Fiber Optics and its Different Applications

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Abstract

The optical fibers which are considered as waveguides can be applied to light transmission applications. The core part of the optical fiber is surrounded by a glass or plastic layer called cladding which is characterized by the refractive index that is lower compared to the core refractive index. The total internal reflection phenomena are necessary for the fine confinements of the light within the waveguide. Basically, optical fibers can be categorized based on the structure, modes number, refractive index profile, dispersion, signal processing ability, and polarization. In this report, we focus on the applications of fiber optics in different area of physics.

Keywords: *Optics, Fiber, Refractive Index.*

I. Introduction

The Fiber optics is very thin strands of purified glass that convey data starting with one point then onto the next as light. Dissimilar to copper wire, fiber optics does not utilize power amid transmission. Optical strands can be either glass or plastic tubing equipped for transmitting light, which is then changed over into sound, discourse or data. Fiber optic links transmit a computerized flag by means of beats of light through the thin strands of glass [1-2].

A fiber optic strand is about the thickness of a human hair, around 120 micrometers in distance across and can convey upwards of 20 billion light heartbeats for each second. The strands are packaged together to frame optical groups, which transmit the light flags over long separations up to 50 km without the requirement for repeaters [3]. Every optic fiber is comprised of three principle parts [4] . The center or the focal point of the optical fiber is a thin strand of glass that conveys the light flag. The cladding is the optical material which mirrors the light flags once more into the center. This keeps the light from getting away and enables it to go through the fiber. The outside coat or cushion covering is made of a plastic material that shields the optical fiber from any dampness, erosion and outer harm.

II. Types of Optical Fibers

To understand the applications of optical fibers, it is important to study their characteristic types. The optical fiber systems will be classified with regards to a specific application to which it is being subjected [5]. Basically, optical fibers can be categorized based on the following aspects:

(i) Structure: According to the structure, the optical fibers are classified as cylindrical, bi-refringent,planar or strip.

(ii) Modes number: According to the modes, optical fibers are classified as multi-mode and single-mode optical fiber.

(iii) Refractive index profile: According to the refractive index, optical fibers are classified into two types such as step-index and gradient-index fibers.

(iv)Dispersion: Based upon the dispersion, optical fibers are classified into natural, dispersion, dispersion shifted, reverse dispersion and dispersion winded fiber.

(v) Signal processing ability: Based on signal processing ability passive data transmission and active-amplifier are the two types of optical fiber.

(vi) Polarization: According to polarization optical fibers are classified to classic, polarization preserving, and polarizing fibers.

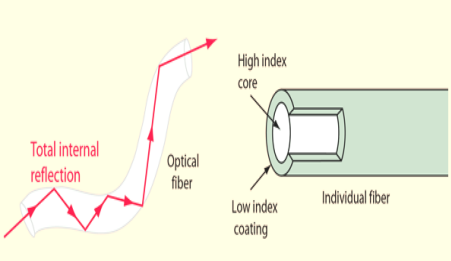

Fig. 1: Diagram of total internal reflection in optical fiber

III. Optical Fiber Sensors

Optical fiber sensors have been developed for a wide range applications in aircraft. Some potential drawbacks can be associated with the optical fiber sensors in aircraft such as requirements for newly developed infrastructure for installation and maintenance [6]. Optical fiber sensors found a wide range of applications due to their lightweight, low-cost, cost-effective, high sensitivity, immunity to corrosion, high-temperature performance, as well as their resistance to electromagnetic interference. Although, installing new layout of optical sensors that could run electrical systems is a big challenge, however, despite these inherent challenges which may seem to hinder any further developments in optical fiber technology, there has been a continuous interest in the commercialization of optical fiber sensors for aviation industries due to the inherent advantages possessed. These include high temperature, joint pressure, and temperature as well as sensors for engine health, hydraulics and landing gear monitoring, an ultra-high sensitive pressure sensor for oil, pneumatic and fluid aero systems, combined acceleration and temperature sensors for condition monitoring for rotating components [6]. Optical fibers also found applicability in air crafts structural health monitoring [7]. Performance monitors are now required for more effective maintenance. Quite a number of applications in modern aircraft required light-weight objects together with improved performance, thus advanced carbon composite materials were exploited and used in the wings of Dreamliner 787 [8], however, this suppers potential new challenges when protection against lightning strikes is required. Here, the optical fibers proffer alternative solution due to the lightweight nature of the fibers and their immunity to electromagnetic interference. Sensors are also used for predictive maintenance in engine health monitoring [9]. For example, sensors can be permanently fitted to send engine health monitoring data to the aircraft pilot. These can include pressure and temperature sensors for monitoring fan, compressors and turbines performances [10].

IV. Applications of Optical Fibers

Fiber optic links are containers of glass that discover a large group of employments in an assortment of fields. Fiber optics have turned out to be progressively more coordinated into systems where they encourage media transmission applications. Since these links are adaptable and inactive, they are regularly utilized as a part of pharmaceutical amid surgeries as light aides and imaging apparatuses. Fiber optic links are additionally utilized as a part of mechanical settings for imaging areas that are hard to reach through ordinary means.

(i) **Media transmission:** Fiber optic links can convey countless flags all the while through a system called wavelength division multiplexing. This builds their proficiency and makes them perfect for transporting substantial amounts of autonomous signs. Their adequacy if additionally caused by their invulnerability to electrical obstruction.

(ii) **Bio Medical:** In medication, optical filaments empower doctors to glimpse and work inside the body through modest cuts without performing surgery. They are utilized for endoscopes instruments for review the inside of empty organs in the body. Most endoscopes have two arrangements of strands: an external ring of indistinguishable filaments that provisions the light, and an internal reasonable package that transmits the picture. Endoscopes might be intended to investigate particular regions. For instance, doctors utilize an arthroscope to analyze knees, shoulders, and different joints.

(iii) **Fiber Optic Cable Sensors:** Fiber optic links sensors are utilized to quantify an assortment of physical properties, for example, mechanical strain, temperature, and weight. Their little size enables them to be utilized as a part of areas that are hard to reach. Some fiber optic sensors measure these properties specifically by utilizing balanced light.

Different sensors utilize fiber optics as bearers to convey light from antagonistic conditions to delicate sensors situated in more secure positions. One illustration is the fiber optic gyrator, which can distinguish mechanical pivot with no moving parts.

(iv) **Fiber Optic Lasers:** Fiber optic links make helpful lasers since they are little and adaptable. Links utilized as a part of lasing require the expansion of uncommon earth components like erbium. The fiber must be optically pumped utilizing a different laser, which is coupled into the optical link. The fiber optic laser has many points of interest that exceed these constraints. The high force light can be transmitted generous separations without much loss of energy.

Inspite the above applications, fiber optics have a wide range of applications. They are used to connect users and servers in a variety of network . It helps to increase the speed and accuracy of data transmission. They are also used in military as hydrophones for seismic and SONAR uses, as wiring in aircraft, submarines and other vehicles and also for field networking. Broadcast/cable companies are using fiber optic cables for wiring CATV, HDTV, internet, video on-demand and other applications. In industries and companies, it is used for imaging in hard to reach areas, as wiring.Optical fibers are also widely used in illumination applications. They are used as light guides in medical and other applications. In some buildings, optical fibers route sunlight from the roof to other parts of the building. Optical fiber illumination is also used for decorative applications, including art, toys and artificial Christmas trees.

V. Conclusions

Optical fiber technology has been used in many areas of telecommunication,photonics, medical and engineering. It has attracted many researchers due to its performance, low loss, no interference, higher bandwidth and its inherently high data-carrying capacity.Although optical fibers have many advantages, there still exist somedisadvantages associated with the optical fiber technology. One of the disadvantages of the optical fibers is that in spite of the natural abundanceof the material for optical fiber construction which is the sand, the fibers are more expensive compared to copper cables. Another disadvantage is that; high-skilled manpower is needed for optical fiber mounting.

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