

The Application of Laser Device to Dental Treatment

Tetsuya Eguchi and Yasuharu Sato

HOYA Photonics corporation, Saitama, Japan

Abstract: The laser light was first introduced as a laser surgical knife in the medical application, which used the thermal energy of laser light. After that, various kinds of laser lights of different wavelengths have been developed and applied in the medical field. Today, the interaction between laser lights and optical characteristics of tissue by laser lights is considered more, and a laser light which gives the best effect to a tissue is selected for each treatment. In this report, I would like to introduce the application of Erbium:YAG laser for dental treatments and the point of view for development of Erbium:YAG laser. Then, I would like to report for the point of view of the perspective in the near future.

Key words : laser, dental treatment, erbium:YAG, wavelength, pulse width

Introduction

There are five actions when the laser light irradiate to the tissue. Those are "Reflection", "Scattering", "Transmission", "Luminescence" and "Absorption". Recently, various kinds of laser lights of different wavelengths applied in the several medical fields. Figure 1 shows the typical laser in the current medical filed.

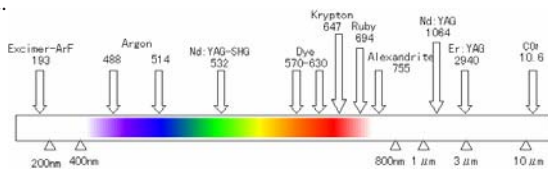


Fig. 1. Typical laser in the current medical filed

For example, In the ophthalmology, Its selected laser light go through the cornea, crystal lens and vitreous body. Then, it reach the retina. The pigment on the retina absorb the laser light and coagulate. For the dental field, carbon dioxide laser and Nd:YAG laser were used for the coagulation of soft tissue. We were focused attention on the absorption of water that make up about 60% of human body. Figure 2. shows the absorption coefficient of water.¹⁾ This figure shows there is a peak of absorption of water around 3 micron. The wavelength of our focused erbium:YAG laser is 2.94 micron. It corresponds this peak of absorption of water.

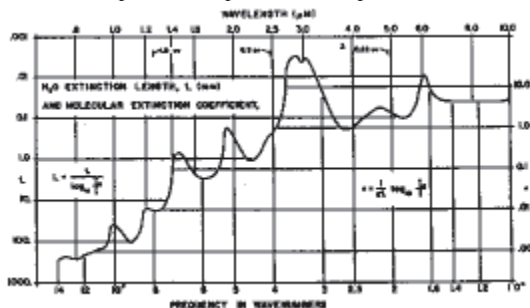


Fig. 2. The absorption coefficient of water between 0.7 and 10 microns.¹⁾

The development of glass fiber

Figure 3. shows the transmission range of wavelength of typical fiber. The transmission range of the wavelength of commonly used quartz fiber is up to 2 micron. Therefore, we had to develop of the fiber for transmitting 2.94 micron light.

HOYA CORPRATION successfully developed the AlF₃ fluoride glass fiber. Figure 4. shows Input-output power characteristics of Er:YAG laser power delivery.²⁾ This fiber is excellent glass fiber with transmittance of high power laser light in the world. However, This has 2 points of disadvantages. One of them is tarnish by moisture. Another one is large minimum radius of bending. Therefore, for the practical use, it needs the sealing of dry air and protection by metal jacket.

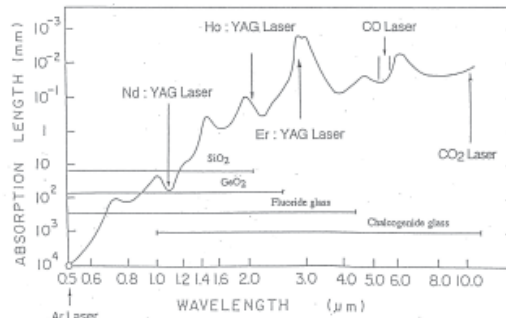


Fig. 3. The transmission range of wavelength of typical glass fiber

Laser devise

Prototype of laser was very big and it need 200V as power source. We developed downsizing each textures. Electric power source, Optical chamber and cooling module. Then, We successfully developed 1st generation dental laser, "ML-22". It had gotten the first approval for ablation of hard tissue from MHW in Japan in 1995. Currently, We introduce the 2nd generation dental laser, "ER-M1". It would be more downsizing than "ML-22".

Contact tip & Handpiece

For dental treatment, We had to consider the access to oral area and sterilization. On the end of fiber, Handpiece is located. A detachable "sleeve" is located on the end of handpiece. Sleeve

can sterilize by autoclave. Additionally, The contact tip screws in to the end of sleeve. The contact tip is consumption article. There are various kind of tips for accessing to various places in oral area.

Perspective

There are 3 points of view for our development of dental laser device in future. The first one is the optimization of laser parameter. Especially, We think we need the optimization of pulse width of laser. Current our laser has 200 micro seconds as pulse width. If it will be longer, it courses more strong the thermal effect to the irradiated tissue. Therefore, it will lead the hemostasis. We developed the new laser device as "ER-D1" for this investigation. Table 1. shows the specification of ER-D1.

Specification of ER-D1.

Figure 5. shows the examples of pulse width of ER-D1. ER-

D1 has variable pulse width from 100 microseconds to 500 microseconds. We would like to investigate the optimization of laser parameter for each dental treatment.

The second one is "downsizing". Current "ER-M1" is compact for actual use. However, we have to do more downsizing in consideration of the space of typical Japanese dental office. The third one is the variation of contact tips. We will keep the development of dental laser in future.

Reference

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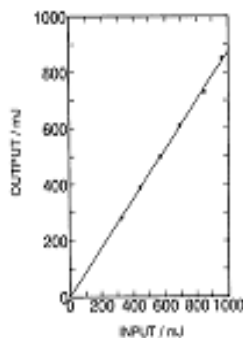
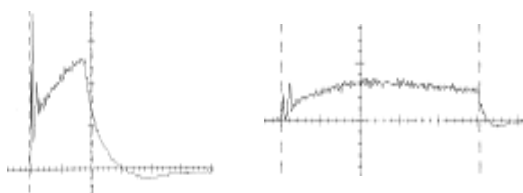


Fig.4. Input-output power characteristics of Er:YAG laser power delivery. (quote from reference 2)

Table 1. The specification of ER-D1

Specification:
Maximum output energy : up to 350 mJ (at end of handpiece)
Maximum output power : 8 W
Maximum repetition rate : up to 60 Hz
Pulse width : 100 ~ 500 microseconds
Size & Weight
300(mm)W X 466D X 750H 60kg
Electric power source : 100V 1.5kVA



100 microsecond 500 microsecond
Figure 5. The examples of pulse width of ER-D1