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FULL SPECTRUM TATTOO REMOVAL LASER SYSTEM

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Abstract

There is a market need for a multipurpose dermatological laser that covers a broad range of tattoo and pigmented lesion removal indications and is also capable of delivering high performance in other aesthetic applications. Recently, a new laser device that fills this need has been developed: the Fotona QX MAX. This new laser system uses frequency up-conversion from a 1064 nm source to deliver 532 nm light; the 532 nm laser light can be further up-converted to deliver 585 nm or 650 nm light. The 1064 nm source laser can operate at extremely high single nanosecond pulse energies, thus overcoming the energy loss problems associated with frequency conversion. The QX MAX is also capable of delivering millisecond pulses at high energy to enable additional treatment modalities.

Introduction

The new QX MAX laser system generates all its different frequencies from a 1064 nm Nd:YAG laser source. A KTP crystal is used as the first wavelength converter; it doubles the frequency of the incoming 1064 nm Nd:YAG beam to produce 532 nm green light.

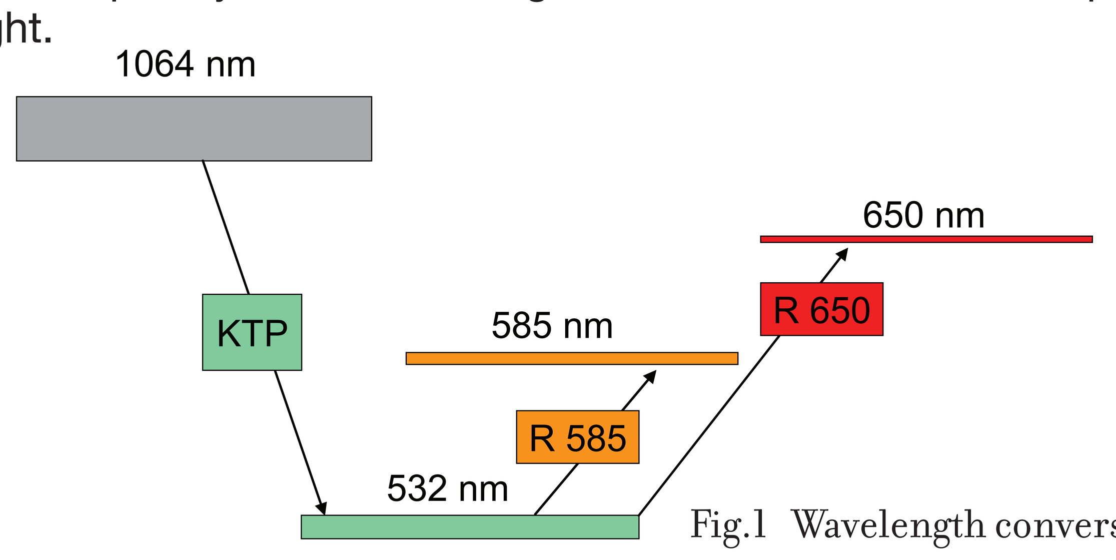

Fig.1 Wavelength conversion diagram

The 532 nm laser beam can be used as a source for the optical pumping of the newly developed solid dye laser handpieces, the Fotona R585 and the Fotona R650, to produce 585 nm (yellow) and 650 nm (red) laser light. These four wavelengths (1064, 532, 585 and 650 nm) have been selected to optimally cover the whole spectrum of colors.

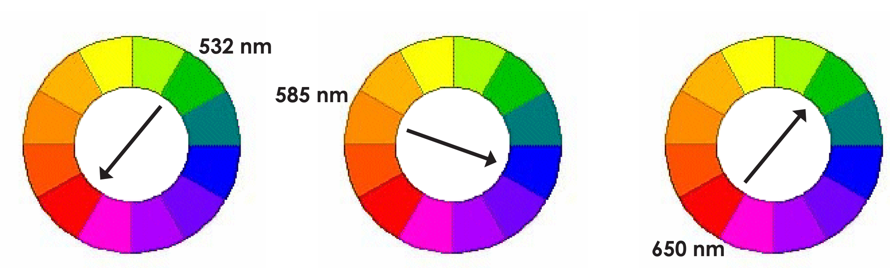

Fig.2
The best absorbtion of particular laser wave length is achieved in its complementary colour

1064 nm Nd:YAG laser light falls into the infrared part of the spectrum and cannot be presented on the complementary colors diagram, Fig. 2. 1064 nm Nd:YAG laser light is well absorbed by dark colors (black, dark blue and brown). As a result, 1064 nm Nd:YAG laser light is the gold standard for the removal of dark tattoo colors and pigmented lesions. The other wavelengths cover different tattoo colors. Green 532 nm laser light removes red, reddish and tan tones. Yellow or orange 585 nm laser light removes blue, bluish and sky blue tones. Red 650 nm laser light removes green and greenish tones.

Highest Energy in a Single Nanosecond Pulse

The Fotona QX MAX has the highest single pulse energy of any Q-switched laser on the market. High energy single pulses are necessary to provide sufficient energy for the up-conversion process. High energies also enable larger spot sizes to be used during treatments. Due to the contribution of scattering, larger spot sizes provide deeper penetration consequently increasing the efficacy and safety of treatment (1).

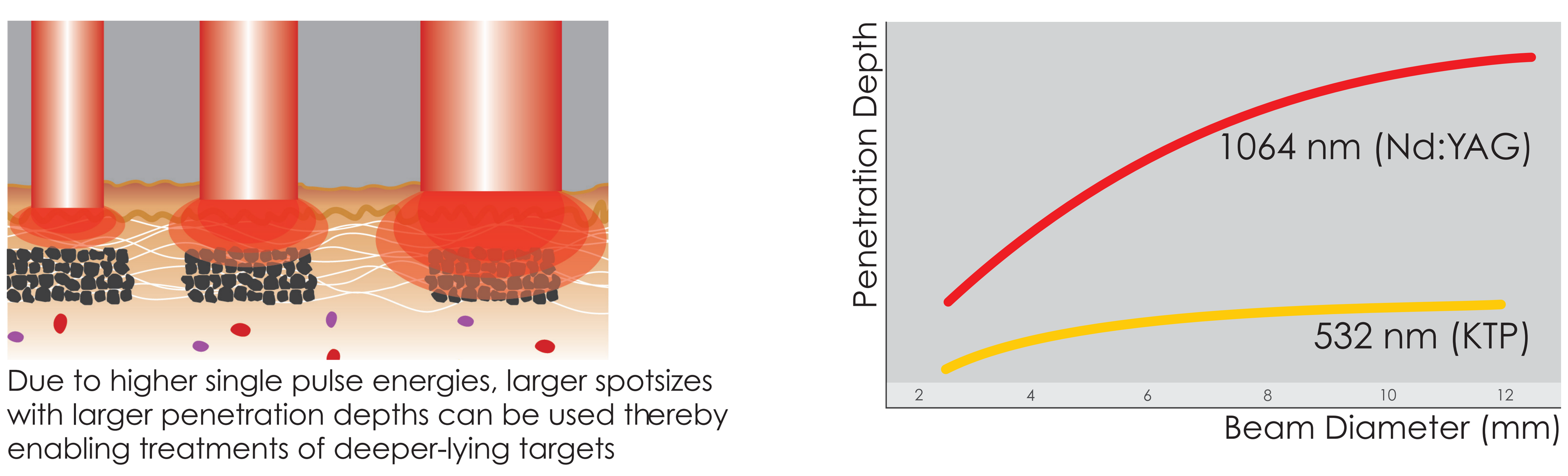

Fig.3 Depth of penetration and efficacy depends on spot size

Only very short single nanosecond pulses are capable of successfully removing tattoos without causing significant skin damage (2,3). When a single nanosecond pulse is fired at a tattoo it causes photoacoustic interaction, which breaks the cells containing tattoo ink, and the ink granules, into small fragments. (2,3). White light flashes as the laser pulse strikes the tattoo pigment; this is caused by the generation of laser-induced plasma. Immediate whitening appears, which is caused by rapid, micro-localized heating and the resulting gas and steam formation. An optical shield is formed that prevents subsequent laser pulses from reaching the remaining, deeper lying, pigments (as shown in Figs. 4 and 5).

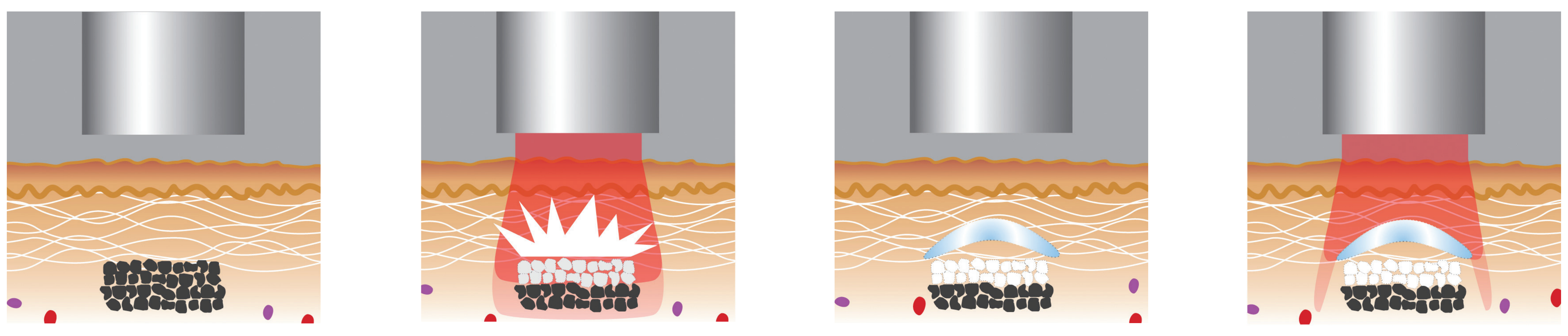

Fig.4 Laser tattoo removal mechanism

Fig.5 Example of immediate whitening of treated tattoo

Single Pulse vs. Multiple Pulse

The optical shielding phenomenon makes it impossible to effectively treat deep lying tattoo pigments by applying multiple pulses to the treatment area. Rather, a single high fluence laser pulse should be used to maximize treatment efficacy. If necessary the treatment may need to be repeated after the whitening has disappeared. Fig. 6 shows the difference between a multiple pulse treatment (A) and a single pulse treatment (C) on tattooed pig skin with fluence and wavelength held constant.

Tattoo dot (A) was treated with four consecutive 1064 nm pulses, each having a fluence of 0.9 J/cm^2 separated by 65 µsec interpulse periods, resulting in a total applied fluence of 3.6 J/cm^2. Dot (C) was treated with one 1064 nm pulse with a total fluence of 3.6 J/cm^2.

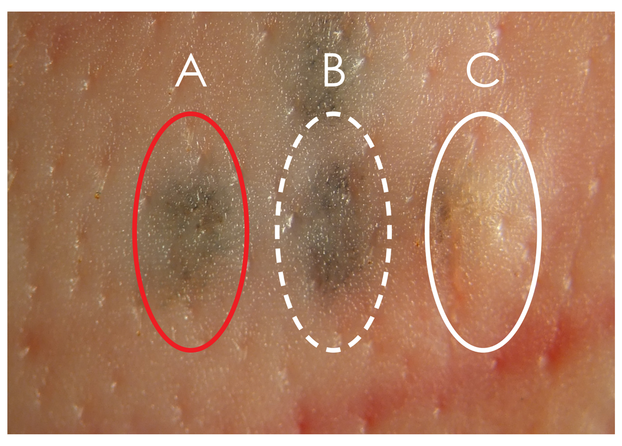

Fig.6 Three tattoo dots on the pig skin: A) following a treatment with four consecutive 0,9 J/cm^2 pulses; B) untreated dot; C) following a treatment with a single 3,6 J/cm^2 pulse. Only the tattoo dot in the area C was removed.

As can be seen from Fig. 6, the ability of Fotona QX MAX to deliver high energy in a single pulse is of utmost importance since multiple pulsing on the same skin area has no effect.

Beam Profile Consideration

In addition to high single pulse energy, the homogeneity of the laser beam profile is important in laser systems. A homogeneous beam profile provides safety during treatment as it enables even distribution of energy across the treated area. A homogenous beam profile minimizes epidermal damage and decreases bleeding, tissue splatter, and transient textural changes in the skin. However, due to the non-linearity of Q-switched lasers, achieving homogeneous beam profiles has been a serious challenge for the laser industry. In the Fotona QX MAX, a special patent-pending Fotona Optoflex technology is used to achieve an almost perfect homogeneity of the beam profile (See Fig. 7).

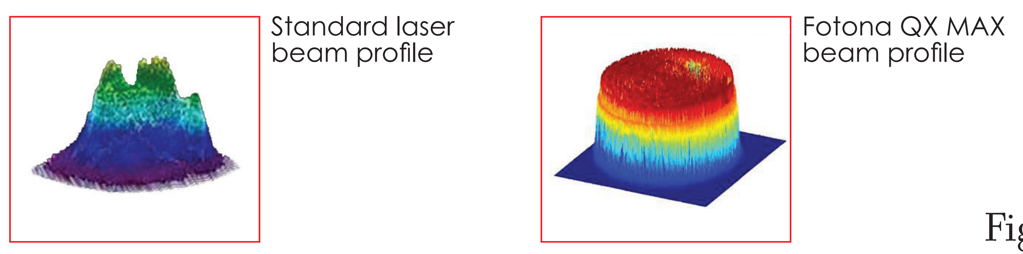

Fig.7 Homogeneity of beam profile

Additional treatment modalities with millisecond pulses

The Fotona QX MAX operating at 1064 nm is capable of delivering long 0.1 to 1.0 msec (Fotona Accelera) pulse durations at high pulse energies for additional treatment modalities, such as skin whitening, skin rejuvenation, vascular and acne treatments, and hair removal. An important feature or this treatment regime is the new FRAC3 effect (4,5). FRAC3 is a novel Fotona 3D non-ablative fractional treatment method which produces a unique self-induced skin rejuvenation effect as it seeks out miniscule, age-related skin imperfections in the skin and leaves surrounding tissue unaffected to promote faster healing.

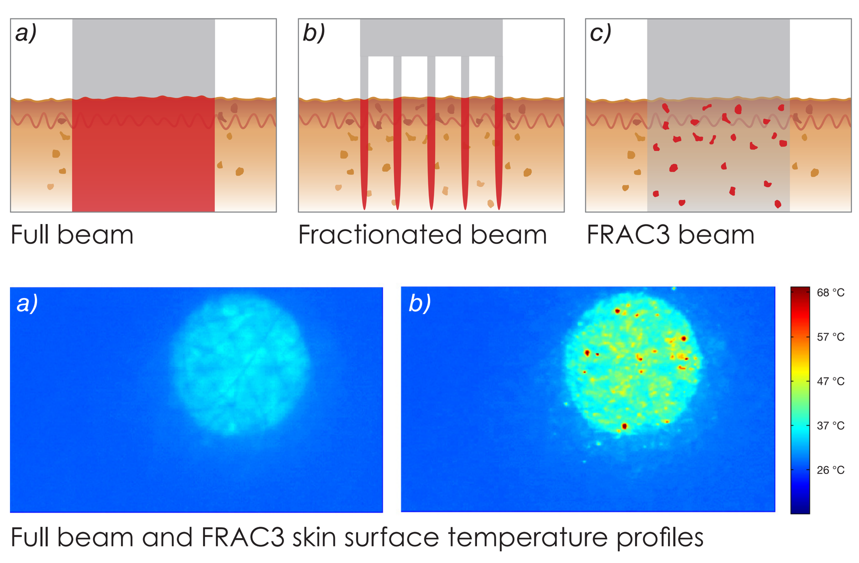

Fig.8 FRAC3 modality

Fig.9 The Fotona QX MAX

Conclusion

The Fotona QX MAX Laser System combines 4 different wavelengths (1064, 532, 585 and 650 nm) in an advanced, high-powered laser solution for tattoo and pigmented lesion removal. Because of the included Accelera Nd:YAG laser, the treatment range of the QX MAX encompasses all of the most popular aesthetic treatments. The Accelera Nd:YAG laser can provide effective hair removal and vascular treatments. The QX MAX also enables Fotonas's FRAC3 treatment modality, a non-ablative, 3D, self-induced fractional treatment which is used for rejuvenation and anti-aging treatments. The Fotona QX MAX is an important addition to the arsenal of medical lasers.

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