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# Function of Optical Fiber and its Application in Various Industries

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***ABSTRACT:*** ***A long fiber that is often constructed of glass or plastic is used in optical fiber technology to transmit data utilizing short light pulses. Signal loss is reduced by metal wires; hence they are preferable for transmission in optical fiber communications. The problem arises to other cable such as inadequate transmission power excessive signal loss brought on by an excessively lengthy wire span. Signal loss that is too great because to damaged connections. Excessive signal loss as a result of a bad connection or splice. Hence all these this problem overcomes with help of optical fiber such as to transport data, fiber optic cables include a core that conveys light. In comparison to copper connections, fiber optic cables can now transmit messages at rates that are just 31% slower than the speed of light. In this paper author discussed the working principle of optical fiber, types of optical fiber, and its application in different sectors. It concluded that the use of optical fiber cable in communication networks has become increasingly popular, and a dizzying number of suppliers are now vying to produce and provide fiber optic cables. In the future, more and more automobiles are using fiber optics due to its ability to save space and provide greater illumination, and fiber optic technology is anticipated to play a significant role in this expansion.***

***KEYWORDS:*** ***Cable, Dielectric, Optical Fiber, Telecommunications, Technology.***

## 1. INTRODUCTION

The transmission of data across optical fibre lines may include sending light pulses from one location to another. These cables are currently employed for communication purposes, including the sending of voice messages and photos. These cables may be composed of glass or plastic and designed to transport data more swiftly and efficiently than copper wires. These cables revolutionized the telecommunications sector and were essential for data transmission. These cables therefore took the role of copper cables. The Internet is now accessible everywhere. As a result, it is able to browse websites, download films, and make phone calls. Using the fibre optic cables beam, [1],[2]. The term "optical fibre cable" refers to a cable that transmits data using fibre (threads) or plastic (glass). This cable is made up of a collection of glass threads that carry information via light rays. These cables have various benefits over other communication cable types, including better bandwidth, less fragile than metal cables, less thin, lighter, and the ability to carry data digitally. The installation is more costly, more delicate, and challenging to secure together are the primary drawbacks of these cables. For LAN, these wires are necessary. As a result, telecom providers are using these connections to replace telephone lines [3],[4]. Fiber optics will be used in all communications in the future. These cables' look, stiffness, endurance,

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tensile strength, flammability, length, temperature range, and ductility are the primary design factors.

The internet, high-definition television, dike surveillance, as well as endoscopy. These are only a few of the many uses for optical fibers that can play important roles [5],[6]. All of these applications are, of course, subject to the always evolving expectations of the end users, which frequently boil down to the phrases better, quicker, and cheaper. As a result, during the past several decades, the discipline of fiber optics, which is a branch of study concerned with the design and use of optical fibers, has emerged as a significant area of practical research. Two significant application areas in the field of fiber optics are sensor systems and fiber-optic telecommunication systems. Large bandwidths may be achieved with optical fibers for telecommunication while minimizing transmission losses. Small parameter changes in the fiber characteristics can be used in sensor systems as a gauge for things like ruptures or temperature changes inside the surrounding material. Evidently, each of these applications places a distinct restriction on the optical fiber's used parameters [7],[8]. Glass or plastic may be used to create an optical fiber. Dopants are added to these fundamental elements to provide a refractive-index profile that is unique to the fiber and enables light to be directed along its core. The computer has evolved into a crucial instrument in the design and production of an optical fiber [9],[10]. The fit between a specific optical fiber design and the finished product has significantly improved as a result of better production process control. Due to the fact that fiber optics is an established subject of study and that present fibers are already pretty good, advancements can only be made by building fiber models and doing accurate and painstaking computations of the parameters that define the fiber (Figure 1).

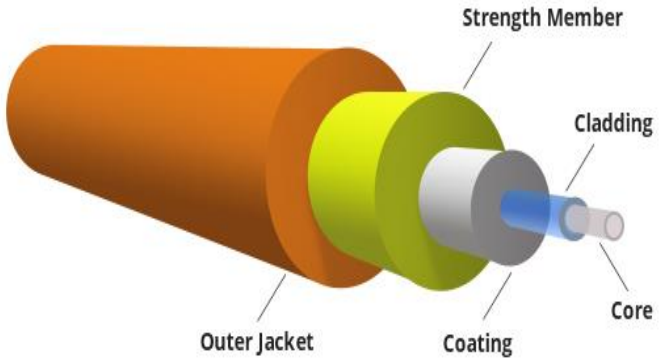


**Figure 1: Illustrates the part of optical fiber in which uses light pulses instead of electrical pulses to transmit information.**

*1.1. Working of the Optical Fiber:*

The transfer of information by light atoms, as opposed to photons, is the basis for optical fiber's operation. The fiberglass core and cladding have a unique refractive index that causes them to

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bend that incoming light at a certain angle. When light signals are sent over an optical cable, they adhere to a technique known as total internal reflection that prevents them from bounce off the cladding as well as core in a series of zigzag motions. A long, thin thread of simple material is an optical fiber. This cable has a cylinder-like form. This cable's center contains the core, and the outside covering it is known as the cladding. Here, the cladding serves as a layer of defense. Other than glass, many forms of plastic are used to make both of these. As a result, light might move extremely slowly through the core before reaching the cladding. Light from the core bounces off the cladding's edge when it encounters it at an angle less than 90 degrees. If light doesn't reach the fiber's ends, it quickly twists or stretches, preventing any further light from escaping. The cable's cladding may get damaged after being scraped. Thus, a plastic layer that resembles a buffer shields the cladding. This buffered fiber could be found in a jacket-like layer with increased toughness. Consequently, using the fiber is simple and won't harm it.

## 2. DISCUSSION

The main communication axis of the world is made up of optical fibers because of their great information capacity. The deployment of fiber optics now complies with national as well as international standards and guidelines due to the increasing demand for fast information transfer.

### *2.1. Types of Optical Fibre:*

A cylindrical, hair-thin optical fiber can be made of glass or another transparent dielectric material. In optical communication, evanescent waves composed of transparent dielectric materials are employed as the fiber. The different types of optical fibre are:

#### *2.1.1. Multimode Optical Fiber:*

Light may go through more reflections because multimode fiber optic cable enables many light modes to flow through a bigger core. This form of fiber has the benefit of allowing the use of an inexpensive transceiver, however it also introduces significant attenuation and dispersion. This basically implies that signal quality soon deteriorates because of how much space the core's size gives light to bounce as it goes down the fiber. Additionally, because it cannot be amplified, it can only be utilized over small distances using straightforward, low-cost transceivers. i.e., when a cheap solution is require. Multimode fiber is not appropriate for lengths more than 200–300 meters. Wherever small distances are required, such within a data center, it is most frequently encountered. The OM4 fiber, which can handle 10 as well as 100G traffic signals up to 100 meters, is an illustration of this. There are two main types of multimode fiber:

- Gradient-index multimode fiber

The more prevalent kind of multimode fiber now in use is this one. Gradient-index multimode fibers provide for better grouping of light rays because light closer to the axis moves more slowly than light close to the cladding. Then, as you move away from the central axis and towards the cladding, the refractive index steadily drops.

- Step-index multimode fiber

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Light in this kind of multimode fiber bounces off the cladding and travels in different zigzags and straight lines. It has the effect of causing various light modes to exit the fiber at various moments. The signal begins to lose part of its structure as other modes begin to propagate.

### *2.1.2. Single-mode optical fiber:*

Compared to multimode fiber, single-mode optical fiber does have a smaller core and only supports one kind of light transmission. This kind of signal attenuation is lowest because there are less light reflections, allowing light to go further. It connects to single-mode optics, which transport a single wavelength of light in a straight line down through fiber using a laser as the light source. Despite having a core that is generally 9 m in size rather than 50 m or more, it nonetheless has the same 125 m cladding as multimode fiber. The best fiber for long-distance networking is single-mode fiber because of its high bandwidth. This also comes in a range of sorts that are tailored to certain regions of the fiber.

### *2.1.3. Non-dispersion-transfer fiber:*

In the 1980s, non-dispersion-shifted fiber (NDSF) was the most widely used kind of fiber. Before wavelength division multiplexing (WDM) technologies were widely used for optical networking, it was designed for the 1310nm area of fiber. The decreased dispersion of NDSF within this range prevents as much light from reflecting off the core. However, because current WDM systems operate in a considerably larger range at 1550 nm, connection distances are constrained.

### *2.1.4. Dispersion-transferred fiber:*

Dispersion-transferred fibers come in two different varieties. It is challenging to employ the originally dispersion-shifted fiber type with some types of contemporary WDM systems since it is only capable of single process and is designed for usage at 1550nm. The optical fiber of choice for brand-new fiber installations is non-zero dispersion-shifted fiber, with an extremely low dispersion. For the usage of high-capacity, high-data-rate DWDM networks, it is the most practical form of single-mode fiber.

## *2.2. Application of optical fiber:*

Medical Industry - Fiber optic cables are utilized in a wide range of equipment because they are extremely flexible and thin. Both science and medicine employ fiber optic lines. Gaining access to the body's inside is beneficial. The doctor can observe the body's inside organs thanks to optical fiber. These fibers are injected into the body's bare spaces to accomplish this. When performing a variety of medical procedures, such as surgery, biomedical research, as well as microscopy, the optical fiber functions as a laser. Any non-invasive surgical technique must include optical communication. A typical term for this is an endoscopy. In these kinds of applications, the surgical region of the body is illuminated by a tiny, brilliant light. As a result, it is possible to minimize the size and quantity of skin-related wounds or slits. In order to communicate: Massive volumes of data can be sent across fiber optic lines at breakneck rates. In order to create Internet cables, this technique is frequently employed. Increasing numbers of

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communication sectors are replacing conventional wire with optical fiber. Optic fiber lines are less clumsy, can transport more data, and are much more flexible than copper wires because of this. Another crucial characteristic of optical fiber that makes it the material of choice for the communication sectors is its ability to transmit data quickly. The amount of time it takes to transport data and files throughout the network has been significantly reduced, as can be seen by users. Optical fiber is frequently employed in the defense industry, which is another significant use. These cables are appropriate for data transfer in aerospace and defense applications that demand high levels of data security. The powerful and reliable communication capabilities of optical fibers make them suitable for use in aircraft wiring and the construction of hydrophones for seismic and sonar applications.

## 3. CONCLUSION

In terms of the pulse width, one can state that for shorter optical fibers, a pulse of smaller width is required to have a greater resolution, but for longer optical fibers, a pulse of larger width is required. Because there are fewer losses at longer wavelengths at 1550 nm and fewer regenerators are required, this wavelength is used by the majority of long-haul systems. They displayed and compared concurrently, on the same window, in order to calculate the losses resulting from the bending of a optical fiber cable. Conclusion: If all businesses that implement fiber-optic cables for high-capacity links on current medium- and low-voltage electrical network lines implemented the suggestions made in this study, such as using mechanical calculations of the maximum permissible stress and electric fields, they would not only extend the useful life of the optical fiber but also lower the cost of maintenance, preventing breakage. This implied that the essential function of optical fiber is the transfer of information as light. The usage of optical fiber is really more advantageous than the conventional use of metal wires. These cables are made up of 1,000 brief optical fibers enclosed in insulation for protection. Four decades ago, optical fiber was first made available for purchase. Since entering the market, fiber optic cable has transformed the whole telecommunications industries.

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