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Laser Module for Acupuncture

Fidelis Zaini Jutamulia
Private Practice, Jalan Gumilang No. 4, Bogor, 16143, Indonesia

A laser module including a modified laser diode is proposed for acupuncture. The modified laser diode has a collimating lens in the can of its package, so a collimated laser light is emitted from the modified laser diode. The collimated laser light may be used as acupuncture needle replacement. © Anita Publications. All rights reserved.

Keywords: Laser module, laser diode, collimated laser light, orthogonal cylindrical lenses, pulled preform, acupuncture, needle replacement.

1 Introduction

The insertion of acupuncture needles into acupuncture points to treat diseases has been practice for at least 2000 years. The addition of electricity or electro acupuncture was documented in a French text as early as in 1825. Recently, acupuncture using laser has been proposed and demonstrated. The effectiveness of laser acupuncture has been documented [1,2], where laser beam replaces an acupuncture needle. Most lasers used in acupuncture are known as low-level lasers, because they are not the same as lasers used for laser surgery, in which high power lasers are used as a scalpel to burn or cut. Studies show that low-level lasers can help regenerate cells, decrease pain, reduce inflammation, improve circulation, and stimulate hair growth, to name a few examples.

2 Laser Diode

Laser diodes or scientifically known as semiconductor lasers have been commercially available at least for 3 decades. A laser diode emits laser light by providing electric current. A schematic diagram of laser diode is shown in Fig 1 [3].

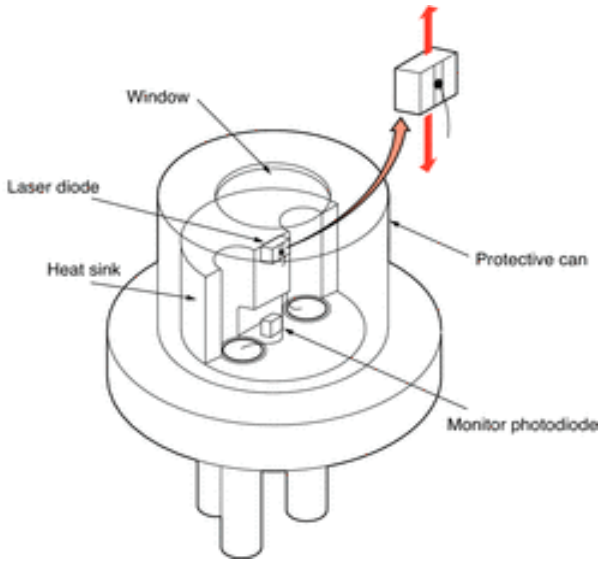

Fig 1. Schematic diagram of a laser diode in TO can. The magnified part shows the semiconductor substrate that emit laser light when electric current is supplied.

Corresponding author :
e-mail: skinsaemegamulia@yahoo.co.id (Fidelis Zaini Jutamulia)

Laser diodes are packaged in a small package known as TO can. The TO cans having diameters 9 mm, 5.6 mm, and 3.8 mm are most commonly available. Figure 2 shows schematically dimension of a 9 mm TO can laser diode. Fig. 2 also shows a picture of 9 mm TO can laser diode.

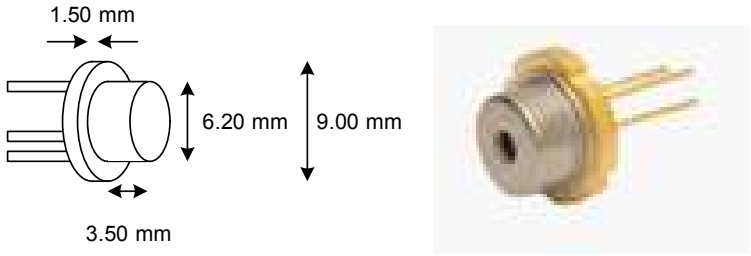

Fig 2. Dimension and picture of 9 mm TO can laser diode.

The laser light emitted by a laser diode quickly diverges as shown in Fig 3. The diverging angles in horizontal and vertical directions are different. The large diverging angle is for example 30^o and the small diverging angle is for example 10^o. Thus it may not be used as an acupuncture needle replacement.

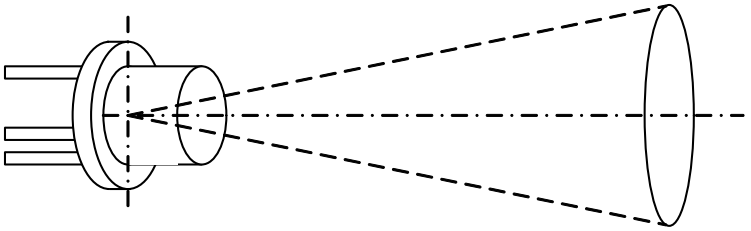

Fig 3. Laser light from a laser diode diverges quickly.

3 Modification of laser diode

The laser light from a laser diode must be collimated. However, in order to use the collimated laser light as an acupuncture needle replacement, the collimated laser beam must be small in diameter. To get a small diameter collimated beam, the collimating lens must be small and placed very close to the laser diode.

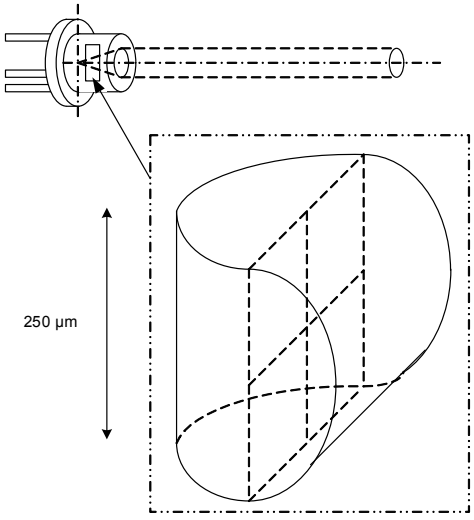

Fig 4. A very small collimating lens is placed very closed to the laser source in the package after the can is removed.

A very small lens, for example, having 250 μm size may be used. Since the lens is very small, it must be placed very closed to the laser diode. The can of the laser package may be opened and removed. The small collimating lens is placed closed to the laser emitting end of the laser diode as shown in Fig 4.

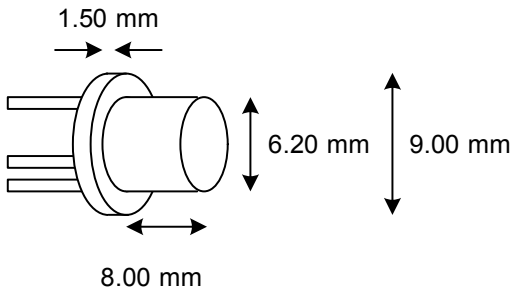

Fig 5. Dimension of 9 mm TO can laser diode having new can.

After the collimating lens is fixed to the laser diode, for example using glue, a new can may cover the laser diode and the collimating lens as shown in Fig 5. However, to give space for the collimating lens, the new can may be longer than the original can. For example, the length of the new can is 8 mm, while the length of the original can is 3.5 mm. Note the length of the new can may be longer or shorter than 8 mm.

4 Collimating Lens

The collimating lens actually consists of two orthogonal cylindrical lenses as shown in Fig 4. Figure 6 shows that the first cylindrical lens collimates the light in horizontal direction. However, the light in vertical direction is not affected by the first cylindrical lens.

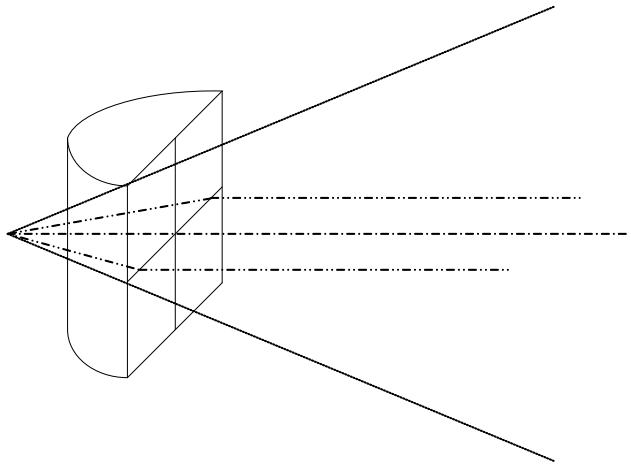

Fig 6. The first cylindrical lens collimates light in horizontal direction.

The second cylindrical lens of the collimating lens is orthogonal to the first cylindrical lens of the collimating lens. The second cylindrical lens collimates the light in vertical direction as shown in Fig 7. In this manner, the collimating lens consisting of two orthogonal cylindrical lenses collimates the light emitted by the laser diode.

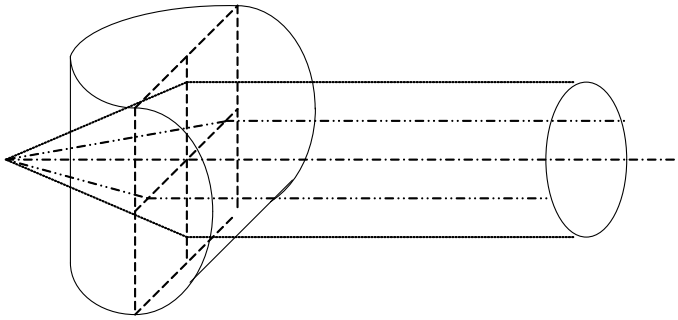

Fig 7. The second cylindrical lens of the collimating lens collimates light in vertical direction.

The reason to use two orthogonal cylindrical lenses to collimate the laser light instead of using a single spherical lens is that the collimating lens is very small, for example, about 250 μm. It is very difficult to make a small spherical lens.

The first and second cylindrical lenses are made separately. The cylindrical lens is first made in a preform having correct shape but much larger than the final size. For example, the cross-section of the preform is about 25 mm. The preform is being fed slowly into a heater and is pulled from other side of the heater [4]. The pulled cylindrical lens will have the shape as the preform, but the cross-section is reduced to 250 μm. Figure 8 shows schematically a preform is reduced to a final size cylindrical lens.

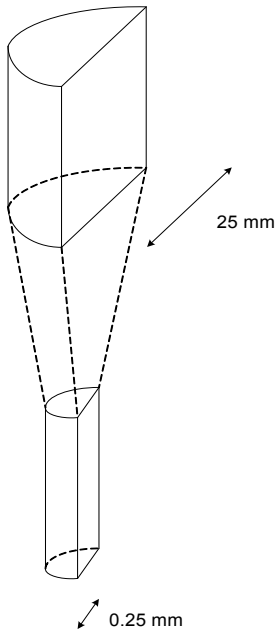

Fig 8. A preform is pulled in a heater to reduce its size.

5 Laser acupuncture needle replacement

The modified laser diode that emits a collimating laser light may be used as acupuncture needle replacement. The modified laser diode shown in Fig 5 may be fixed in a pad as shown in Fig 9. The pad may have adhesive so the pad can be stuck to the skin of an acupuncture point.

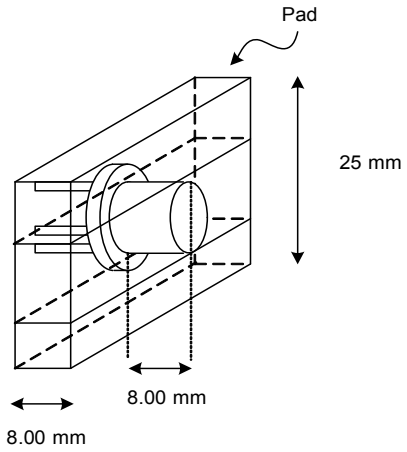

Fig 9. A modified laser diode fixed in a pad to stick to the skin of acupuncture point.

The penetration of laser light having 100 mW/cm^2 in skin is given in the Table 1 [5,6]. In the proposed system using the modified laser diode, since the collimating lens is about 0.25×0.25 mm^2, the power of the laser diode of about 0.06 mW is equivalent to 100 mW/cm^2. This indicates that a commercially available and FDA approved laser diode <5mW is sufficient.

Table 1. Penetration of laser light in skin.

Wavelength (nm)	Color Range	Penetration (mm)
150-380	UV	<0.1
390-470	Violet to Deep Blue	~0.3
475-545	Blue-Green	0.3-0.5
545-600	Yellow to Orange	0.5-1.0
600-650	Red	1.0-2.0
650-950	Deep Red-NIR	2-3
950-1200	NIR	1

Since the acupuncture needle is usually inserted into skin about 2-3 mm, it is believed that laser penetration of at least 2-3 mm is required. Laser light may generate heat to stimulate the acupuncture point. In the acupuncture operation, the power of the laser is increased from zero to a threshold level of sensation by the patient. The laser may be modulated to emit repetitive pulses to enhance the effect of the laser. The practitioner will be able to determine with an appropriate treatment duration depending on the desired clinical result and patient progress.

6 Photobiostimulation

Laser acupuncture not only provides physical stimulation such as heat at the acupuncture point similar to mechanical stimulation provided by an acupuncture needle. Moreover, the laser light may also generate the photobiostimulation [5,6]. The laser light especially in the red and NIR (near infrared) spectra is absorbed by mitochondrial chromophores in a cell. Consequently, a cascade of events occur in the mitochondria, leading to biostimulation of various processes. This absorption of light energy may cause photodissociation of inhibitory nitric oxide, leading to enhancement of enzyme activity, electron transport, mitochondria respiration, and adenosine triphosphate production. The laser light alters the cellular redox

state, which induces the activation of numerous intracellular signaling pathways, and alters the affinity of transcription factors concerned with cell proliferation, survival, tissue repair, and regeneration.

7 Concluding Remark

We propose a modified laser diode, which emits a collimated laser light from the TO can. The diameter and length of the TO can are 9 mm and about 8 mm, respectively. The modified laser diode can be fixed in a pad of 25×25 mm^2, and the pad sticks to an acupuncture point. The laser light not only acts as acupuncture needle replacement, but also generates photobiostimulation.

References

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