will be honored guest speaker for the 2025 UW ECE Graduation Ceremony, which will take place in the Alaska Airlines Arena at Hec Edmundson Pavilion on Wednesday, June 11, from 7 to 9 p.m.Learn MoreUW ECE undergraduate Mary Bun studies multitasking in fruit flies to offer valuable insights into disorders like Parkinson's disease. Her work is inspired by neural engineering research led by UW ECE and UW Medicine Professor Chet Moritz.Learn MoreShanti Garman is a doctoral degree candidate at UW ECE, studying and working in the Sensor Systems Lab. She is also an instructor in the Department's Professional Master's Program as well as a mentor to aspiring engineers and first-generation college students.Learn MoreUW ECE students toured inside the Washington Nanofabrication Facility, where tiny tech is transforming research in quantum, chips, medicine and more.Learn MoreUW ECE Associate Teaching Professor Mahmood Hameed has a superpower — his unique ability to connect with students. He is known for his exceptional ability as an educator and his passion for teaching.Learn MoreUW ECE undergraduate Kyshawn Warren part of NSF-funded team of researchers using eye-tracking technology to help create autonomous systems that can adjust to individual comfort levels.Learn MoreUW ECE Professor Maryam Fazel is a program co-chair for the 2025 International Conference on Machine Learning, which will be held from July 13 to 19 in Vancouver, Canada.Learn MoreUW ECE Assistant Professor Serena Eley studies superconductors and magnets, searching for ways to fine-tune the atomic disorder landscape in these materials and leverage their unique properties for quantum technology development.Learn MoreAmy Orsborn, a Clare Boothe Luce Assistant Professor in Electrical & Computer Engineering and Bioengineering at the UW, has been awarded a 2025 Sloan Research Fellowship, one of the most prestigious honors awarded to early-career researchers in the U.S and Canada.Learn MoreUW ECE and Physics Professor Arka Majumdar and his students have collaborated with Princeton University to build a new type of compact camera engineered for computer vision. Their prototype uses optics for computing, significantly reducing power consumption and enabling the camera to identify objects at light speed. Learn MoreUW ECE doctoral student Niveditha Kalavakonda is engineering an autonomous robotic assistant for providing surgical suction. This device is at the leading edge of technology and is helping to explore a new field: collaborative human-robot interaction in surgical environments.Learn MoreRead the latest issue of The Integrator, UW ECE's flagship annual magazine highlighting the Department's extraordinary faculty and student research, achievements, alumni stories, special events and more from this past year!Learn MoreUW ECE faculty are leaders in microchip design and are known internationally for their creative, interdisciplinary approaches to chip design and development.Learn MoreUW ECE Assistant Professor Kim Ingraham designs personalized, adaptive control strategies for assistive robotic devices, such as exoskeletons and powered wheelchairs. Her work brings people together from different backgrounds to produce more usable assistive robotic devices.Learn MoreUW ECE Assistant Professor Sajjad Moazeni and graduate students in his lab are part of a multidisciplinary, multi-institutional research team developing a new, three-dimensional imaging system for early detection of lung cancer.Learn More The global photonics market size was valued at USD 630 billion in 2021. It is estimated to reach an expected value of USD 1,100 billion by 2030, growing at a CAGR of 7.3% during the forecast period (2022–2030). Photonics is widely touted to be a critical enabling technology for the emergence of smart systems that make judicious use of energy without compromising on the efficiency of overall systems. Many industries use technology to increase efficiency, fueling growth, including healthcare, automotive, communications, manufacturing, and retail. These sectors' investments have recently experienced significant growth as well. The primary engine driving the photonics market is silicon-based photonics applications. In telecommunications and data center applications, hybrid silicon lasers (silicon and group III-V semiconductor) are employed, benefiting them from III-V semiconductor materials' light-emitting capabilities. Furthermore, technological advancements in light-based technologies have been driving the new wave of innovation by providing sustainable solutions to global challenges, which have been identified as a significant driving factor for the global market. Silicon photonics is an evolving branch of photonics offering a clear advantage over electric conductors used in semiconductors, which are used in high-speed transmission systems. This technology is expected to push the transmission speeds up to 100 Gbps, with companies like IBM, Intel, and Kothura achieving breakthroughs using the technology. Besides, this technology revolutionizes the semiconductor industry, enabling high-speed data transfer and processing. The increasing adoption of LiDAR scanners also creates a massive opportunity for silicon photonics LiDAR in medical and industrial applications. For instance, in 2020, SiLC collaborated with Varroc Lighting Systems to offer its FMCW LiDAR into the latter's headlamp. Moreover, the silicon photonic LiDAR from Yokohama University integrated a chip's OPA scanning, lasers, modulator, and photodetectors. Furthermore, researchers at the National Institute of Standards and Technology (NIST) identified a class of silicon photonic sensors that may be effective in high-radiation environments because of their ability to withstand high radiation doses. Thus, the market is expected to invest heavily in the mass adoption of this technology and be a key aspect in developing high-performance computing to improve performance and efficiency. Therefore, the emergence of silicon-based photonics is driving the market. Increased focus on high performance and eco-friendly solutions In the present day, modern technological advancements seldom occur without the environment being considered. Preserving the planet plays an ever-greater role in forging the direction of innovations in photonics technology, and, conversely, photonics is having a considerable impact on the environment. Photonics-based devices offer higher energy efficiency than other technologies in many verticals, which has been identified as a significant market driver. In industrial applications, photonics-based processes have been identified to consume 30% less energy than conventional machines while providing faster operating time and material wastage savings of up to 94%. The technology helped reduce the world's lighting energy consumption and revolutionized data transfer and its associated energy needs. Similarly, solar energy, one of the photonics technologies, is being observed to address a critical environmental issue. Likewise, scientists are harnessing photonics technologies in sensors to detect chemical and particulate emissions that are harmful to the environment. Hence, the increasing focus on high-performance and eco-friendly solutions is expected to drive the demand and positively impact market growth. Global photonics market restraint High initial cost of photonics-enabled devices Technology adoption is being hampered by the higher initial cost of silicon-enabled goods and gadgets compared to traditional goods. Although the technology offers greater performance and efficiency, many small- and medium-sized end users in various sectors still cannot afford photonics-based equipment. Furthermore, in the photonic market, many venture capitalists (VC) are highly optimistic about the adoption and expansion of the technology. However, many believe technology may take much more time than accepted to gain its full potential. Due to this, the market does not have as much investment as expected. Additionally, there is a high level of initial investment required in industries for integrating such photonics technology for automation purposes. Automated systems' high costs concern effective and robust hardware and efficient software. Automation equipment requires increased capital investment to invest in smart manufacturing (a computerized system can cost millions of dollars to install, design, and fabricate). Thus, industries rely on existing technologies at a lower price, ultimately challenging their adoption. Global photonics market opportunities Increased use of photonics for non-invasive healthcare From physics to biological sciences, photonics technology has spread quickly. Many stages of medical and biological research employ light and laser technology. Studying biological components in-depth is made possible through spectroscopy. Medical lasers are essential for success in all fields, including medication research, delivery, medical imaging, genomics, and robotic surgery guidance. Perhaps the most critical part of medicine that photonics changes are diagnosis. OCT scanning is a recent innovation that can identify several conditions that were previously challenging. The field of ophthalmology is the first and most affected to gain from OCT. Glaucoma, retinopathy, and other forms of visual deterioration can all be seen during eye scans utilizing OCT. All contemporary optometry clinics use technology since it is crucial for diagnosing novel retinal illnesses. Hence, such applications in the healthcare sector propel market growth. By region, the global photonics market is segmented into North America, Europe, Asia-Pacific, and the Rest of the world. Asia Pacific accounts for the largest market share and is estimated to grow at a CAGR of 7.1% during the forecast period. Japan is the third-largest economy in the world; it had a GDP worth USD 5,082 billion in 2019, representing 4.22% of the world economy. It still holds a significant share in the photonics market and is becoming more open to collaborations. Big corporations want to stay on top and seek investments to fuel growth. The market size, emerging openness, and dynamic photonics industry can surely benefit innovative companies in Japan, thereby driving the country's market growth. Moreover, with the significant increases in internet traffic due to data from social media, video streaming services, working from home, IoT, and the country's overall digitization, players are investing in photonic integrated circuits (PIC). PICs are devices in which optical functions are integrated into wafer materials such as silicon, indium phosphide, and silicon nitride and have immediate applications in transceivers for optical communications. For instance, in November 2020, Hitachi High-Tech Corporation announced that VLC Photonics SL (VLC) has become Hitachi High-Tech's subsidiary company and will continue providing photonic integrated circuit (PIC) engineering services as part of the company's broader offering. According to the company, besides the optical communications market, PICs are also becoming a critical platform technology within many industrial sectors, such as automotive sensing, environmental testing, health sciences, and quantum technology. Such instances are likely to propel the market growth in the region. North America is expected to account for USD 230 billion by 2030, registering a CAGR of 7.5% during the forecast period. The photonics market share is expected to witness significant growth in the North American region over the forecast period, with the United States dominating the regional market. The increase in the photonics market demand in this region strongly correlates with the development of adjacent markets such as lighting, safety & defense applications, healthcare, and production technology. Also, the United States leads the data center hardware market, which remains one of the significant applications for photonics. The presence of several market incumbents, such as IBM, Intel Corp., and HP, with greater access to R&D funds is expected to drive growth in this region. The United States has the highest concentration of photonics-based applications companies relying excessively on consumer feedback. According to a paper presented at the Optical Society of America's (OSA) Conference on Lasers and Electro-Optics (CLEO) and published online in the OSA Technical Digest, a group of people created a single thin layer of integrated silicon photonics that emulated the lens and sensor of a digital camera, reducing the thickness and cost of digital cameras. This was designed at the California Institute of Technology. Such trends are expected to boost the adoption of photonic sensors in the regional consumer technology industry, thereby stimulating the market's growth. Europe is the third largest region. Photonics offers solutions that address critical societal challenges, such as energy generation and energy efficiency, healthy aging of the population, climate change, and security. The European region forms a significant proportion of the world's analysis of fundamental photonics, providing Europe with a dominant position in the world. Due to industry development activities, Germany is expected to exhibit a considerable growth rate over the forecast period. For instance, the country is increasingly investing in upgrading and installing advanced telecom equipment and infrastructure. Besides this, photonics also sees an increase in usage across various industries in this country, like healthcare, due to growing consumer awareness boosting the adoption rate of photonics in this industry. Need a Custom Report? We can customize every report - free of charge - including purchasing stand-alone sections or country-level reports The global photonics market is segmented by application and region. By application, the global photonics market is segmented into surveying and detection, production technology, data communication, image capture and display, medical technology, lighting, and other applications (traffic and research). The Image Capture & Display segment accounts for the largest market share and is estimated to grow at a CAGR of 7.2% during the forecast period. Image capturing & displays deal with a broad palette of interrelated photonics technologies. The global demand for displays and TVs with the latest display technologies is increasing, further augmenting the demand. With the proliferation of smart TVs, consumers looking to update their devices to the latest technologies are expected to drive the market. Optical systems can capture and interpret hand movements contactless, with low installment and maintenance costs. These optical systems can be used in sterile workplaces such as hospital operating rooms, driving the need for photonics. The Surveying & Detection segment is the second largest. Photonics plays a significant role in surveillance systems adopted in law & enforcement along with the defense sector as the demand for such solutions is increasing along with the proliferation of technology in the industry. Further, the high focus of the governments on developing drones is anticipated to aid the surveillance hardware market in the defense sector. Biometric devices are expected to replace traditional systems as the primary means of user authentication. Photonics-based sensors are widely employed in the design of biometrics systems, which could lead to an overall reduction in costs while improving the accuracy and reliability of these systems. Such factors drive segment growth. The Data Communication segment is the third largest. The demand for technology in the market is anticipated to be driven by the expanding usage of optical solutions in communication technologies such as optical broadband, with the segment occupying a significant part of the market. With the growing use of optical networks as part of the infrastructure, the investment from telecommunication companies in enhancing legacy networks is expected to drive the demand. Moreover, with the proliferation of technologies and growing consumption of video content over the internet, the need for broadband is increasing worldwide. Photonics provides novel and disruptive techniques required to cope with the increasing requirements for bandwidth capacity, particularly in backbone networks. Surveying & Detection Production Technology Data Communication Image Capture & Display Medical Technology Lighting Displays Information Photovoltaics Measure and Machine Vision Defense and Security Optical Component Others (Traffic and Research) List of key players in Photonics Market Hamamatsu Photonics KK Intel Corporation Polatis Photonics Inc. Alcatel-Lucent SA Molex Inc. (Koch Industries) Infinera Corporation NEC Corporation Innolume GmbH Finisar Corporation IPG PPhotonic Osram Licht AG Philips Photonics (Trumpf GmbH) Photonics SAS (Keopsys) Schott AG Carl Zeiss AG (Scantinel Photonics GmbH). Recent Developments August 2022 - The capital-intensive semiconductor sector now has a new funding model due to Intel Corporation's groundbreaking Semiconductor Co-Investment Program (SCIP). One of the most significant worldwide alternative asset managers, Brookfield Asset Management, and Intel have entered into a legally binding agreement as part of Intel's program that will give Intel access to a larger and newer pool of capital for industrial build-outs. July 2022 - NEC Corporation increased its capacity to deliver End-to-End Open RAN ecosystems, along with system design and integration for legacy networks, to operators globally with its agreement to acquire Aspire Technology Unlimited Company (Aspire Technology), headquartered in Dublin, Ireland. Photonics Market Segmentations By Application (2018-2030) Surveying & Detection Production Technology Data Communication Image Capture & Display Medical Technology Lighting Displays Information Photovoltaics Measure and Machine Vision Defense and Security Optical Component Others (Traffic and Research) Frequently Asked Questions (FAQs) Photonics Market size will grow at approx. CAGR of 7.3% during the forecast period. Some of the top prominent players in Photonics Market are, Hamamatsu Photonics KK, Intel Corporation, Polatis Photonics Inc., Alcatel-Lucent SA, Molex Inc. (Koch Industries), Infinera Corporation, NEC Corporation, Innolume GmbH, Finisar Corporation, IPG PPhotonic, Osram Licht AG, Philips Photonics (Trumpf GmbH), Photonics SAS (Keopsys), Schott AG, Carl Zeiss AG (Scantinel Photonics GmbH)., etc. Asia-Pacific has been dominating the Photonics Market, accounting for the largest share of the market. The North America region is projected to exhibit the highest rate of growth in the Photonics Market. The global Photonics Market report is segmented as follows: By Application Microchip manipulating light instead of electricity A photonic integrated circuit (PIC) or integrated optical circuit is a microchip containing two or more photonic components that form a functioning circuit. This technology detects, generates, transports, and processes light. Photonic integrated circuits use photons (or particles of light) as opposed to electrons that are used by electronic integrated circuits. The major difference between the two is that a photonic integrated circuit provides functions for information signals imposed on optical wavelengths typically in the visible spectrum or near-infrared (850–1650 nm). One of the most commercially utilized material platforms for photonic integrated circuits is indium phosphide (InP), which allows for the integration of various optically active and passive functions on the same chip. Initial examples of photonic integrated circuits were simple 2-section distributed Bragg reflector (DBR) lasers, consisting of two independently controlled device sections—a gain section and a DBR mirror section. Consequently, all modern monolithic tunable lasers, widely tunable lasers, externally modulated lasers and transmitters, integrated receivers, etc. are examples of photonic integrated circuits. As of 2012, devices integrate hundreds of functions onto a single chip.[1] Pioneering work in this arena was performed at Bell Laboratories. The most notable academic centers of excellence of photonic integrated circuits in InP are the University of California at Santa Barbara, USA, the Eindhoven University of Technology, and the University of Twente in the Netherlands. A 2005 development[2] showed that silicon can, even though it is an indirect bandgap material, still be used to generate laser light via the Raman nonlinearity. Such lasers are not electrically driven but optically driven and therefore still necessitate a further optical pump laser source. Photonics is the science behind the detection, generation, and manipulation of photons. According to quantum mechanics and the concept of wave–particle duality first proposed by Albert Einstein in 1905, light acts as both an electromagnetic wave and a particle. For example, total internal reflection in an optical fibre allows it to act as a waveguide. Integrated circuits using electrical components were first developed in the late 1940s and early 1950s, but it took until 1958 for them to become commercially available. When the laser and laser diode were invented in the 1960s, the term "photonics" fell into more common usage to describe the application of light to replace applications previously achieved through the use of electronics. By the 1980s, photonics gained traction through its role in fibre optic communication. At the start of the decade, an assistant in a new research group at Delft University Of Technology, Meint Smit, started pioneering in the field of integrated photonics. He is credited with inventing the Arrayed Waveguide Grating (AWG), a core component of modern digital connections for the Internet and phones. Smit has received several awards, including an ERC Advanced Grant, a Rank Prize for Optoelectronics and a LEOS Technical Achievement Award.[3] In October 2022, during an experiment held at the Technical University of Denmark in Copenhagen, a photonic chip transmitted 1.84 petabits per second of data over a fibre-optic cable more than 7.9 kilometres long. First, the data stream was split into 37 sections, each of which was sent down a separate core of the fibre-optic cable. Next, each of these channels was split into 223 parts corresponding to equidistant spikes of light across the spectrum.[4] Unlike electronic integration where silicon is the dominant material, system photonic integrated circuits have been fabricated from a variety of material systems, including electro-optic crystals such as lithium niobate, silica on silicon, silicon on insulator, various polymers, and semiconductor materials which are used to make semiconductor lasers such as GaAs and InP. The different material systems are used because they each provide different advantages and limitations depending on the function to be integrated. For instance, silica (silicon dioxide) based PICs have very desirable properties for passive photonic circuits such as AWGs (see below) due to their comparatively low losses and low thermal sensitivity, GaAs or InP based PICs allow the direct integration of light sources and Silicon PICs enable co-integration of the photonics with transistor based electronics.[5] The fabrication techniques are similar to those used in electronic integrated circuits in which photolithography is used to pattern wafers for etching and material deposition. Unlike electronics where the primary device is the transistor, there is no single dominant device. The range of devices required on a chip includes low loss interconnect waveguides, power splitters, optical amplifiers, optical modulators, filters, lasers and detectors. These devices require a variety of different materials and fabrication techniques making it difficult to realize all of them on a single chip.[citation needed] Newer techniques using resonant photonic interferometry is making way for UV LEDs to be used for optical computing requirements with much cheaper costs leading the way to petahertz consumer electronics.[citation needed] The primary application for photonic integrated circuits is in the area of fiber-optic communication though applications in other fields such as biomedical[6] and photonic computing are also possible. The arrayed waveguide gratings (AWGs) which are commonly used as optical (de)multiplexers in wavelength division multiplexed (WDM) fiber-optic communication systems are an example of a photonic integrated circuit which has replaced previous multiplexing schemes which utilized multiple discrete filter elements. Since separating optical modes is a need for quantum computing, this technology may be helpful to miniaturize quantum computers (see linear optical quantum computing). Another example of a photonic integrated chip in wide use today in fiber-optic communication systems is the externally modulated laser (EML) which combines a distributed feed back laser diode with an electro-absorption modulator[7] on a single InP based chip. As global data consumption rises and demand for faster networks continues to grow, the world needs to find more sustainable solutions to the energy crisis and climate change. At the same time, ever more innovative applications for sensor technology, such as Lidar in autonomous driving vehicles, appear on the market.[8] There is a need to keep pace with technological challenges. The expansion of 5G data networks and data centres, safer autonomous driving vehicles, and more efficient food production cannot be sustainably met by electronic microchip technology alone. However, combining electrical devices with integrated photonics provides a more energy efficient way to increase the speed and capacity of data networks, reduce costs and meet an increasingly diverse range of needs across various industries. The primary application for PICs is in the area of fibre-optic communication. The arrayed waveguide grating (AWG) which are commonly used as optical (de)multiplexers in wavelength division multiplexed (WDM) fibre-optic communication systems are an example of a photonic integrated circuit.[9] Another example in fibre-optic communication systems is the externally modulated laser (EML) which combines a distributed feedback laser diode with an electro-absorption modulator. The PICs can also increase bandwidth and data transfer speeds by deploying few-modes optical planar waveguides. Especially, if modes can be easily converted from conventional single-mode planar waveguides into few-mode waveguides, and selectively excite the desired modes. For example, a bidirectional spatial mode slicer and combiner[10] can be used to achieve the desired higher or lower-order modes. Its principle of operation depends on cascading stages of V-shape and/ or M-shape graded-index planar waveguides. Not only can PICs increase bandwidth and data transfer speeds, they can reduce energy consumption in data centres, which spend a large proportion of energy on cooling servers.[11] Using advanced biosensors and creating more affordable diagnostic biomedical instruments, integrated photonics opens the door to lab-on-a-chip (LOC) technology, cutting waiting times, and taking diagnosis out of laboratories and into the hands of doctors and patients. Based on an ultrasensitive photonic biosensor, SurfiX Diagnostics' diagnostics platform provides a variety of point-of-care tests.[12] Similarly, Amazec Photonics has developed a fibre optic sensing technology with photonic chips which enables high-resolution temperature sensing (fractions of 0.1 milliKelvin) without having to inject the temperature sensor within the body.[13] This way, medical specialists are able to measure both cardiac output and circulating blood volume from outside the body. Another example of optical sensor technology is EFI's "OptiGrip" device, which offers greater control over tissue feeling for minimal invasive surgery. PICs can be applied in sensor systems, like Lidar (which stands for light detection and ranging), to monitor the surroundings of vehicles.[14] It can also be deployed in-car connectivity through Li-Fi, which is similar to WiFi but uses light. This technology facilitates communication between vehicles and urban infrastructure to improve driver safety. For example, some modern vehicles pick up traffic signs and remind the driver of the speed limit. In terms of engineering, fibre optic sensors can be used to detect different quantities, such as pressure, temperature, vibrations, accelerations, and mechanical strain.[15] Sensing technology from PhotonFirst uses integrated photonics to measure things like shape changes in aeroplanes, electric vehicle battery temperature, and infrastructure strain. Sensors play a role in innovations in agriculture and the food industry in order to reduce wastage and detect diseases.[16] Light sensing technology powered by PICs can measure variables beyond the range of the human eye, allowing the food supply chain to detect disease, ripeness and nutrients in fruit and plants. It can also help food producers to determine soil quality and plant growth, as well as measuring CO2 emissions. A new, miniaturised, near-infrared sensor, developed by MantiSpectra, is small enough to fit into a smartphone, and can be used to analyse chemical compounds of products like milk and plastics.[17] In 2025, researchers at Columbia Engineering developed a 3D photonic-electronic chip that could significantly improve AI hardware. By combining light-based data movement with CMOS electronics, this chip addressed AI's energy and data transfer bottlenecks, improving both efficiency and bandwidth. The breakthrough allowed for high-speed, energy-efficient data communication, enabling AI systems to process vast amounts of data with minimal power. With a bandwidth of 800 Gb/s and a density of 5.3 Tb/s/mm², this technology offered major advances for AI, autonomous vehicles, and high-performance computing.[18] The fabrication techniques are similar to those used in electronic integrated circuits, in which photolithography is used to pattern wafers for etching and material deposition. The platforms considered most versatile are indium phosphide (InP) and silicon photonics (SiPh): Indium phosphide (InP) PICs have active laser generation, amplification, control, and detection. This makes them an ideal component for communication and sensing applications. Silicon nitride (SiN) PICs have a vast spectral range and ultra low-loss waveguide. This makes them highly suited to detectors, spectrometers, biosensors, and quantum computers. The lowest propagation losses reported in SiN (0.1 dB/cm down to 0.1 dB/m) have been achieved by LioniX International's TriPleX waveguides. Silicon photonics (SiPh) PICs provide low losses for passive components like waveguides and can be used in minuscule photonic circuits. They are compatible with existing electronic fabrication. The term "silicon photonics" actually refers to the technology rather than the material. It combines high density photonic integrated circuits (PICs) with complementary metal oxide semiconductor (CMOS) electronics fabrication. The most technologically mature and commercially used platform is silicon on insulator (SOI). Other platforms include: Lithium niobate (LiNbO3) is an ideal modulator for low loss mode. It is highly effective at matching fibre input–output due to its low index and broad transparency window. For more complex PICs, lithium niobate can be formed into large crystals. As part of project ELENA, there is a European initiative to stimulate production of LiNbO3-PICs. Attempts are also being made to develop lithium niobate on insulator (LNOI). Silica has a low weight and small form factor. It is a common component of optical communication networks, such as planar light wave circuits (PLCs). Gallium arsenide (GaAs) has high electron mobility. This means GaAs transistors operate at high speeds, making them ideal analogue integrated circuit drivers for high speed lasers and modulators. By combining and configuring different chip types (including existing electronic chips) in a hybrid or heterogeneous integration, it is possible to leverage the strengths of each. Taking this complementary approach to integration addresses the demand for increasingly sophisticated energy-efficient solutions. As of 2010, photonic integration was an active topic in U.S. Defense contracts.[19][20] It was included by the Optical Internetworking Forum for inclusion in 100 gigahertz optical networking standards.[21] A recent study presents a novel two-dimensional photonic crystal design for electro-reflective modulators, offering reduced size and enhanced efficiency compared to traditional bulky structures. This design achieves high optical transmission ratios with precise angle control, addressing critical challenges in miniaturizing optoelectronic devices for improved performance in PICs. In this structure, both lateral and vertical fabrication technologies are combined, introducing a novel approach that merges two-dimensional designs [22] with three-dimensional structures. This hybrid technique offers new possibilities for enhancing the functionality and integration of photonic components within photonic integrated circuits.[23] Integrated quantum photonics Optical computing Optical transistor Silicon photonics

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Brenner, K.-H. (1988). "A programmable optical processor based on symbolic substitution". Appl. Opt. 27 (9): 1687–1691. Bibcode:1988ApOpt..27.1687B. doi:10.1364/AO.27.001687. PMID 20531637. S2CID 4648075. Retrieved from " Company > Overview RP Photonics is an independent and privately owned company. We strive for excellence and great reliability in the quality of our products and customer service, often taking unconventional and innovative approaches. The founder and executive of RP Photonics is the photonics expert Dr. Rüdiger Paschotta, a widely recognized leader in the field. The main activities of RP Photonics are: → go to the software pages The Companies Due to our move from Germany to Switzerland in 02/2022, there are currently two RP Photonics companies: RP Photonics AG (Switzerland) This is the active company. The address: RP Photonics AG, Bannhaldenstr. 38, CH-8500 Frauenfeld (see also: contact information). Founder and executive: Dr. Rüdiger Paschotta Company ID: CHE-141.173.265 RP Photonics Consulting GmbH (Germany) Originally (in 2004), RP Photonics was founded in Zürich, Switzerland. In 2010, RP Photonics moved to Bad Dürrheim, Germany (Waldstr. 17, 78073 Bad Dürrheim), and kept the original name. Since February 2022, RP Photonics is back in Switzerland. It is now an AG (stock corporation), and "consulting" has been removed from the company name, since it is no longer the central business area.