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A STUDY ON RECENT DEVELOPMENTS AND FUTURE TRENDS IN OPTICAL FIBER TECHNOLOGY

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ABSTRACT :

Everywhere on this planet hair-thin optical fibers move massive quantities of knowledge from one location to the next. The carrying of this knowledge has many attractive properties of optical fibers. We have tremendous capacity to carry information, are low cost and have protection from the many disruptions that can affect electrical wires and wireless communication connections. Optical fibers have played a crucial role in making the incredible growth in worldwide communications that has taken place over the last 25 years possible, and are critical in facilitating the proliferation of the Internet. Thanks to its high data-rate, long-distance communication capacity, fiber optic technology has long dominated the industry. Fiber optic technology has proven much better than metal wires. Signal loss is smaller in fiber optics, and is unable to interfere. For many applications, such as financial algorithmic trading and cloud computing, supercomputers, less latency is a primary requirement. For most telecommunications networks fiber optics are used as a data transmission medium.

KEYWORDS : *Optical fiber, Fiber Technology, Optical Fiber Technology, Optical fiber monitoring, Optical fiber communication, Technology.*

INTRODUCTION

The optical fiber is a lightweight, transparent fiber created by drawing a slightly thicker diameter of glass (silica) or plastic than that of a human hair. Most commonly, optical fibers are used as a means of transmitting light between the two ends of the fiber and see wide use in fiber optic communications, where they allow transmission over longer distances and at higher bandwidths than electrical cables. Instead of metal wires, fibers are used because signals pass through them with less loss; however, fibers are resistant to electromagnetic interference, a problem metal wires suffer from. Fibers are often used for lighting and photography, and are also wrapped in packages so that they can be used to bring light into, or images from enclosed spaces, as in a fiberscope case. Often used for a range of other applications are specially built fibers, some of which are fiber optic sensors and fiber lasers.[1]

Fiber optics, or optical cable, refers to the medium and technologies associated with information being transmitted as light waves through a glass or plastic strand of cable. Fiber optics is used for high-performance, long-distance data networking.

For telecommunications infrastructure such as internet, television and telephones, fiber optics are also widely used. For example, companies like Verizon and Google use fiber optics with their Verizon FIOS and Google Fiber systems, which provide customers with gigabit internet speeds.

Fiber optic cables are used because they have many benefits over copper cables, such as higher bandwidth and speed transmission.

A fiber optic cable can contain a varying number of these fibers of glass— from a few to a few hundred. Another glass layer called cladding is covering the glass fiber core. The cladding is covered by a layer known as a buffer loop, and a jacket layer serves as the final protective layer for each line. [2]

International companies today are seeking quicker, healthier, and greater communications power systems for their network operations. Fiber optic technology will play a major role in this development. A research conducted by Research and Markets estimated that the annual compound growth rate for the fiber optic market could hit 8.5 percent by 2025, suggesting more businesses would look to the solutions offered by this technology.Fiber optic cable is proving to be a critical component of industrial infrastructure from healthcare systems to the marine environment.

For residential applications fiber optic cable assemblies are also playing an increasingly important role. Homeowners now demand high-speed Internet connectivity as part of their everyday lives, and leaders in the telecommunications and data industry are turning to fiber optic technology as a clean, secure way to provide the services they want.[5]

What is Fiber Optical Technology?

Fiber optics, or optical fibers, are long and thin threads of precisely drawn glass about a human hair's diameter. Such fibers, called optical cables, are packaged in coils. We depend on them to relay long distance light signals.The light signals at the transmission source are loaded with data... the same data that you see on a computer screen. Therefore, the optical fiber transmits "information" to the receiving end by light, where the light signal is decoded as information. Hence, fiber optics is in reality a transmitting medium–a "wire" for carrying signals at extremely high speeds over long distances. Initially developed fiber optic cables for endoscopes in the 1950s. The goal was to help doctors view a human patient's inside without any major surgery. In the 1960s, telecommunications engineers discovered a way to send and receive telephone calls at the "speed of light" using the same technology That is about 186,000 miles per second in a vacuum, but it slows to about two-thirds of that level in a cable. [4]

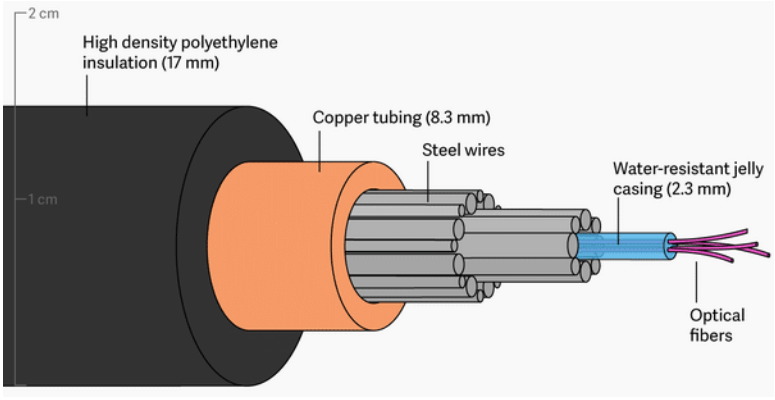

Figure 1. Fiber Optic Cable

(Figure 1.): Fiber optics transmit data via a fiber optic cable in the form of light particles— or photons— that pulse. The core of the glass fiber and the cladding each have a different refractive index which bends the incoming light at some angle. We represent the center and cladding in a sequence of zig-zag bounces as light signals are transmitted through the fiber optic cable, adhering to a method called complete internal reflection. Due of the denser glass layers, light signals do not travel at the speed of light, but they travel about 30 per cent slower than the speed of light.The fiber optics transmission also needs repeaters at distant intervals to regenerate the optical signal by converting it to an electrical signal, processing the electrical signal, and retransmitting the optical signal[2] to refresh or improve the signal during its journey.

Fiber optics uses

Digital networking is a common case for using fiber optics due to the capacity of optical fiber to relay data and have a high bandwidth. Similarly, fiber optics is often used to provide improved communications and efficiency in broadcasting and electronics.Digital networking is a common case for using fiber optics due to the optical fiber's ability to transmit data and a high bandwidth. Likewise, fiber optics is also used in broadcasting and electronics to provide better connectivity and performance.

In addition to its ability to provide temperature sensing, the military and space industries often make use of optical fiber as a medium of communication and signal transfer. Despite their lighter weight and smaller scale, fiber optic cables can be advantageous.

Fiber optics is widely used to provide precise illumination in a number of medical instruments. It also enables biomedical sensors increasingly to assist in minimally invasive medical procedures. Since optical fiber is not susceptible to electromagnetic interference, it is suitable for various tests, such as MRI scans. Many fiber optics medical uses include X-ray photography, endoscopy, light therapy, and surgical microscopy. [2]

Development of Fiber Optic Technology

Fiber optic cables consist of either one or multiple thin glass threads, covered by a flexible, translucent sheath. This technology uses light pulses rather than electric pulses to communicate information. As a result, it offers technically boundless capabilities for success.

The capability could be even greater than you imagine: National Geographic estimates that the new transatlantic cable is capable of transmitting 100 hours of digital video or 30 million phone calls from one side of the ocean to the other at speeds of a single second.

There are many applications for fiber optic cable assemblies and their uses only increase. This technology is the cornerstone of military networking, medical imaging and laser operations, as well as private and public networking of cable and internet networking.

One reason fiber cables are used so commonly is that they are extremely secure. There is no electromagnetic field in this system and data can not be detected, slowed down or jumbled with other signals.

Fiber optics reliability, speed, and protection comes at a higher cost compared to other cable choices on the market. But it remains competitively priced on the marketplace compared with the increasing cost of copper, which is used in other cable technology. Moreover, metallic cabling is inherently thicker, which limits load efficiency and makes it harder to mount in more demanding environments. Fiber optics provide the visibility and protection in infrastructure projects that modern homeowners and business leaders expect. [4] Fiber optics is now a day a part of our telecommunication network. Low loss optical data transfer is a crucial element of the performance of optical communication technology. Communication system efficiency depends on bandwidth signal to noise ratio (SNR) and received signal and this definition is called channel capacity. Regarding optical networks the use of single mode fiber (SMFs) in passive optical splitters has been proposed. The next generation network is Fiber-to-Home network. In 1990, the first optical fiber amplifier was introduced. To order to prevent degradation, amplification is carried out using a fiber optic amplifier to allow data signal to travel hundreds of kilometers. Wavelength division multiplexing is provided to improve optical network transmission capacity. For different settings, such as shallow water, acoustic communication has many limitations and the only way to address this shortcoming is optical underwater communication. The only explanation for more efficient optical communication is that optical signals are much stronger than electrical signals. New technologies have come into play where optical standards produce highly coherent optical carriers for purposes of transmission. Today, on an international scale, fiber optic networks are being carried out for days where fiber optics relay light that is modulated by electrical signal resembles an atomic clock.

Recent Developments in Fiber Optic Communication:

Several advancements in the area of fiber optic communication have occurred in different fields, some of which are as follows.

A. Material used in fiber optic cable

In addition to silica, chalcogenide, fluoroziconate, fluoroaluminate are the ingredients used to produce the fiber. In all materials sapphire gives longer wavelength. Following are the few innovations that occur in the material wise manufacture of fiber fluoride glass and are made of specific metal fiber fluorides. These are low viscosity optical non-oxide glasses. Optical Low Viscosity lenses. The optical fluoride glazing attenuation is very small. Silica is the substance that is often found in fiber. It is chemically purified, so loss of absorption is very small. Silica has a wide transmission capacity, but the main property of silica is that it can be doped with different materials such as aluminum oxide, germanium dioxide, which makes it highly effective. Chalcogenide glass is made of one of the highly flexible chalcogenide compounds. Phosphate glass is made from metaphosphates of different metals that have high doping concentration.

While silicon dioxide (Sio2) is the main fiber optic material, the center of the fiber is made of phosphorus oxychloride (Poc13) for some time. Fiber can also be made of tetrachloride from germanium (Gecl4). The substance we are defines the degree of attenuation, which is the most critical aspect of fiber optic communication.Higher the degree of attenuation will resulting in transmission of discrete light wave signals.

B. Sensor development

In optical fiber communication fiber optic sensors are used as a sensing feature. The strength of light, they can differ. Intrinsic sensors are designed to provide broad-distance distributed sensing. Such sensors have the main function of calculating temperature, strain, pressure and other quantities. Fiber optic temperature sensor is used in industrial surveillance applications. But the main purpose is to collect temperature data and gain experience of implanting. Tip-covered sensor that is also known as a point sensor

that is used when fiber comes into contact with reactive chemical element because chemical change will lead to fiber change. In optical fiber communication fiber optic sensors are used as a sensing feature. The strength of light, they can differ. Intrinsic sensors are designed to provide distributed sensing over large distance. Such sensors have the main function of calculating temperature, strain, pressure and other quantities. Fiber optic temperature sensor is used in industrial surveillance applications. But the main aim is to gather data about the temperature and obtain implanting experience. Tip-covered sensor that is also known as a point sensor that is used when fiber comes into contact with reactive chemical element as chemical change will lead to fiber change.

Extrinsic sensors are used for the transmission of modulated light from either an electronic or non-fiber optic system. They can enter places which are inaccessible. They can also measure internal temperature. Extrinsic fiber optic sensors are very common because of their measuring signal capability without noise pollution. They are primarily used for calculating speed, acceleration, rotation, vibration, displacement, and temperature.

C. Developments in fiber technology

Current research in technical aspects of fiber optic communications is underway on high altitude platforms (HAPs). HAP are airships situated 17 to 25 km above ground level. To stop heavy atmospheric laser beam impacts. In this technology, HAP acts as a data link. Other rapidly evolving technology is free-space networking in which satellite–to–satellite crosslinks can be used via optical networking links. That technology is ready to be built. Physical communication efficiency can be increased by the use of photon counting receivers. Backhaul network and telecommunications switches used a copper fiber network which will provide a high bandwidth capacity of 50 mbps. The network uses fiber-optic cables that give them a range of 450 meters, which is very mild. The main factor of fiber optic communication is the optical laser. This is the system which generates light source. If laser wave length is short it can produce high output power. Laser can monitor sudden shift in wavelength. Single mode laser has seen considerable growth in the recent past. Optical fiber may also be used as a sensor for temperature, strain, pressure. The interfero-metric sensor relies on the change in light phase, it is the propagation of the light wave across fiber. Intension metric depends on power transfer, and the volume of power transfer is radial through Fiber[3].

Evolution of Fiber Optics Communication:

Corning Glass Works was the 1st commercial fiber optic fiber in 1970. Around the same time, GaAs semiconductor lasers were jointly developed for lightweight transmission via fiber optic cables. The first fiber-optic communication network was developed in 1975. It used GaAs semiconductor lasers, operated at a wavelength of.8 µm and approx. bit rate. 45MB / sec with a repeater range of around 10 km.

Around about in 1990, the third generation of operational and engaging fiber optic communication was established at a wavelength of about 1.55µm. These third gene systems were operational at a small rate of up to 2.5 Gb / sec, a solitudinal longitudinal fiber with a repeater region length of 100Kilometres.

The 4th generation of optical fiber systems developed the use of optical amps as a standby for consumed WDM (multiplexing of the wavelength division) and repeaters to increase information levels. Approximately by 1996, the transmission of approx. 11.300 kilometers at an information rate of 5GB / sec was well-tried to use submarine cables[8].

Using DWDM (Dense Wave Division Multiplexing) the 5th gene optical fiber communication boots up information speeds. Additionally, consideration of optical solutions, the area unit beats which can sanctuate their figure by combating the undesirable diffusion belongings, is being investigated. The fibre optic networking case shown in Figure 2.

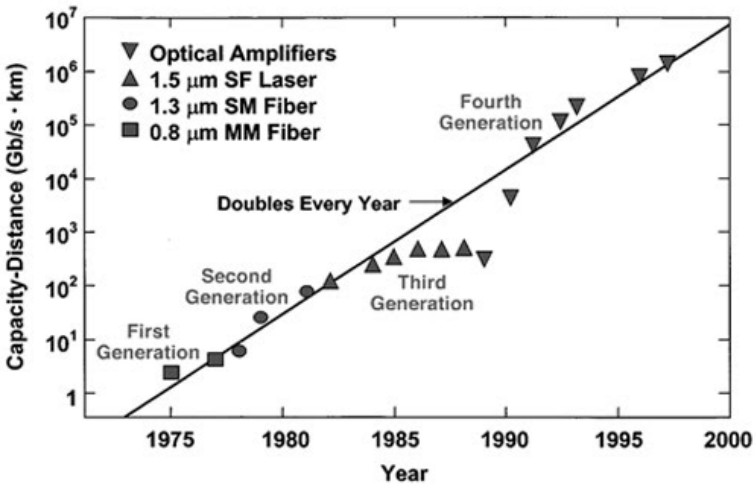

Figure 2: Fiber Optics Communication Generations [7]

Fiber Optics Communication Future Trends:

Fiber Optics is essentially the future of information exchange. Enlargement of technology and rising competition and competition for optical fiber communication have distracted the case of optical fibre communication. With the advancement of revolutionary and a lot of positive information technologies, it is anticipated to get on in the long run. Additional down are some of the intended forthcoming trends in optical fiber communication.

A. Optical Communication Networks

All optical fiber connectivity is intended to be completely within the visual region, offering a boost to connect all communication networks with fiber optics. Both signals within the optical domain will be controlled in these networks, with no form of electrical manipulation. Today, in the electrical realm, processing and interchanging of signals happens, optical signals are ultimately converted to electrical signals until they become optical signals that are transmitted to their terminal over long distances. This optical to electrical conversion and, by comparison, the performance in extra dormancy on the network can be a constraint on achieving terribly high knowledge rates.

Another benefit of all optical networks is that if the rate increases, there will be no need to adjust the natural philosophy, meanwhile all signals phase and steering inside the optical space takes place[9]. At the other hand, this may formerly evolve into realism, optical steering problems, and wavelength interchange must be resolved. To catch associate actual results of these problems investigation is constant.

B. Optical Information Broadcasting Network

Actually, due to the randomness of the complex distribution of information calculation, earlier optical networks do not seem to be able to adapt to the exponential growth of future facilities. Such networks rely primarily on manual network property configuration is extremely time-consuming and unable to completely familiarize themselves with the up-to-date network pressure.Smart as a whip optical network can be an emerging trend-setting optical network organization, with applications such as: aggressive assignment of direction, traffic engineering, distinctive network supervision management procedures, on-demand information calculation, flexible communication abilities, wholesale wavelengths, leasing of wavelengths, discriminated facilities for Excel multiplicity of Excellence of Service levels, and so on. It will take time to ensure that the smart can be extended to all or some network stages as a whip optical network. This will be implemented first in long-haul networks, and will be extended bit by bit to the edge of the network[10].

C. Optical Multi-Terabit Networks

DWDM is paving the multi-terabit transmission approach. Within increasing multi-terabit optical networks, the worldwide need for enhanced accessibility of information measurements has been directed to the priority. There are currently four 40Gb / s terabit mistreatment networks with a combined capacity of one hundred DWDM channels (Dense Wave Division Multiplexing). With 100 Gb / s, students try to realize an even bigger measure of knowledge. By consistently that the prices of fiber optic modules, the accessibility within the future of a lot of superior knowledge measure is surmisible.

D. Ultra–high Haul Optical broadcast

The constraints imposed due to imperfection inside the transmission medium are multiple subjects for study in this revolutionary–end of the day Optical transmission. Cancelation of the dispersion result has led researchers to examine the possible blessings of the propagation of soliton waves. Some knowledge of the contacts between the light-weight magnetic attraction wave and thus the transmitting medium is actually to keep in the direction of associated networks with the optimum circumstances for propagating a lightweight pulse[11].

E. Polymer Optic Fibers

Once synonymous with alternative electronic communication response, it provides various assistances such as wireless communication systems, copper cables and optical fiber. Chemical compound optical fibers have relaxed and less restricted optical signals processes compared to glass optical fibers, and are additionally elastic for plug interconnections[13].Because of its paybacks, the use of chemical compound optical fibers is currently being studied by numerous R&D teams, as the transmitting medium for aircraft. The use of chemical compound transmission fibers Optical Fibers seems to be potential for future craft applications[14] as decided by the German component center. In addition, chemical compound optical fibers are likely to move copper cables for the past mile from the telecommunications list of the company's last delivery box and thus the attended finish shopper[15] for some reason. The upcoming conventional Gigabit chemical compound optical fiber will be fascinated with Tomlinson-Harashima Pre coding, PAM modulation design and construction Co set committal to writing Modulation.

F. Improved Laser Technology

Another future development is to add existing semi-conductor lasers to an intense range of lasing wave lengths[12]. For some nice density optical applications, shorter wavelength lasers with dreadfully good efficiency commands are of interest. A variety of optical laser sources that are generated spectrally by chirping to recover for chromatic dispersion are currently gift. Here chirp management means that the optical maser is regulated in such a way that it undergoes a rapid shift in its wavelength when firing a pulse decreases the heartbeat chromatic dispersion. There is a need to create devices that define this sort of laser to be used to. And also, for future coherent optical systems, the only mode tunable lasers are of excellent importance. Those tunable laser lasers can be adjusted in a single longitudinal manner to vary frequencies.

G. Neural Network Nodes with Laser

Neural network with optical maser is that the fiber optics network nodes are obviously an honest choice for development. The chosen hardware configuration used in the optical field and thus the use of ultra-fast photonic segments is expected to increase or improve the efficiency and the speed of telecommunications networks[12]. In the coming optical networks, it will evolve in a lot of complicated ways; the use of optical maser neural nodes would be a great response.

H. High–Altitude networks

There are actually optical layers of satellite communications and orbit-to-ground connections, the latter being affected by negative atmosphere. Gift research investigates optical connectivity to and from

platforms at high altitude.High altitude platforms airships gift higher than the clouds at a height of about 25 km, wherever the unfavorable area resulting in a light beam is lower than straight above the bottom [16].

I. Optical Transmitter / Receiver Technology Improvement

Also for optical signals with unreliable undulation and low signal to noise quantitative relationship during transmission, high quality transmission in fiber optics communication is important. The work is constant to develop optical transceivers that endorse revolutionary and progressive intonation technology, with outstanding chromatic diffusion and Optical Signal to Noise quantitative relation (OSNR) tolerance, which can be extended to ultra-long tow communication systems. In addition, enhanced fault rectification codes, which are substantially competent than these BCH concatenated codes, will be accessible within the near future.

J. Optical Amplification Technology Improved

One of the intense technologies utilized in optical fiber communication systems is EDFA (Erbium Doped Fiber Amplifier). Someday, superior technologies to boost EDFA (Erbium Doped Fiber Amplifier) act are going to be established. thus as to surge the gain information measure of EDFA (Erbium Doped Fiber Amplifier), healthier gain leveling technology for great exactness optical amplification are going to be established. Also, with the aim of achieving a complicated output power, and a lesser noise figures, high power pumping lasers that have brilliant optical amplification options with results of on the far side +20dBm, and really very little noise numeral are supposed to occur within the close to forthcoming.

K. WDM Technology Improvements

Investigation is constant on the way to prolong the variety of wavelengths for which multiplexing structures of wave partitions can function. The wavelength window (C band) currently ranges from a.53-1.57µm. Dry fiber with a low loss window guarantees that the leeway ranges from one.30-1.65 µm. Furthermore, advances in optical filtering technology for wave partition multiplexing within the forthcoming are expected.

Advantages of Optical Fiber Technology

Fiber optic cables are primarily used for its benefits over copper cables. Advantages include:

- Improved bandwidth capacities support.
- Light will continue to fly without needing too much signal boost.
- Unlike electromagnetic interference, they are less vulnerable to intrusion.
- They may be immersed in water-fiber optics used in more dangerous conditions such as underwater cables.
- Fiber optic cables are lighter, thinner and safer than copper wire cables
- They don't need to be held or replaced as much.

CONCLUSION:

In the telecommunications field fiber optics is a big factor. The low attenuation characteristics, low properties of absorption loss and high bandwidth make it suitable for higher bit transmission. Fiber optic chemical and temperature sensor are combined and used for clinical and environmental control applications. Fiber optics industry growth will continue to grow over the next decade. Fiber optics moves toward home applications over the next few decades. This is currently only used in commercial applications for days. Fiber optic infrastructure will transform our lives and move the face of telecommunications.

Development is expected to continue in the future, but as new improvements and tests have already been achieved in the laboratory must be applied to sensible application and implementations leading to a whole new generation of fiber optics communications.

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