A Novel Infrared Programmable Wavelength Light Source for Permanent Hair Reduction

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A novel infrared programmable wavelength system for hair removal is described which combines the safety and efficacy of infrared lasers in treating a range of skin types with the efficiency and economics of flashlamp technology.

Market Background

Hair removal is the most popular light-based aesthetic procedure, with over 1.4 million procedures performed in the U.S. in 2004 [1]. This represents an increase of 53% over 2003. The continued growth of the hair removal category is due in part to technological advances, i.e. making the procedure safer and more effective for a wider range of patients. While the earliest laser hair removal systems offered results for light-skinned patients with dark hair, use of longer wavelengths, longer pulse widths and more aggressive cooling has broadened the patient base for light-based hair removal. The novel Prowave 770 from Cutera combines these benefits with a large spot size and high repetition rates to offer fast and effective treatments to address the needs of a variety of patients.

Laser Hair Removal

Lasers have been used very successfully for light-based hair removal. The 694 nm ruby laser was the first application of the theory of selective photothermolysis (SP) to treat unwanted hair using lasers. Following the theory, appropriate wavelength, pulse width and epidermal cooling are chosen to allow targeted destruction of the hair follicle while minimizing the effect on the epidermis and surrounding tissue. Due to strong melanin absorption in the epidermis, use of the ruby laser was limited mostly to skin types I, II and III. Subsequent development of lasers using longer wavelengths in the infrared spectrum allowed for the treatment of a wider range of skin types, culminating with the development of the long-pulsed 1064 nm Nd:YAG laser for use on all skin types and tanned skin [2].

Flashlamps – An Alternative Technology

Flashlamps are an attractive light source due to the typically lower system complexity and the ability to treat larger treatment areas as compared to lasers. In fact, some of the early light based hair removal systems used flashlamps, but as with the ruby laser, were limited in the range of skin types which could be safely treated.

Typical flashlamp systems use high electrical current pulses to emit primarily in the ultraviolet and visible spectral range. For use in hair removal, a wavelength filter is often used to block short wavelengths, while allowing longer wavelengths through. The choice of this specific wavelength filter often balances the desire for longer infrared wavelengths to optimize safety with the need for sufficient output energy to produce effective treatments. By using standard flashlamp and power supply designs, many companies have chosen to use a wavelength filter around 650 nm. This represents a design compromise limiting utility for darker skin types, much as the ruby laser was limited in its use.

ProWave 770

The ProWave 770 from Cutera combines a novel flashlamp emitting in the infrared with a one-touch programmable wavelength handpiece to allow treatment on a wide range of skin types.

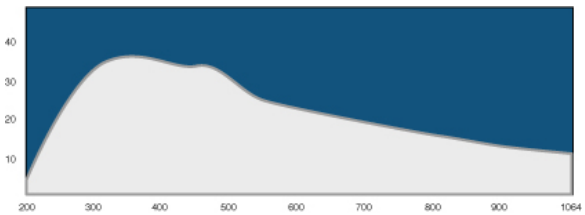

Figure 1a: Reproduction of the spectrum for a flashlamp driven at a typical high current density, showing most energy in the visible spectrum.

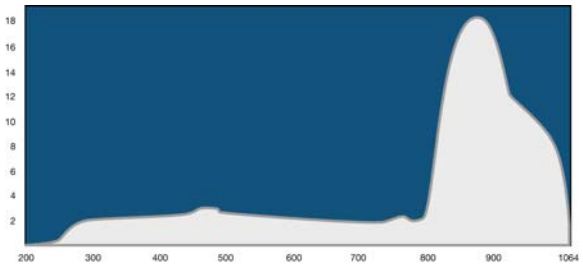

Figure 1b: Reproduction of the spectrum for the ProWave custom flashlamp driven at low current density. With this unique design, most of the energy is emitted in the infrared.

The first innovation is to incorporate a custom flashlamp and power supply that cause more of the energy to be emitted in the desirable infrared range. A comparison of a standard unfiltered flashlamp output to the ProWave spectrum is shown in Figures 1a and 1b. The ProWave output is achieved by customizing the fill gas used in the flashlamp as well as running the system at a low current density so the output is dominated by the atomic line structure emission rather than the blackbody radiation spectrum.

A second innovation is to build in the capability for electronically shifting the peak output wavelength within the spectrum by varying the current density in the lamp while still allowing a similar range of output fluences. Thus, even longer wavelengths can be selected for treating darker skin types. Table 1 shows the difference for Program A, B and C of the ProWave 770.

Program Mode	A	B	C
Peak Wavelength	810 nm	845 nm	880 nm
Pulse Widths (ms)	9 – 39	11 – 71	48 – 153
Temperature	Cool	Cooler	Coldest

Table 1. Overview of parameter differences for Program A, B and C on the ProWave 770.

While the ProWave is technically advanced, the user interface is straightforward. A user only needs to select the program (A, B or C based on the patient's skin and hair), fluence and repetition rate. The advanced power supply and custom lamp design allows the user to operate at high repetition rates at effective treatment fluences. This capability, when combined with a large 10x30 mm treatment area, distinguishes ProWave as one of the fastest devices available for hair removal. This novel device provides safe treatments of patients with skin type I through V without compromising efficacy. While these results will be summarized in a separate paper, Figures 2 demonstrates the results using the ProWave 770.

Summary

The ProWave 770 is a novel infrared programmable wavelength system that combines the benefits of infrared wavelengths for safely and effectively treating a wide range of skin types with the speed and efficiency of flashlamp technology.

References

[1] American Society for Aesthetic Plastic Surgery 2004 Cosmetic Surgery National Data Bank Statistics, http://www.surgery.org/press/statistics-2004.php

[2] Elizabeth L. Tanzi, MD and Tina S. Alster, MD; "Long-Pulsed 1064-nm Nd:YAG Laser Assisted Hair Removal in All Skin Types," Dermatol Surg 2004; 30:13-17.

Figure 2: Before and 5 weeks after treatment with the ProWave 770 (Photo courtesy of Leonardo Rasi, MD)