EC DENTAL SCIENCE
Review Article

# LASER: One Step towards Future

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**Received:** January 27, 2020; **Published:** February 29, 2020

## Abstract

LASER treatment is one of the most advanced equipment of health care activities. To make a fearless health service environment now a days LASER is an unavoidable opportunity for the practitioners. To make dental care more comfortable for the patients; LASER is the first choice for the treatment. In the different stages of dental procedure use of LASER is the most convenient. Therefore, the dentists and the health practitioners should have a little understanding about LASER activity. The purpose of this paper is to describe briefly the different varieties of LASER along with their mechanism. LASER can be classified depending on the site of application and wavelength. We already know the efficiency of the LASER treatment and it is necessary to acknowledge the generation procedure to have a better implication towards the treatment.

***Keywords:*** *LASER; Health Care Activities; Dental Care*

## Introduction

Dentistry is the functional science of the teeth and its associated bone, soft tissue with their sequential organization. The generation of dentistry initiated with the evolution of the human courtesy in order to achieve a compatible living. Augmentation of science and technology is also equipping dentistry as an advanced field of treatment. Among various treatment modals of advanced dentistry LASER is one of them.

We all know the term LASER stands for "Light Amplification by Stimulated Emission of Radiation" and this acronym reveals the definition as well as the mode of action of LASER technology. This magnificent technology works by producing and amplifying light.

LASER has a vast arena of utility in the field of medicine and dentistry. Hence, for health practitioner who works with LASER; it is better to have a little understanding about its variations.

### Types of LASER

LASER can be classified generally in two different ways. Firstly, depending on its Laser wavelength as well as the field of application and secondly depending on its composition.

### Depending on the wavelength, Laser can be classified into two types

#### Low wavelength Laser or Soft tissue LASER

The soft tissue LASERs have the wavelength that absorb water and hemoglobin that is actually oxygenating protein in red blood cells. LASERs in the near-infrared light spectrum (from 810 to 1,340 nm) have high affinity for hemoglobin and melanin but minimal or absent affinity for hard dental tissues. When irradiating a tooth with safe clinical parameters, there is no ablative interaction with the enamel and dentin, but only the release of thermal energy that diffuses deeply toward the pulp tissue, rich in their absorbing chromophore, the hemoglobin [1].

This attribute of Laser technology is suitable for soft tissue management around the tooth. The diode LASER Soft Tissue Lasers can be used for gingival contouring, leveling, troughing, gingivectomy, other periodontal procedure, exposure of unerupted tooth, operculectomy, frenectomy, treatment of oral aphthous ulcers [2], soft tissue incision, ablation and removal of soft tissue lesions [3-5].

Besides these activities soft tissue Lasers can also be safely used in the peri-implant area [6].

| **Soft tissue LASERs and wavelengths [6]** | |
|---|---|
| Carbon dioxide Lasers | 10,600 nm |
| Er: YAG Lasers | 2,950 nm |
| Er: Cr: YSGG Lasers | 2,780 nm |
| Nd: YAG Lasers | 1,064 nm |
| Diode Lasers | 810 - 980 nm |
| Argon Lasers | 457 - 502 nm |

***Table 1***

### High wavelength LASER or hard tissue LASER

Hard tissue LASER works with hard tissue volume of the oral cavity as well as in the other section of the body. As we know, it is the wavelength that works. In Hard tissue LASERs the wavelength pass through the water and bone which specifically deals with calcium phosphate of the bones and teeth and absorbed by them. But all the tooth does not have the same composition of water, collagen matrix or hydroxy apatite and along with that there are primary and permanent teeth who also have different absorption capacity and wavelength affinity. Therefore, it is important to understand the energy setting before starting any of the Laser procedures.

In dentistry, Hard Tissue Lasers helps in detecting cavities, dealing with the tooth sensitivity and also preparing teeth for dental fillings.

There are two types of LASERs for hard tissues.

**Cold Laser:** Cold Laser is the Low-Level Laser Therapy (LLLT) device. The reason behind calling it ‘cold’ is it is the type of Laser which do not increase the temperature of the object or the working surface while it is working. Cold Lasers deliver power from 1 mW to 500 mW. Cold Lasers are namely:

- Carbon dioxide lasers
- Argon lasers
- Neodymium-yttrium-aluminum-garnet
- Potassium-titanyl-phosphate
- Helium neon
- Ruby laser
- Excimer laser
- Holmium: YAG laser [7].

**Hard Laser:** Hard Lasers are also called hot Lasers. This is the high-powered Laser. This Lasers have the output larger than one Watt (1000 mW) [8].

The Hard Laser is used for cavity detection by studying the by-product produced by decay. It shapes teeth for fill and restorative works. Laser replaces traditional dental drill. Which is an astonishing inclination for the operative dentistry in terms of reducing painful procedure of tooth preparation. Laser eliminates the need of local anesthetic injection. It is also used to seal the dentinal tubule to treat sensitivity [9].

The first dental LASER for soft tissue treatment was invented in 1960. In 1997 the first hard tissue LASER treatment was invented with the approval of FDI [10].

Depending on the composition of the LASER it can be classified into following types.

**Gas LASER:** A gas laser is a kind of Laser in which electricity is discharged through a gas when it (gas) wants to produce coherent light. The gas Laser was the first continuous light Laser and the first Laser to operate on the principle of converting electrical energy to a Laser light output [11].

| Gas LASERs: |
|---|
| Carbon dioxide Carbon monoxide Helium-neon Nitrogen TEA laser Asterix IV laser ISKRA4,5 |
| Distinct subtypes: Chemical laser, Excimer laser, Ion laser, Metal-vapor laser [11]. |

***Table 2***

**Chemical laser:** Chemical lasers are powered by a chemical reaction and can achieve high powers in continuous operation. To understand the mechanism, we can observe one chemical laser activity. In the hydrogen fluoride laser (2.7 - 2.9 μm) and the deuterium fluoride laser (3.8 μm) the activity will be initiated by the combination or union or mixture of the hydrogen or deuterium gas with the combustion products of ethylene in nitrogen trifluoride. Here this chemical reaction is giving the opportunity to release a large amount of energy very quickly through which the chemical laser is being powered. Therefore, this high-power laser is the object of special interest to the military and industrial applications.

This hyperactive chemical laser was invented by George Claude Pimentel [11].

**Excimer Lasers:** Excimer Lasers are activated by a chemical reaction of excited dimer. This dimer is a short lived dimeric or hetero dimeric molecule formed from two atoms at least one of which is in an excited electronic state. They typically produce ultraviolet light and are used in semiconductor photolithography and in LASIK eye surgery. Between two atoms of the dimer; one should be a noble gas (argon, krypton or xenon) [11].

The ultra-violet light from an excimer LASER is well absorbed by biological matter and organic compounds. Excimer LASERs can remove exceptionally fine layers of surface materials with almost no heating or change to the remainder of the material which is left intact. These properties make excimer LASERs well suited to delicate surgeries such as eye surgery and LASIK. And also, precision micromachining organic material (including certain polymers and plastics). It also treats some dermatological conditions including psoriasis, vitiligo, atopic dermatitis, alopecia areata and leukoderma [12].

| Excimers |
|---|
| Argon fluoride laser Krypton fluoride laser Nike laser Xenon monochloride [12]. |

***Table 3***

**Ion Laser:** Ion Laser are the LASERs that uses ionized gas as its lasing medium. The LASER is a structure consists of a sealed cavity containing the laser medium and mirrors that forms a resonator. Here greater amount of current is used to excite ions to create ionic transition which eventually produces the specific amount of light. If we roll up in one word, we can say that energized ionic transition produces the LASER action. Due to high amount of electrical activity the LASER machine can be heated; therefore, some of them are water cooled and some are air cooled. After observing the input and output activity we can assume that the power efficiency of ion LASER is very low.

Different types of ion LASERs are:

1. Krypton LASER
2. Argon LASER
3. A mixture of Ar and Kr
4. Helium-Cadmium LASER [13].

**Metal-vapor lasers:** These lasers typically generate ultra-violet wavelength and have particularly narrow oscillation linewidths (usually less than 3 GHz). E.G: copper vapor laser, Helium silver laser, neon-copper laser etc [11].

**Diode Laser:** Semi-Conductor; diode Lasers: Argon Lasers. Diode laser directly convert electrical energy into light. A laser diode is electrically a PIN diode. The 'P' is for a 'positive' end and 'I' for the most active 'intrinsic' region and the 'N' is for the 'negative' end. The electrons and holes are pumped in to the 'N' and 'P' region. With the improvement of technology, the modern lasers are using the double -hetero-structure implementation where the carriers and the photons are confined in order to maximize their chances for recombination and light generation. The goal is to recombine all the carriers in the I (intrinsic) region and produce light. Therefore, laser diodes are fabricated using direct band gap semi-conductors. The activity starts from the 'N' doped substrate using the crystal growth technique which is called epitaxial structure. Growing the I doped active layer it is followed by the P doped cladding and a contact layer. The active layer consists of quantum walls generally which provide lower threshold current and higher efficiency [14,15].

It has different wavelengths which causes visible light and infrared beams.

**Dye Lasers**: A dye Laser is a Laser in which an organic dye is used as an active Laser medium. Usually it is a liquid solution. Dye Lasers has a wider range of wavelength than gases and most solid-state lasing media. i.e. Rhodamine 6G, it can be tuned from 635 nm (orangish-red) to 560 nm (greenish-yellow) and can produce pulses of 16 femtoseconds [16].

**Solid State Lasers**: Nd: YAG Lasers, Er: YAG Lasers, Er, Cr: YAG Laser, Ho: YAG Laser, KTP Laser. A solid-state laser is a Laser that uses a solid medium. Generally, the active medium of a solid-state laser consists of a glass or crystalline "host" material, to which is added a "dopant (doping agent) " such as neodymium, chromium, erbium [17], thulium [18] or ytterbium [19]. Many of the common dopants (doping agents) are rare-earth elements, because the excited states of such ions are not strongly coupled with the thermal vibrations of their crystal lattices (phonons) and their operational thresholds can be reached at relatively low intensities of laser pumping.

Semiconductor-based lasers are also in the solid state but are generally considered as a separate class from solid-state lasers.

### The last words

In this paper we have discussed different types of laser to introduce it briefly as laser is a vast topic to describe and explain. Since the time of invention laser activity is showing its advanced implementation at every aspect of its utilization. Therefore, with more advancement of science technology laser is developing and getting more closer to life and living untiringly.

## Conclusion

The paper has described the different classes of LASER depending on their site of application, composition and wave length. It is one of the most advanced procedures to utilize in the field of medical treatment. The description of this technology in a short paper is usually impossible by keeping in mind that the world is progressing every day. Nevertheless, knowledge is endless therefore the author has tried to spot a little light on the variety of LASER technology to enhance the integrity of treatment.

## Acknowledgment

The author wants to acknowledge the enormous contribution of Late. Kazi Sufia Khanom and Dr. Syed Muntasir Mamun in conceiving the idea and their sincere cooperation.

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**Volume 19 Issue 3 March 2020**