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Research Article

ANALYSIS OF THE THEORETICAL APPROACH TO THE EXTENDED RANGE OF THE OPTICAL FIBRE WITH THE REDUCTION OF “WATER PEAK”

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ABSTRACT

The article is devoted to the analysis and study of the fibre optic spectrum, as well as the curvature of the fibre throughput characteristic. The effect of “water peaks” was also studied on the characteristics and ranges of transmitted signals of lasers of different technologies, respectively, and a conclusion was drawn on the work done.

KEYWORDS

Spectrum analysis, bandwidth curvature, fibre, water peak, laser characteristics, technology, fibre elongation, absorption spectrum, emitters, communication line, encoder, colour dispersion, multimode and single mode.

INTRODUCTION

In traditional optical fibre, when emitting with At 1400 nm there is a sharp increase in the attenuation coefficient. This phenomenon is called "peak water". The reason for the appearance of such a “peak” is the atomic hydrogen present in the fibre. There are fibres from various manufacturers with a reduction in such “peaks,” and OFS managed to eliminate this effect almost completely in the All Wave ZWP single-mode fibre [1-9]. To produce this fibre, a patented fibre drawing method is used and pure synthetic quartz glass of high purity is used. All Wave ZWP fibre operates across a range of wavelengths 1260 - 1625 nm, which provides 1.5

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times more operating wavelengths than traditional single-mode fibre [1].

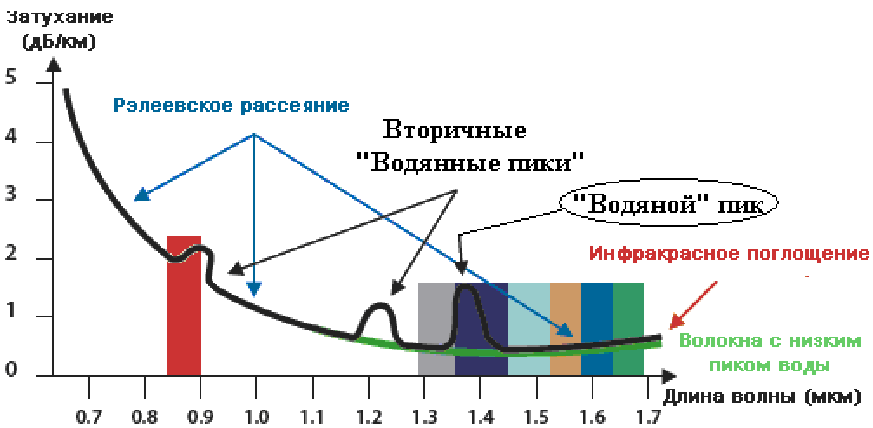

Figure 1. The absorption spectrum of optical fibre

Emittersused in fibre-optic communication lines must satisfy the following important requirements:

- the radiation should be carried out at the wavelength of one of the fibre transparency windows (in traditional optical fibres there are three windows in which lower light losses during propagation are achieved: 850, 1300, and 1550 nm);
- the radiation source must withstand the required modulation frequency to ensure data transmission at the required speed;
- the main part of the emitted light from the laser must enter the fibre with minimal losses and have a sufficiently high power so that the signal can be transmitted (4). Where "water peaks" does not occur in characterization.

It is advisable to use lasers based on solid semiconductors as radiation sources for fibre-optic links. This paper presents the search for a semiconductor laser structure based on connections of the third and fifth groups for 3rd generation fibre-optic communication lines and the conclusion of their application to the corresponding project. A third-generation fibre-optic communication line (FOCL) allows information to be transmitted by photons. The photon moves at the speed of light and increases the speed of information transfer. The basic components of such a system are a transmitter, an optical fibre, a receiver, a repeater (R), and amplifiers (A) (Fig. 2).

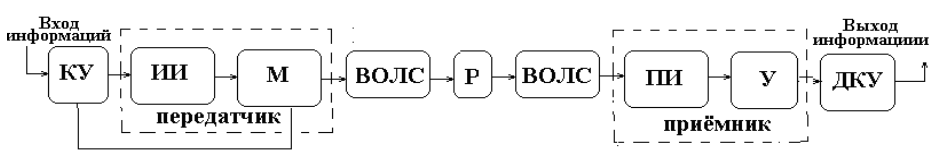

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Figure 2 - Structure of a fibre-optic communication system

An important element is the encoder (CU) and decoder (DCU). The transmitter, in general, consists of a radiation source (IS) and a modulator (M). Most often, lasers serve as emitters. The advantage of optical fibre is primarily its low losses, which allows information to be transmitted over long distances. The second most important parameter is high throughput. That is, all other things being equal, one fibre optic cable can transmit the same amount of information as, for example, ten electrical wires [5-12]. Another important point is the ability to combine several fibre optic lines into one cable. And there will be no interference in the channel. Transmitters are designed to provide the original signal, usually in electrical form, and convert the signal into the optical range. Diodes, laser diodes and lasers can be used as transmitters. 1G transmitters include a light-emitting diode that operates at a wavelength of 0.85 microns. 2G transmitters operated at a wavelength of 1.3 microns. The 3G transmitters were implemented on laser diodes with a wavelength of 1.55 microns in 1982. Using lasers as transmitters provides a huge advantage. Particularly because the emission is stimulated, the power output increases. Also, laser radiation is directed, which increases the efficiency of interaction in optical fibres. The narrow spectral linewidth reduces colour dispersion and increases transmission speed. If you create a laser that operates stably in one longitudinal mode during each pulse, you can increase the information throughput. To achieve this, laser structures with distributed feedback can be used. Optical fibre in fibre-optic communication lines is the main element [1,3,4,12,13,17]. The passage of light through an optical fibre is ensured by the effect of total internal reflection. Accordingly, it consists of a central part - the core and a shell made of material with a lower optical density. Based on the number of types of waves that can propagate through optical fibre, they are divided into multimode and single-mode. Single-mode fibres have better attenuation and bandwidth characteristics. However, their disadvantages are associated with the fact that the diameter of single-mode lines is on the order of several micrometres. This makes radiation injection and fusion difficult. The diameter of a multimode core is tens of micrometers, but their bandwidth is somewhat smaller and they are not suitable for propagation over long distances. As light travels through the fibre, it attenuates. Devices such as repeaters (Fig. 3) convert the optical signal into an electrical one and, using a transmitter, send it further along the line with greater intensity.

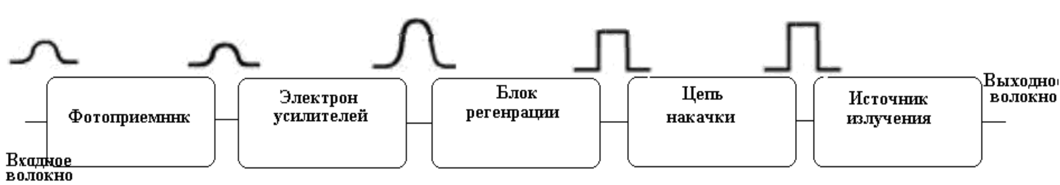

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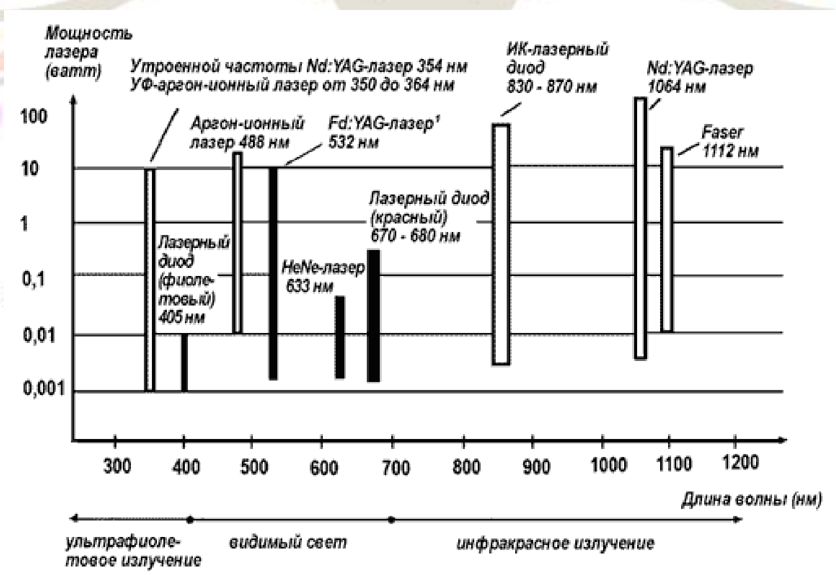
Figure 2 – Block diagram of repeater devices.

Amplifiers directly amplify the optical signal. Unlike repeaters, they do not correct the signal but only amplify and amplify both the signal and the noise. Once the light has passed through the fibre, it is converted back into an electrical signal. This is done by the receiver. They are usually semiconductor-based photodiodes or phototransistors. The advantages of FOCL include low signal attenuation, wide bandwidth, and high noise immunity. Because the fibre is made of a dielectric material, it is immune to electromagnetic interference from surrounding copper cabling systems and electrical equipment that can induce electromagnetic radiation. Multi-fibre cables also do not have the problem of cross-influence of electromagnetic radiation inherent in multi-pair copper cables [17-22]. Among the disadvantages, it should be noted the fragility of the optical fibre and the complexity of installation. In some cases, micron precision is required. An optical fibre has an absorption spectrum shown in Figure 1.

The 3G generation fibre optic line implements information transmission at a wavelength of 1.55 microns. From the figure, it can be seen from the spectrum that the absorption at this wavelength is the smallest, it is on the order of 0.2 dB/km.

A).



b).

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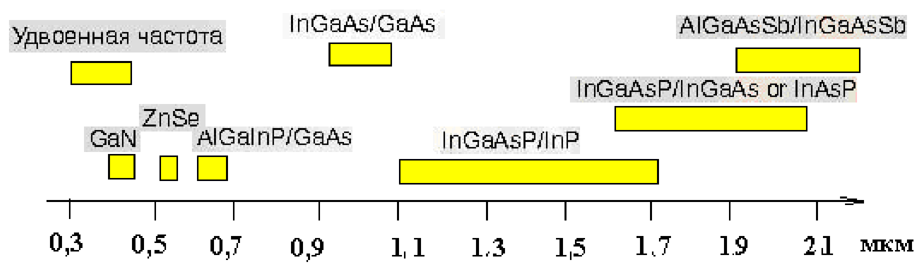

Figure 4. Emitted spectra of laser emitters: a) general view, b) atomic absorption diodes.

One of the types of OS organization (technology) can be considered by wavelength multiplexing. Wavelength division or WDM (Wavelength Division Multiplexing) technology first emerged as 2 carriers in one fibre used in a wavelength division multiplexing system. With the reduction and elimination of absorption "water peaks" in the fibre, the number of simultaneously transmitted carriers has increased significantly. At first, the standard assumed a frequency separation of 100 GHz (about 0.8 nm) between the 1528 and 1570 nm carriers. The smaller the frequency (or wavelength) step, the more stringent the requirements for the laser. (4) At a step of 0.2 nm, the laser operates at the coherence limit, and expensive laser cooling is required. (4). Different companies use different equipment with the same technology (see Table 1)[1-7].

Table 1.

Company	*Model*	*Technology type*	*Channel*	*Speed*	*Step*	**Band**
Alcatel	1626LM	DWDM		1-10 Gbit/s	50 GHz	WITH
Ciena	Core Stream	DWDM	96 / 192	1-10 Gbit/s	100 GHz	WITH
Cisco	ONS 15800	DWDM		100 M - 10 Gbt/s	50GHz	1509-1602
Ericsson	Smart PXM	DWDM		270 M -- 10 Gb		C, L, C+L
Fujitsu	Flashwave 7300	DWDM		40 Gbps	100/50	C, L
Lucent	WaveStar OLS 1/6 T	DWDM		100M--10Gb/s		C + L
Marconi	Mult-Layer Swch	DWDM		100 M--10 G		C, L, C+L
Nortel	OPTera Con. HDX	DWDM		155 M - - 40 G	100/50	C, L, C+L
Siemens	Infinity WLS	DWDM		2.5 – 10 G		C + L

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Conclusion

In conclusion, when making optical fibre, the method of drawing the fibre is a more important process. The use of synthetic quartz glass of high purity is one of the more effective methods. The use of synthetic quartz glass of high purity reduces and eliminates the problems we discussed in this article. You can continue to explore aspects for a more thorough answer to the question asked.

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