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# REVIEW ARTICLE

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# Photonix, System and Components

**Dr. (Mrs.) Shakuntala Pandey[1] Dr. Anil Pandey[2]**

[1]Professor, Govt. Madhav Science College, Ujjain

[2]Professor, Govt. Vikram College, Khachrod Distt. Ujjain

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## INTRODUCTION

Photonic is the science of light. It is the technology of generating, controlling, and detecting light waves and photons, which are particles of light. The characteristics of the waves and photons can be used to explore the universe, cure diseases, and even to solve crimes. Scientists have been studying light for hundreds of years. The colours of the rainbow are only a small part of the entire light wave range, called the electromagnetic spectrum. Photonics explores a wider variety of wavelengths, from gamma rays to radio, including X-rays, UV and infrared light.

It was only in the 17th Century that Sir Isaac Newton showed that white light is made of different colors of light. At the beginning of the 20th Century Max Planck and later Albert Einstein proposed that light was a wave as well as a particle, which was a very controversial theory at the time. How can light be two completely different things at the same time? Experimentation later confirmed this duality in the nature of light. The word Photonics appeared around 1960, when the laser was invented by Theodore Maiman.

Even if we cannot see the entire electromagnetic spectrum, visible and invisible light waves are a part of our everyday life. Photonics is everywhere; in consumer electronics (barcode scanners, DVD Players remote TV control), telecommunications (internet), health (eye surgery, medical instruments), manufacturing industry (laser cutting and machining), defense and security (infrared camera, remote, sensing), entertainment(holography, laser shows) etc.

Photonics is the science and technology of generating controlling, and detecting photons, which are particles of lights. Photonic underpins technologies of daily life from smart phones to laptops to the internet to medical instruments to lighting technology.

Scientists, Engineers and technicians perform cutting edge research surroundings the fields of photonics. The sciene of light is also actively taught in classroom and museums where teachers and educators share their passion for this field to young people and the general public. Photonics opens a world of unknown and far reaching possibilities limited only by lack of imagination.

Photonics is the science of light (Photon) generation, detection, and manipulation through emission, transmission, modulation, signal processing, switching amplification, and detection sensing. Though covering all lights's technical applications over the whole spectrum.

## HISTORY OF PHOTONICS

The word 'photonics' is derived from the Greek word "photos" meaning light; 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.

Photonics as a field began with the invention of the laser in 1960. 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.

During the period leading up to the dot-com crash circa 2001, photonics as 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.

Though coined earlier, the term photonics came into common use in the 1980s as fiber-optic data transmission was adopted by telecommunications network operators. At that time, the term was used widely at Bell Laboratories. 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.

## RELATIONSHIP TO OTHER FIELDS

### Classical optics

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.

### Modern optics

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.

### Emerging fields

Photonics also relates to the emerging science of quantum information and quantum optics, in those cases where it employs photonic methods. Other emerging fields include optomechanics, which involves the study of the interaction between light and mechanical vibrations of mesoscopic or macroscopic objects; opto-atomics, in which devices integrate both photonic and atomic devices for applications such as precision timekeeping, navigation, and metrology; polaritonics, which differs from photonics in that the fundamental information carrier is a polariton, which is a mixture of photons and phonons, and operates in the range of frequencies from 300 gigahertz to approximately 10 terahertz.

### Applications

A sea mouse (*Aphrodita aculeata*),[3] 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, lighting, metrology, spectroscopy, holography, medicine (surgery, vision correction, endoscopy, health monitoring), military technology, laser material processing, visual art, biophotonics, 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, laser defense, and fusion energy, to name several interesting additional examples.

### Overview of photonics research

The science of photonics includes investigation of the emission, transmission, amplification, detection, and modulation of light.

### Light sources

Light sources used in photonics are usually far more sophisticated than light bulbs. Photonics commonly uses semiconductor light sources like 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.

### Transmission media

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.

**Amplifiers**

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.

**Detection**

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.

**Modulation**

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.

**Photonic systems**

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.

**Photonic integrated circuits**

Photonic integrated circuits (PICs) are optically active integrated semiconductor photonic devices which consist of at least two different functional blocks, (gain region and a grating based mirror in a laser...).

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