Available online at www.iseec2012.com

I-SEEC 2012

Proceeding - Science and Engineering (2013) 439–444

Proceeding
Science and Engineering

www.iseec2012.com

Science and Engineering Symposium
4th International Science, Social Science, Engineering and Energy Conference 2012

A New Generation Laser Therapy 1,036 nm by μ-ring Resonator for Chickenpox Treatment Application

J. Phelawan[a,*], N. Pornsuwancharoen[a]

[a]Nano Photonics Research Group, Department of Electrical Engineering, Faculty of Industry and Technology, Rajamangala University of Technology Isan Sakhon Nakon Campus, Sakhon Nakon 47160, Thailand.

Abstract

The Chickenpox was a disease caused by viral infection and debilitating dermatologic disease, which is conventionally treated by laser therapy using a microring resonator system. We have an evolving understanding of laser tissue interactions involving Varicella virus-produced porphyrins. This system can be a development of lasers to target sebaceous glands. We have lead to the development of an escalating number of laser, light for chickenpox. The result showing the full width at half maximum is 0.1 nm, the power of laser between 200 - 250 W, and the wavelength laser is 1,036 nm, which can be treatment of chickenpox diseases.

Selection and/or peer-review under responsibility of Faculty of Science and Technology, Kasem Bundit University, Bangkok.

Keywords: chickenpox, lasers, radiofrequency, photodynamic therapy, micro-ring resonator

1. Introduction

A generation laser therapy of 1,036 nm by μ-ring resonator for Low Level Laser Therapy (LLLT) [1] is a light source treatment that generates light by micro ring resonator [2-3] of a single wavelength. A micro ring resonator system is of no heat, sound, or vibration. Instead of producing a thermal effect, A micro ring resonator system may act via non-thermal or photochemical reactions [4] in the cells, also referred to as photobiology or biostimulation [5].

Laser radiation and monochromatic light may alter cell and tissue function. Some laboratory studies suggest that irradiation stimulates collagen production alters DNA synthesis [6] and improves the function of damaged neurological tissue. The therapy of laser treatment is used most such as laser treatment of hypertrophic scars, Keloids, and Striae [7], There is a comparison of a 585 nm flashlamp-pumped pulsed dye laser and laser treatment wavelength 585 -645 nm [8-11], the laser virus treatment in Ref. [12-19].

In this paper, we have designed the laser surgery that may best be able to be accomplished by triggering

* Corresponding author.*E-mail address:* phelawan_1328@hotmail.com

regression of blood vessels and, therefore, fibroblasts within the chickenpox treatment. By so, further deposition of connective tissue may be halted.

2. Theory and background

2.1 Chickenpox

Chickenpox (or chicken pox) is a highly contagious disease caused by primary infection with varicella zoster virus (VZV)[20]. It usually starts with vesicular skin rash mainly on the body and head rather than at the periphery and becomes itchy, with raw pockmarks, which mostly heal without scarring. On examination, the observer typically finds lesions at various stages of healing.

Chickenpox is an airborne disease spread easily through coughing or sneezing of ill individuals or through direct contact with secretions from the rash. A person with chickenpox is infectious for one to two days before the rash appears. They remain contagious until all lesions have crusted over (this takes approximately six days). Immuno-compromised patients are contagious during the entire period as new lesions keep appearing. Crusted lesions are not contagious

Fig. 1. A single blister, typical during the early stages of the rash [10]

2.2 Laser treatment

The combination Laser Therapy Targets Melasma is caused by an overproduction of melanin, a natural substance in the body that gives skin its color and can lead to dark patches on the face. While melasma may occur in anyone, the condition most commonly affects women with darker Mediterranean skin, Asians, and Hispanics. Dr. Kauvar explained that melasma is typically controlled with topical medications that contain ingredients to lighten the skin, such as hydroquinone or retinoids. Along with regular use of broad-spectrum sunscreen with a Sun Protection Factor (SPF) of 30 or higher, this treatment can resolve the excess pigmentation and prevent further darkening of the skin in Ref. [21]. The study included 52 women with grades 3 and 4 cellulite. Participants were treated with a 1064 nm Nd:YAG laser, after which they underwent an autologous fat transplantation in fat-depleted target areas. The laser was used to break down fat stored in fat cells, then to superficially break up the fibrous bands that connect the muscle to the skin and cause the skin to dimple and have an orange peel-like effect. Autologous fat was then transplanted to the areas with the most severe concave contour deformities. The goal was to fill out those areas in order to provide a smoother, more even contour to the target skin's surface in Ref. [22].

2.3 Laser generation

Light from a monochromatic light source is launched into a ring resonator with constant light field amplitude (E_0) which is the combination of terms in attenuation (α) and phase (ϕ_0) constants, which results in temporal coherence degradation. Hence, the time dependent input light field (E_{in}), without pumping term, can be expressed as

$$E_{in}(t) = E_0 e^{-\alpha L + j\phi_0(t)}. \quad (1)$$

where L is a propagation distance(waveguide length).

We assume that the nonlinearity of the optical ring resonator is of the Kerr-type; i.e., the refractive index is given by

$$n = n_0 + n_2 I = n_0 + (\frac{n_2}{A_{eff}})P, \quad (2)$$

where n_0 and n_2 are the linear and nonlinear refractive indexes, respectively. I and P are the optical intensity and optical power, respectively. The effective mode core area of the device is given by A_{eff} . For the microring and nanoring resonators, the effective mode core areas range from 0.10 to 0.50 μm^2[3].

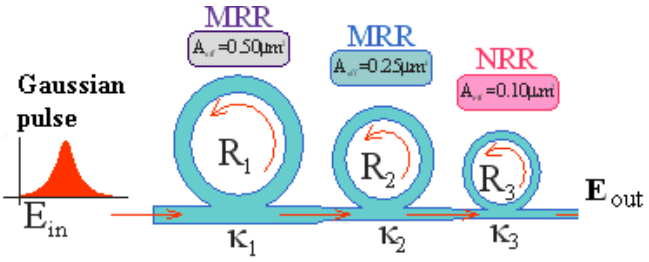

Fig. 2. The diagram of μ-ring generation at 1,036 nm for laser treatments

When a Gaussian pulse is input and propagated within a fiber ring resonator, the resonant output is formed, thus, the normalized output of the light field is the ratio between the output and input fields ($E_{out}(t)$ and $E_{in}(t)$) in each roundtrip, which can be expressed as

$$\left|\frac{E_{out}(t)}{E_{in}(t)}\right|^2 = (1-\gamma)\left[1 - \frac{(1-(1-\gamma)x^2)\kappa}{(1-x\sqrt{1-\gamma}\sqrt{1-\kappa})^2 + 4x\sqrt{1-\gamma}\sqrt{1-\kappa}\sin^2(\frac{\phi}{2})}\right] \quad (3)$$

Equation (3) indicates that a ring resonator in the particular case is very similar to a Fabry-Perot cavity, which has an input and output mirror with a field reflectivity, (1- κ), and a fully reflecting mirror. k is the coupling coefficient, and $x = \exp(-\alpha L/2)$ represents a roundtrip loss coefficient, $\phi_0 = kLn_0$ and $\phi_{NL} = kL(\frac{n_2}{A_{eff}})P$ are the linear and nonlinear phase shifts, $k = 2\pi/\lambda$ is the wave propagation number in a vacuum. Where L and α are a waveguide length and linear absorption coefficient, respectively. In this work, the iterative method is introduced to obtain the results as shown in equation (3), similarly, when the output field is connected and input into the other ring resonators.

3. Result and Discussion

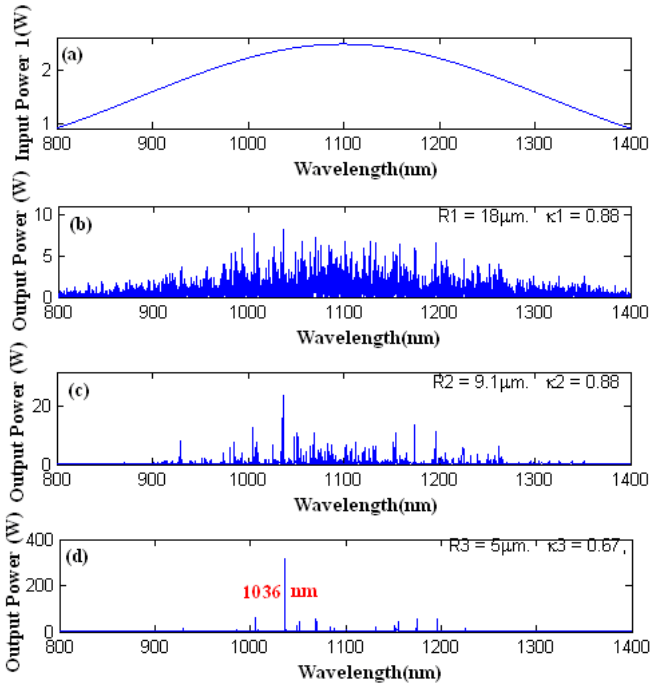

Fig. 3. Result of laser therapy for chickenpox (Varicella virus) application

Fig. 3 shows the result of the rings resonator device whose input signal is a Gaussian pulse 2.5 W in Fig. 3(a). The output signals of first ring (R1) are the chaotic and filtering signals obtained by the second (R2) and the third rings (R3). The parameters of ring radii are 18μm, 9.1 μm and 5 μm for R1-R3 as shown in Fig.3 (b-d), the single peak is 250 W as shown in Fig. 3(d). The coupling coefficients (κ1, κ2, κ3) of the rings are 0.88, 0.88 and 0.67. The center wavelength is 1,110 nm. In Fig. 4(a-c) similarly to Fig. 3(a-c) and Fig. 4(d) is expansions of output of the third ring resonator, where output have full width at half maximum is 0.1 nm. The power of laser treatment is 250 W. We can vary the parameter of the ring resonator system for treatment suitability.

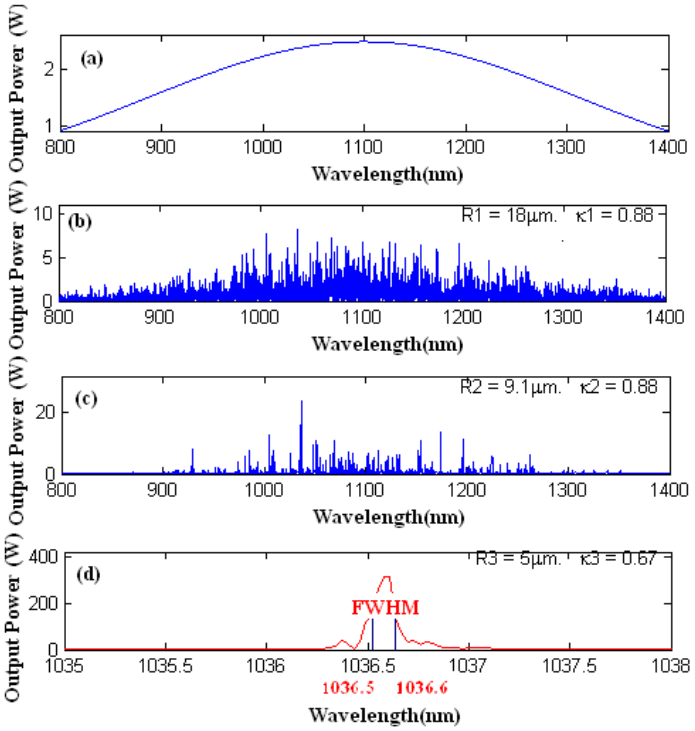

Fig. 4. Result of full width at half maximum: FWHM is 0.1 nm for laser treatment

The medicine and the dose: As with other forms of medication, Low Level Light Therapy: LLLT has its active ingredients or "medicine" (irradiation parameters) and a "dose" (the irradiation time). Table 1 lists [1] the key parameters that define the medicine and Table 2 [1] defines the dose. It is beyond the scope of this paper to exhaustively list and discuss every conceivable aspect of laser radiation or other light sources; however, we believe we have captured the main elements with some comments from others. Energy (J) or energy density (J/cm2) is often used as an important descriptor of LLLT dose, but this neglects the fact that energy has two components, power and time in equation (4),

$$\text{Energy (J)} = \text{Power (W)} \times \text{Time (s)} \quad (4)$$

and it has been demonstrated that there is not necessarily reciprocity between them; in other words, if the power doubled and the time is halved, then the same energy is delivered, but a different biological response is often observed [1].

4. Conclusion

We have achieved a generated laser treatment for Chickenpox treatment at wavelength of 1,036 nm. The power of laser is 250 W, which have varied the power suitable for treatment. The important factor of laser therapy is energy (J) per time (sec.) of laser source. In the near future, the laser treatments will be easy for therapy, Simple Generation System, Low energy, Portable device, Precision Small Treatment System will be simple for us to use.

References

[1] Ying-Ying Huang , Aaron C.-H. Chen , James D. Carroll , Michael R. "Hamblin BIPHASIC DOSE RESPONSE IN LOW LEVEL LIGHT THERAPY", University of Massachusetts, ISSN: 1559-3258 DOI: 10.2203/dose-response.09-027.Hamblin.

[2] P.P.Yupapin, W. Suwancharoen, ,S. Pipatsart, An optical tunable band-pass filter using chaotic signals in a nonlinear micro ring resonator Proceedings of SPIE - The International Society for Optical Engineering 6793 2008.

[3] P.P. Yupapin, W. Suwancharoen, Chaotic signal generation and cancellation using a micro ring resonator incorporating an optical add/drop multiplexer Optics Communications 280 (2) , 343-350.

[4] B D McSwain, D I Arnon, "Enhancement effects and the identity of the two photochemical reactions of photosynthesis", Proc Natl Acad Sci U S A. 1968 November; 61(3): 989–996.

[5] F. M. Bento, F. A.O. Camargo, B.C. Okeke, W. T. Frankenberger, "Comparative bioremediation of soils contaminated with diesel oil by natural attenuation,biostimulation and bioaugmentation", Bioresource Technology,Volume 96, Issue 9, June 2005, Pages 1049–1055.

[6] Y. Zhang, X. Wu, D. Guo, O. Rechkoblit, Z. Wang, "Activities of human DNA polymerase κ in response to the major benzo[a]pyrene DNA adduct: error-free lesion bypass and extension synthesis from opposite the lesion DNA Repair", Vol. 1, 17 (2002), 559-569.

[7] Tina S. Alster, MD. "Laser Treatment of Hypertrophic scars, Keloids, and Striae". Dermatologic clinics, volume 15 Number 3 July 1997.

[8] Alster TS, Kovak S, Rosenbach A : Comparision of a 585 nm flashlamp-pumped pulsed dye laser at normal and l W fluence with a high-energy, pulsed CO2 laser in the treatment of striae. Dermatol Surg 1997, (in press).

[9] Alster TS, McMeekin TO: Improvement of facial ance scars by the 585 nm flashlamp-pumped pulsed dye laser. J Am Acad Dermatol 35:79, 1996.

[10] Alster TS, Williams CM: Treatment of keloid sternotomy scars with 585 nm flashlamp-pumped pulsed dye laser. Lancet 345:1198, 1995.

[11] F.H. Mustafa, M.S. Jaafar, A.H. Ismail, P15 The effect of diode laser (645 nm) on the treatment of epidermis diseases for different colors skin in the photo dynamic therapy (PDT), Photodiagnosis and Photodynamic Therapy, Volume 7, Supplement 1, July 2010, Page S37.

[12] Dierickx C, Goldman MP, Fitzpatrick RE : Laser treatment of erythematous/hypertrophic and pigmented scars in 26 patients. Plast Reconstr Surg 95:84, 1995.

[13] Riad Haddad, Eviatar Nesher, Jerry Weiss, Yehuda Skornick, Hanoch Kashtan. Photodynamic therapy for Bowen's disease and squamous cell carcinoma of the skin Photodiagnosis and Photodynamic Therapy, Volume 1, Issue 3, November 2004, Pages 225-230.

[14] Anthony M. Rossi, Maritza I. Perez, Laser Therapy in Latino Skin, Facial Plastic Surgery Clinics of North America, Volume 19, Issue 2, May 2011, Pages 389-403.

[15] Edyta Paszko, Carsten Ehrhardt, Mathias O. Senge, Dermot P. Kelleher, John V. Reynolds, Nanodrug applications in photodynamic therapy, Photodiagnosis and Photodynamic Therapy, Volume 8, Issue 1, March 2011, Pages 14-29.

[16] Carla Y. Pumphrey, Wayne L. Gray, The genomes of simian varicella virus and varicella zoster virus are colinear , Virus Research, Volume 26, Issue 3, December 1992, Pages 255-266.

[17] Toby M. Ward, Marshall V. Williams, Vicki Traina-Dorge, Wayne L. Gray, The simian varicella virus uracil DNA glycosylase and dUTPase genes are expressed in vivo, but are non-essential for replication in cell culture, Virus Research, Volume 142, Issues 1–2, June 2009, Pages 78-84.

[18] Wood MJ (October 2000). "History of Varicella Zoster Virus". Herpes 7 (3): 60–65.

[19] Z. Simunovic, K. Simunovic, "Low level laser therapy applied as monotherapy method in theatment of herpes virus infection" , Photodiagnosis and Photodynamic Therapy, Volume 5, Supplement 1, August 2008, Pages S30-S31.

[20] Kiyofumi Mochizuki, Hirofumi Matsushita, Yuji Hiramatsu, Kazuo Yanagida, "Detection of Varicella-Zoster Virus Genome in the Vitreous Humor From Two Patients With Acute Retinal Necrosis; Lacking or Having a PstI Cleavage Site",Japanese Journal of Ophthalmology, Vol. 42, (1998), 208-212.

[21] American Academy of Dermatology, "New combination laser therapy effective in treating Melasma", Published on February 8, 2012 at 6:04 AM On the surface, it would seem as though the skin, http://www.news-medical.net/news/20120208/New-combination-laser-therapy-effective-in-treating-melasma.asp.

[22] Combination laser treatment and fat transplantation helps combat cellulite, a new study shows, Aesthetic Medicine, Posted on May 13, 2009, 9:59 a.m.,http://www.worldhealth.net/news/combination_laser_treatment_and_fat_tran1.