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ATTENUATION ON OPTICAL FIBER: A REVIEW

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ABSTRCT: The present paper is highlighting the introduction to fiber optics, working of fiber optics, types of fiber optics. Optical fibers are widely used in fiber-optic communications, which permits transmission over longer distances and at higher bandwidths (data rates) than other forms of communication. Fibers are used instead of metal wires because signals travel along them with less loss and are also immune to electromagnetic interference. Fiber optic lines are strands of optically pure glass as thin as a human hair that carries digital information over long distances. Here the advantages of fiber optics also have been discussed. There are several researches in the field of fiber optics. Therefore the existing researches also have been mentioned here. Here the various factors that influence the communication in fiber optics are explained. These factors are Signal distortion, Condition for signal distortion-less transmission, Special nature of Optical Signal, Attenuation on Optical Fiber, Material Loss, Scattering Loss, Micro-Bending Losses, Radiation or Bending Loss. Fiber optics is capable to transfer more data at higher throughput.

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KEYWORDS: MMF, SMF, GIMMF, Fiber, MCVD, Matlab, Attenuation, Microbend Losses

[1] INTRORDUCTION

An optical fiber is a flexible, transparent fiber made of very pure glass (silica) not much wider than a human hair that acts as a waveguide, or "light pipe", to transmit light between the two ends of the fiber. The field of applied science and engineering concerned with the design and application of optical fibers is known as fiber optics. Optical fibers are widely used in fiber-optic communications, which permits transmission over longer distances and at higher bandwidths (data rates) than other forms of communication. Fibers are used instead of metal wires because signals travel along them with less loss and are also immune to electromagnetic interference. Fibers are also used for illumination, and are wrapped in bundles so they can be used to carry images, thus allowing viewing in tight spaces. Specially designed fibers are used for a variety of other applications, including sensors and fiber lasers The yellow cables are single mode fibers; the orange and blue cables are multi-mode fibers: 50/125 µm OM2 and 50/125 µm OM3 fiber respectively.

Optical fiber typically consists of a transparent core surrounded by a transparent cladding material with a lower index of refraction. Light is kept in the core by total internal reflection. This causes the fiber to act as a waveguide. Fibers that support many propagation paths or transverse modes are called multi-mode fibers (MMF), while those that only support a single mode are called single-mode fibers (SMF). Multi-mode fibers generally have a larger core diameter, and are used for short-distance communication links and for applications where high power must be transmitted. Single-mode fibers are used for most communication links longer than 1,050 meters (3,440 ft).

[2] TYPES OF FIBER OPTICS

Single mode fiber

Fiber with a core diameter less than about ten times the wavelength of the propagating light cannot be modeled using geometric optics. Instead, it must be analyzed as an electromagnetic structure, by solution of Maxwell's equations as reduced to the electromagnetic wave equation. The electromagnetic analysis may also be required to understand behaviors such as speckle that occur when coherent light propagates in multi-mode fiber. As an optical waveguide, the fiber supports one or more confined transverse modes by which light can propagate along the fiber. Fiber supporting only one mode is called single-mode or mono-mode fiber. The behavior of larger-core multi-mode fiber can also be modeled using the wave equation, which shows that such fiber supports more than one mode of propagation (hence the name). The results of such modeling of multi-mode fiber approximately agree with the predictions of geometric optics, if the fiber core is large enough to support more than a few modes.

The waveguide analysis shows that the light energy in the fiber is not completely confined in the core. Instead, especially in single-mode fibers, a significant fraction of the energy in the bound mode travels in the cladding as an evanescent wave.

The most common type of single-mode fiber has a core diameter of 8–10 micrometers and is designed for use in the near infrared. The mode structure

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depends on the wavelength of the light used, so that this fiber actually supports a small number of additional modes at visible wavelengths. Multi-mode fiber, by comparison, is manufactured with core diameters as small as 50 micrometers and as large as hundreds of micrometers.

Multi mode fiber

Fiber with large core diameter (greater than 10 micrometers) may be analyzed by geometrical optics. Such fiber is called multi-mode fiber, from the electromagnetic analysis (see below). In a step-index multi-mode fiber, rays of light are guided along the fiber core by total internal reflection. Rays that meet the core-cladding boundary at a high angle (measured relative to a line normal to the boundary), greater than the critical angle for this boundary, are completely reflected. The critical angle (minimum angle for total internal reflection) is determined by the difference in index of refraction between the core and cladding materials.
The propagation of light through a multi-mode optical fiber Rays that meet the boundary at a low angle are refracted from the core into the cladding, and do not convey light and hence information along the fiber. The critical angle determines the acceptance angle of the fiber, often reported as a numerical aperture. A high numerical aperture allows light to propagate down the fiber in rays both close to the axis and at various angles, allowing efficient coupling of light into the fiber. However, this high numerical aperture increases the amount of dispersion as rays at different angles have different path lengths and therefore take different times to traverse the fiber.

OPTICAL FIBER TYPES

In graded-index fiber,

The index of refraction in the core decreases continuously between the axis and the cladding. This causes light rays to bend smoothly as they approach the cladding, rather than reflecting abruptly from the core-cladding boundary. The resulting curved paths reduce multi-path dispersion because high angle rays pass more through the lower-index periphery of the core, rather than the high-index center. The index profile is chosen to minimize the difference in axial propagation speeds of the various rays in the fiber. This ideal index profile is very close to a parabolic relationship between the index and the distance from the axis.

[3]LITERATURE REVIEW

In 2018, Jianxiang Wen, et al. [1] wrote on All-Fiber OAM Amplifier. This Amplifier works with high purity along with broadband spectrum gain. The present Amplifier is related to fuse taper VBC. FMF is the short form of Active and passive few-mode fibers. It carries same geometric parameters. A VBC has been formulated with the use of a single-mode fiber.

In 2016, Xiaohui Liu , et al. [2] proposed Fiber optic pressure. They also considered the temperature monitoring structure. This system is very applicable for downhole application. There presented a pressure and temperature monitoring structure. This structure is related to fiber Bragg grating and extrinsic Fabry-Perot interferometer.

In 2016, Junfeng Jiang , et al. [3] described the development of optical fiber temperature sensor. This sensor is applicable in aviation business. The Temperature has been considered an essential parameter to manage the applications. This parameter is applicable in aviation business. They launched a series of optical fiber temperature sensors.

In 2017, Di Yang , et al. [4] reviewed An optical fiber comprehensive analysis system. This system is efficient for spectral-attenuation. Along with this, it is also capable for geometry parameters measurement. They proposed a quickly geometry parameters measurement on G652, G655, G657, GI50, GI62.5 fibers. Than with this system they achieved accuracy within 1percent for spectral-attenuation measurement.

In 2011, Roman Kruglov , et al. [5] wrote on Gbit/s short-reach transmission. This transmission executes over 35 m large-core graded-index polymer optical fiber. They have demonstrated the robust 10 Gbit/s short-reach transmission.

In 2017, Liyun Ding , et al. [6] wrote on Fiber optic sensor. This sensor is related to polarization-based absorption of grapheme. Here the Grapheme is mentioned to indicate the polarization-based optical absorption in the feasible spectral range. It indicates more absorption for s-polarized light as compare to p-polarized light.

In 2017, Jianan Fu , et al. [7] wrote on Mach-Zehnder interferometer in embedded-core optical fiber. A novel MZI related to pair of long period fiber gratings in an ECOF has been presented with experiment. Two LPGs which carries similarity with peak attenuation of nearly 3dB have been made-up.

In 2017, Konstantin Hicke, et al. [8] proposed the Condition monitoring of industrial infrastructures. They have used the distributed fiber optic acoustic sensors. DAS is capable to work like a brilliant tool for real-time condition monitoring. It is applicable when there is a diversity of industrial as well as civil set-up. The present review has portrayed a subset of their current research activities.

In 2017, Liu Nianyun, et al. [9] reviewed the Strain measurement of spiral bevel gear. They have used the optical fiber gratings. They proposed a spiral bevel gear strain measurement with the use of optical fiber gratings. High-speed and heavy-duty SBG has been considered a key element of the power dealing of intersection axes.

In 2017, Yujia Zhao , et al. [10] Provided a novel fiber Michelson interferometer. This novel is related to cascaded twin core fiber and side-hole fiber. The interferometer has fabricated by fusing the TCF and SHF. The interferometer is capable to calculate the curvature and temperature.

In 2017, B. C. Yao , et al. [11]did research on partially reduced graphene oxide based FRET on fiber-optic interferometer. This research has been done for biochemical detection. An all-fiber graphene oxide (GO) that is related to`FRET concept has been proposed here. The define technique carries both good selectivity and high sensitivity.

In 2015, Jianxiang Wen, et al. [12]wrote on Spun-Related Effects on Optical Properties of Spun Silica Optical Fibers. The consequences on the optical characteristic of silica optical fibers due to the effects associated with Spun have been considered experimentally. These consequences are considerable in the case of highly spun (short pitch length) fibers. These fibers are described at high rotation speed along with a small drawing rate. Spun fibers of different pitch lengths are formed by them.

In 2013, Feng WenMagneto [13]-optic four-wave mixing in fibers: Theory and experiment. They put forward a complete magneto-optic four-wave mixing theory in linearly birefringent fibers for guided optical waves .

In 2010,Hua Bai , et al. [14] wrote on Surface-enhanced Raman scattering optical fiber sensor using biconical taper fiber. A fresh surface-enhanced Raman scattering (SERS) optical fiber sensor in which biconical taper fiber is used is suggested.

In 2008,Zhi-Yong Dai, et al. [15] wrote on Landslide monitoring based on high-resolution distributed fiber optic stress sensor. A landslide monitoring application which uses a high-resolution distributed fiber optic stress sensor is make known by them. The intra-stress distribution and change in landslide bodies is examined by the use of sensors. Whenever there is a possibility of landslides, an early warning is given by them.

In 2002, M.C.J. Large, et al. [16] Explained Single-mode micro structured polymer optical fiber. Firstly they create a single-mode micro structured polymer optical fiber (MPOF). After that they described the guiding characteristics.

In 2008, Masahito Morimoto, et al. [17] presented review on R=1mm 90°-Bent Multi-Mode Optical Fiber. In this paper, they have searched the bending losses and the polarization dependent losses of 90° light beam deflection for multi-mode optical fibers (MMF).

In 2017, C. B. et al. [18] stated highly sensitive fiber-optic Fabry-Perot geophone with graphene-coated PMMA membrane. They put forward an extremely responsive fiber-optic Fabry-Perot interferometric geophone (FFPG) by means of graphene which is layered with PMMA crust. After that they illustrate it. In this the mechanical power of the crust is improved with the help of graphene coating.

In 2017, Zinan Wang , et al. [19] did research Towards ultra-long-distance distributed fiber-optic sensing. Because of the exceptional benefits of Distributed fiber-optic sensing (DFOS), it is gaining huge consideration in both academic research and industrial applications.

In 2017, Lingxia Chen , et al. [20] provided a comparison of clinic based dosimeters based on silica optical fiber and plastic optical fiber for in-vivo dosimeter. At Galway Clinic, the creation and evaluation of 4 sensors which are based on silica optical fiber and plastic optical fiber for clinical in-vivo dosimeter is done on site.

In 2006, Clark Kinlin, et al[21] Proposed Asian Optical Fiber Communication & Optoelectronic Exposition & Conference. The following topics were dealt with: advanced optical communication network; radio-over-fiber network; optical heterodyne OPESK system; polarisation mode dispersion on a single mode fiber; ultrafast bit and byte addressing; all optical memory; microring resonators; token-based optical burst switching ring network; GMPLS Testing; Kerr nonlinearity; optical ASK-DPSK system; optical ASK-DQPSK system; CAD for photonics devices and circuit; ion-exchanged glass waveguide technology; fiber optical communication; PPM receiver; deep space communication; SOA based fiber ring laser; photonic crystal waveguide; fiber grating laser module package; PMD distribution measurement by an OTDR with polarimetry; deep-blue organic light emitting device; optical fiber Raman temperature sensor; and integrated network management system for 3TNET.

In 1999, D.J. DiGiovanni , et al. [22] discussed about Specialty of optical fiber. A considerable viable achievement is obtained by a no of equipments which are fiber-based in the previous 10 years.

In 2015, Tong Wang, et al.[23] put forward a new single fiber optical tweezers based on GIMMF: Simulation and experiment. On the basis of a graded-index multimode fiber (GIMMF), fresh single fiber optical tweezers is put forward by them. Its length is arbitrary (when the length is larger than 5mm).

[4]MOTIVATION OF RESEARCH

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The motivation of research has been listed below:

(1)To consider the challenges in fiber optical communication

(2) To highlight the various factors that influences the communication in fiber optics

(3)To transfer more data at higher throughput

(4)To set the optimized configuration of fiber optics considering different attenuation factors

(5) To highlight the loopholes of existing researches

(6) To provide the greater bandwidth than metal cables by fiber optics

[5] PROBLEM FORMULATION

The general reason of fiber optic faults is broke down of fibers. Excessive signal loss has been occurred Due to physical stress or excessive bending Insufficient transmitting power. Because of long cable span it is possible that there will be loss of signal. Besides this, the Excessive signal loss is feasible if there is an infected connector. In the case of broken and damaged fibers, it is not feasible to repair the system by simply effort. To find out the fault, a fiber optic tracer is applied in order to point out the faults in the cable. The present work is similar as a miniature flashlight. This flashlight uses an LED to connect with cable connector. It has been done to check the continuity of signal. If the fibers are unbroken and executing properly, than the light shown at one end of cable will be appear at other end of the cable. The constituents of fiber optic cable are fragile. These can be damaged in case of stretched from a long distance. To prevent the fibers becoming damaged, it is necessary to use a required cable length. It must be pulling at the jacket of the cable than using the grips at the connectors. It must be used the grips to disconnect the connector from the socket. There will be some risk if Fiber optic cable has excess length after a connection. There will be risk of bending, twisting, or winding around itself. Because of some actions the cable can be permanent damage with their components. There is different type of Cables available in different lengths. So we should make sure our requirement using a measuring tape. Position all the equipment that is intended to connect with the cable. In order to know the length of wire, for this measure the distance between them. There are some varieties that have a rod to avoid the bent in it. These are capable to avoid the recurrence of similar issue. A thorough visual inspection of the fiber optic cable will be sufficient to highlight any prominent defects. These defects have affected the casing or the conductors. It is necessary to replace the cable in the case of having issues that are visible by inspection, such as splits or scratches.

[6] CONCLUSION

The attenuation of an optical fiber calculates the amount of light lost between input and output. Total attenuation is the sum of all losses. The attenuation of an optical fiber is expressed by the attenuation coefficient which is defined as the loss of the fiber per unit length, in dB/km. The attenuation of the optical fiber is a result of two factors, absorption and scattering. Research has simulated the different factors that are influencing communication in fiber optics. These factors are Signal distortion, Condition for signal distortion-less transmission, Special nature of Optical Signal, Attenuation on Optical Fiber, Material Loss, Scattering Loss, Micro-Bending Losses, Radiation or Bending Loss. Intrinsic Fiber Losses Intrinsic fiber losses are those associated with the fiber optic material. Total loss is proportional to length. In fiber, light is attenuated due to absorption and scattering. These are the primary causes of the losses. Simulations have represented blending loss in macro and micro fiber optics. As the wavelength increases the blending loss also increases. If the transmission has been occurred by a leaky or radiation mode, in this situation the result causes attenuation. In this simulation the attenuation has been calculated using above mentioned formula. Considering number of joints, distance number of connectors, number of splices in elementary cable section, attenuation for one splice (dB), system margin and total length of the optical cable. The attenuation increases as the distance increases.

[7] FUTURE SCOPE

Fiber optics is capable to transfer more data at higher throughput. Data is transferred over longer distances as compare to copper wire. Traditional copper wires transmit electrical currents. But fiber optics works in different way. Fiber optic technology sends pulses of light generated by a light emitting diode or laser along optical fibers. Fiber optic cables have a much greater bandwidth than metal cables. An optical fiber offers low power loss, which allows for longer transmission distances. Thus it is rapidly used in communication day by day. It is essential to make study of factors that are influencing the performance of fiber optics cable. This research would be beneficial to set the optimized configuration of fiber optics considering different attenuation factors.

[8] REFERENCE

[1] J. Wen et al., “All-Fiber OAM Amplifier With High Purity and Broadband Spectrum Gain Based

on Fused Taper Vortex-Beam Coupler," IEEE Photonics J., vol. 10, no. 6, pp. 1–8, 2018.

[2] X. Liu et al., "Fiber optic pressure and temperature monitoring system for downhole application," ICOCN 2016 - 2016 15th Int. Conf. Opt. Commun. Networks, pp. 15–17, 2017.

[3] J. Jiang et al., "Development of optical fiber temperature sensor for aviation industry," ICOCN 2016 - 2016 15th Int. Conf. Opt. Commun. Networks, pp. 15–17, 2017.

[4] D. Yang, D. Li, J. Tao, Y. Fang, X. Mao, and W. Tong, "An optical fiber comprehensive analysis system for spectral-Attenuation and geometry parameters measurement," 2017 Conf. Lasers Electro-Optics Pacific Rim, CLEO-PR 2017, vol. 2017–January, pp. 1–2, 2017.

[5] R. Kruglov, S. Loquai, C.-A. Bunge, O. Ziemann, B. Schmauss, and J. Vinogradov, "10 Gbit/s Short-Reach Transmission over 35 m Large-Core Graded-Index Polymer Optical Fiber," Opt. Fiber Commun. Conf. Fiber Opt. Eng. Conf. 2011, p. OThZ6, 2011.

[6] L. Ding, C. Xu, Z. Xia, B. Xu, and J. Huang, "Fiber optic sensor based on polarization-dependent absorption of graphene," vol. 10323, p. 103237R, 2017.

[7] J. Fu et al., "Mach-Zehnder interferometer in embedded-core optical fiber," vol. 10323, p. 1032344, 2017.

[8] K. Hicke, M.-T. Hussels, R. Eisermann, S. Chruscicki, and K. Krebber, "Condition monitoring of industrial infrastructures using distributed fiber optic acoustic sensors," vol. 10323, p. 103230J, 2017.

[9] N. Liu, Y. Wang, Z. Zhou, and P. Lou, "Strain measurement of spiral bevel gear using optical fiber gratings," vol. 10323, p. 1032324, 2017.

[10] Y. Zhao et al., "A novel fiber Michelson interferometer based on cascaded twin core fiber and side-hole fiber," vol. 10323, p. 1032374, 2017.

[11] B. C. Yao et al., "Partially reduced graphene oxide based FRET on fiber-optic interferometer for biochemical detection," Sci. Rep., vol. 6, pp. 1–4, 2016.

[12] J. Wen et al.,"Spun-related effects on optical properties of spun silica optical fibers," J. Light. Technol., vol. 33, no. 12, pp. 2674–2678, 2015.

[13] F. Wen, B.-J. Wu, S.-B. Li, Z. Li, and K. Qiu, "Magneto-optic Four-wave Mixing in Fibers: Theory and Experiment," Opt. Fiber Commun. Conf. Fiber Opt. Eng. Conf. 2013, p. JTh2A.16, 2013.

[14] H. Bai et al., "Surface-enhanced Raman scattering optical fiber sensor using biconical taper fiber," 2010 Asia Commun. Photonics Conf. Exhib. ACP 2010, no. 60677031, pp. 176–177, 2010.

[15] Z. Y. Dai, Y. Liu, L. X. Zhang, Z. H. Ou, C. Zhou, and Y. Z. Liu, "Landslide monitoring based on high-resolution distributed fiber optic stress sensor," 2008 1st Asia-Pacific Opt. Fiber Sensors Conf. APOS 2008, pp. 1–4, 2008.

[16] M. C. J. Large et al., "Single-mode microstructured polymer optical fiber," Opt. Fiber Commun. Conf. Exhib., pp. 527–528, 2002.

[17] R. M. O. Fiber, M. Morimoto, and K. Suematsu, "R=1mm 90o-Bent Multi-Mode Optical Fiber," pp. 3–5, 2008.

[18] C. B. Yu et al., "Highly sensitive fiber optic Fabry-Perot geophone with graphene coated PMMA membrane," vol. 10323, no. Cvd, p. 103233O, 2017.

[19] Z. Wang, X. Jia, H. Wu, F. Peng, Y. Fu, and Y. Rao, "Towards ultra-long-distance distributed fiber optic sensing," vol. 10323, p. 103230T, 2017.

[20]L. Chen, S. O'Keeffe, P. Woulfe, and E. Lewis, "A comparison of clinic based dosimeters based on silica optical fibre and plastic optical fibre for in vivo dosimetry," vol. 10323, p. 103237C, 2017.

[21]F. Communication and C. Kinlin, "Emergence of Optical Communications '," 2006.

[22]YANGQIAOWEN,CHENSI AND LIPENGFEI," PREPARATION OF ACTIVATED CARBON FROM FURFURAL RESIDUES BY PHOSPHORIC ACID ACTIVATIO ", Biomass Chem Eng, vol. 49, no. 23–6, pp. 82–83, 2015

[23]J. Wen, Tong Wang et al., "Spun-related effects on optical properties of spun silica optical fibers," J. Light. Technol., vol. 33, no. 12, pp. 2674–2678, 2015.

[24] K. Lány, I. Erdélyi, E. Institoris, L. Tardos, and Z. Szabó, "Piperazin-Derivate. II. Wirkung von Piperazin-Derivaten.," Arzneimittel-Forschung/Drug Res., vol. 18, no. 11, pp. 1431–1435, 1968