레이저 광을 이용한 충치의 선택적제거용 파장가변 소자개발

Development of Laser Wavelength Conversion Devices for Selective Ablation of Dental Caries

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As the public oral health condition improves, selective ablation of surface enamel caries with dental lasers attracted attention because of their minimal invasive scheme[1]. Traditional diamond burs are not suitable for the shallow decays on enamel layer, and easy to make cracks and more serious damages on teeth. Recent development of wavelength conversion devices for medical lasers allows freedom on the selectivity of laser wavelength. In this study, it was found that optimum wavelength for selective removal of caries from the sound tissue was estimated to be between 500 ~ 600 nm from the spectral measurement of reflectance as well as direct measurement of onset plasma of sound teeth and caries. Based on this guideline, strategies for the development of QPM devices as the most effective laser wavelength conversion devices[2].

The mechanism of laser ablation is based on the vaporization of materials by the energy absorption of incident light[3]. The figure of merit factor could be defined as the ratio of absorbance of caries and sound teeth as in Eq.(1).

$$Figure\ of\ merit = \frac{absorbance\ of\ caries}{absorbance\ of\ sound\ teeth} \qquad (1)$$

Then optimum wavelength for selective removal of caries from the sound tissue could be derived from the absorption spectra of each patient, which may be different from case by case. Fig.1(a) shows some absorption spectra of caries and sound enamel and dentin. Fig.1(b) is the calculated figure of merit defined in Eq.(1). Values shown in Fig.1(c) is the direct measurement of the onset energy density of the photoablation with the laser wavelength from 460 nm to 600 nm. From the data, it is found that wavelength between 520 nm to 560 nm has the best ablation selectivity. Comparison between usual 1064 nm and more efficient 532 nm laser beams from Nd:YAG laser system was performed and observed by optical microscope and scanning electron microscope to verify the selectivity. About 20 J/cm^2 irradiation with 8 ns pulse of 532 nm laser beam is more effective than 50 J/cm^2 1064 nm laser beam with similar temporal conditions. This ratio is a little bigger than that of calculated figure of merit, because the optical damage threshold of carious teeth is lower than that of sound enamel.

Therefore, direct measurement of the spectral absorbance of patient teeth and corresponding carious part could guide the selection of optimal ablation laser wavelength. However, the wavelength

of laser depends on material nature and only several types of lasers like diode pumped Nd:YAG are practically possible to be adopted for applications as shown in Fig. 2(a).

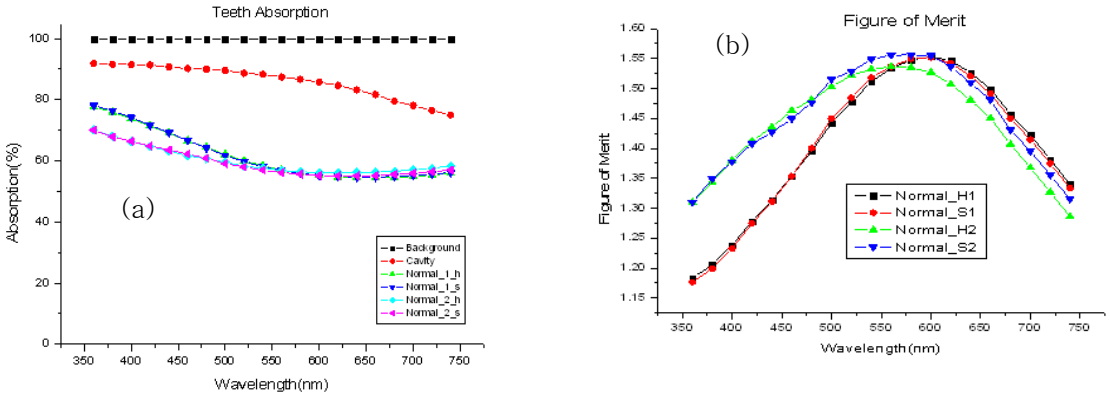

Fig.1(a) Measured absorption spectra of caries and sound enamel of teeth. (b) Calculated figure of merit from the absorption data. (c) Direct measurement of onset energy density ratio of normal vs carious area.

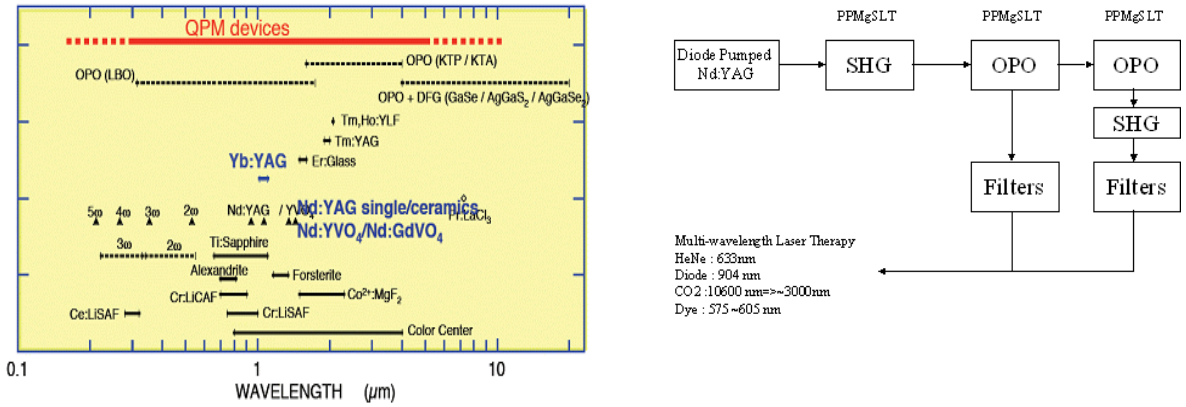

Fig.2(a) Overview of lasers with respect to wavelength.

(b) Schematic of general wavelength conversion laser.

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[2] Missey Mark J., Dominic Vince, Powers Peter E., Schepler Kenneth L., Opt. Lett. **24**, 1227-1229, (1999).