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Development in Field of Optical Fiber Communication: An Analytical Consideration

Asad Ali khan, VK Sharma
Department of Physics, Teerthanker Mahaveer University, Moradabad, UP

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Abstract
This paper provides research and developments in the area of optical fiber communication. Optical fiber is used for transmit telephone signals, Internet communication, and cable television signals. Due to much lower attenuation and interference, optical fiber has large advantages over existing copper wire in long-distance and high-demand applications. The objective of optical fiber to provide a means of information interchanges between end users.

1. Introduction

Recently, optical fiber communication has revolutions the field of long, haul data communication by its immense information carrying capacity and long transmission losses as compared to its electrical counterpart the coaxial cable. Since the carrier frequency in optical fiber communication lies in the optical domain, bit rates in excess of 10 Gigabits / second (GBPS) can be supported with a single wavelength, which is equivalent to sending 150000 voice channels simultaneously through a single optical fiber. In this work we interested in long period grating (LPGs) having broad transmission spectra, which find applications in several in line fiber optic device.

Fiber-optic communication is a method of transmitting information from one place to another by sending pulses of light through an optical fiber. The light forms an electromagnetic carrier wave that is modulated to carry information. First developed in the 1970s, fiber-optic communication systems have revolutionized the telecommunications industry and have played a major role in the advent of the Information Age. Because of its advantages over electrical transmission, optical fibers have largely replaced copper wire communications in core networks in the developed world. Optical fiber is used by many telecommunications companies to transmit telephone signals, Internet communication, and cable television signals. Researchers at Bell Labs have reached internet speeds of over 100 petabits per second using fiber-optic communication [1].

2. Evolution of Fiber Optics

In 1880 Alexander Graham Bell and his assistant Charles Sumner Tainter created a very early precursor to fiber-optic communications, the Photo phone; at Bell's newly established Volta Laboratory in Washington, D.C. Bell considered it his most important invention. The device allowed for the transmission of sound on a beam of light.

On June 3, 1880, Bell conducted the world's first wireless telephone transmission between two buildings, some 213 meters apart [2] Due to its use of an atmospheric transmission medium; the Photophone would not prove practical until advances in laser and optical fiber technologies permitted the secure transport of light.[3] The Photophone's first practical use came in military communication systems many decades later.

***Corresponding Author,**
E-mail address: akumarmbd@gmail.com

In 1966 Charles K. Kao and George Hockham proposed optical fibers at STC Laboratories (STL) at Harlow, England, when they showed that the losses of 1000 dB/km in existing glass (compared to 5-10 dB/km in coaxial cable) was due to contaminants, which could potentially be removed.

The first wide area network fibre optic cable system in the world seems to have been installed by Rediffusion in Hastings, East Sussex, UK in 1978. The cables were placed in ducting throughout the town, and had over 1000 subscribers. They were used at that time for the transmission of television channels, not available because of local reception problems. The system is still in place, but disused.

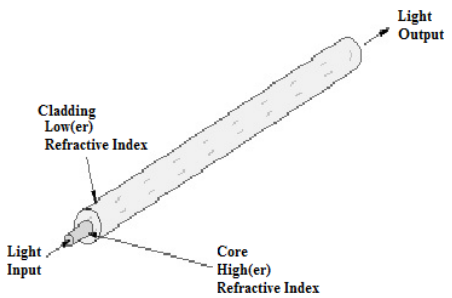
The second generation of fiber-optic communication was developed for commercial use in the early 1980s, operated at 1.3 µm, and used In GaAsP semiconductor lasers. These early systems were initially limited by multi mode fiber dispersion, and in 1981 the single-mode fiber was revealed to greatly improve system performance By 1987, these systems were operating at bit rates of up to 1.7 Gb/s with repeater spacing up to 50 km.

Third-generation fiber-optic systems operated at 1.55 µm and had losses of about 0.2 dB/km.[5] This development was spurred by the discovery of Indium gallium arsenide and the development of the Indium Gallium Arsenide photodiode by Pearsall. Engineers overcame earlier difficulties with pulse-spreading at that wavelength using conventional In GaAsP semiconductor lasers. Scientists overcame this difficulty by using dispersion-shifted fibers designed to have minimal dispersion at 1.55 µm or by limiting the laser spectrum to a single longitudinal mode. These developments eventually allowed third-generation systems to operate commercially at 2.5 Gbit/s with repeater spacing in excess of 100 km.

The fourth generation of fiber-optic communication systems used optical amplification to reduce the need for repeaters and wavelength-division multiplexing to increase data capacity. These two improvements caused a revolution that resulted in the doubling of system capacity every 6 months starting in 1992 until a bit rate of 10 Tb/s was reached by 2001. In 2006 a bit-rate of 14 Tbit/s was reached over a single 160 km line using optical amplifiers.

The focus of development for the fifth generation of fiber-optic communications is on extending the wavelength range over which a WDM system can operate.[4] The conventional wavelength window, known as the C band, covers the wavelength range 1.53-1.57 µm, and dry fiber has a low-loss window promising an extension of that range to 1.30-1.65 µm. Other developments include the concept of "optical solutions, " pulses that preserve their shape by counteracting the effects of dispersion with the nonlinear effects of the fiber by using pulses of a specific shape.

3. Transmitting Light on a Fiber



An optical fibre is a very thin strand of silica glass in geometry quite like a human hair. In reality it is a very narrow, very long glass cylinder with special characteristics. When light enters one end of the fibre it travels (confined within the fibre) until it leaves the fibre at the other end. As shown in Figure an optical fibre consists of two parts: the core and the cladding. The core is a narrow cylindrical strand of glass and the cladding is a tubular jacket surrounding it. The core has a (slightly) higher refractive index than the cladding. This means that the boundary (interface) between the core and the cladding acts as a perfect mirror. Light travelling along the core is confined by the mirror to stay within it - even when the fibre bends around a corner. When light is transmitted on a fibre, the most important consideration is "what kind of light?" The electromagnetic radiation that we call light exists at many wavelengths. These wavelengths go from invisible infrared through all the colours of the visible spectrum to invisible ultraviolet. Because of the attenuation characteristics of fibre, we are only interested in infrared "light" for communication applications. This light is usually invisible, since the wavelengths used are usually longer than the visible limit of around 750 nanometers (nm). If a short pulse of light from a source such as a laser or an LED is sent down a narrow fibre, it will be changed (degraded) by its passage down the fibre. It will emerge (depending on the distance) much weaker, lengthened in time ("smeared out"), and distorted in other ways.

3.1Attenuation

The pulse will be weaker because all glass absorbs light. More accurately, impurities in the glass can absorb light but the glass itself does not absorb light at the wavelengths of interest. In addition, variations in the uniformity of the glass cause scattering of the light. Both the rate of light absorption and the amount of scattering are dependent on the wavelength of the light and the characteristics of the particular glass. Most light loss in a modern fibre is caused by scattering. Typical attenuation characteristics of fibre for varying wavelengths of light are illustrated.

3.2Maximum Power

There is a practical limit to the amount of power that can be sent on a fibre. This is about half a watt (in standard single-mode fibre) and is due to a number of non-linear effects that are caused by the intense electromagnetic field in the core when high power is present.

Polarisation

Conventional communication optical fibre is cylindrically symmetric but contains imperfections. Light travelling down such a fibre is changed in polarisation.

4. Application

Optical fiber is used by many telecommunications companies to transmit telephone signals, Internet communication, and cable television signals. Due to much lower attenuation and interference, optical fiber has large advantages over existing copper wire in long-distance and high-demand applications. However, infrastructure development within cities was relatively difficult and time-consuming, and fiber-optic systems were complex and expensive to install and operate. Due to these difficulties, fiber-optic communication systems have primarily been installed in long-distance applications, where they can be used to their full transmission capacity, offsetting the increased cost. Since 2000, the prices for fiber-optic communications have dropped considerably. The price for rolling out fiber to the home has currently become more cost-effective than that of rolling out a copper based network. Prices have dropped to $850 per subscriber in the US and lower in countries like The Netherlands, where digging costs are low and housing density is high.

5. Conclusions

The optical fibre communication has been discussed. The physics of its different parts has also been discussed. It has been concluded that the optical communication is totally based on the optical This acts as a breakthrough for the technological revolution in the optical fibre communication network by the increase of information carrying capacity and high speed devices.

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