

## Laser Dentistry 101

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## Laser Dentistry 101

Terminology  
Basic sciences  
Clinical applications



## Laser

- Acronym for Light Amplification by Stimulated Emission of Radiation
- Generally refer to a device which uses the natural oscillations of atoms between energy levels for generating coherent electromagnetic radiation.



## Laser in Dentistry A Brief History

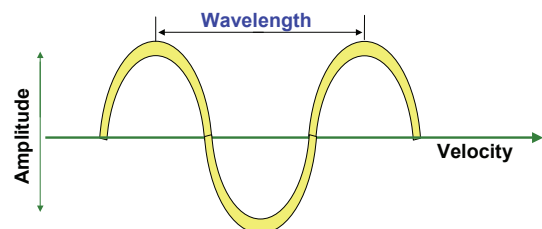
- **1917** Einstein Theory of Stimulated Emission
- **1960** Maiman First Laser Developed (Ruby)
- **1964** Stern & Sognaes First Laser Research in Dentistry (Ruby)
- **1990** Myers & Myers First Dental Laser Introduced (Nd: YAG)

## Electromagnetic Waves

- Time varying electric and magnetic fields propagating through space
- Light is a form of electromagnetic energy emitted as a photon traveling in waves
- Joule : unit of energy
- Watt : unit of power
- 1 Joule= 1 w ×1 second
- Hertz (Hz) : pulse per second (pps)



## Electromagnetic Waves



Frequency is the number of complete oscillations of the wave per second.



## Electromagnetic Waves

- **Wavelength** is the physical property that determines the classification of electromagnetic energy and lasers are named by their characteristic wavelength and active medium.
- **Wavelength** is the distance a photon travels through one complete oscillation and is measured from wave crest (peak) to wave crest (peak).
- Wavelength is measured in meters.
  - **Micrometer** ( $\mu\text{m}$ ) =  $10^{-6}$  meters or micron ( $\mu$ )
  - **Nanometer** (nm) =  $10^{-9}$  meters

## Electromagnetic Waves

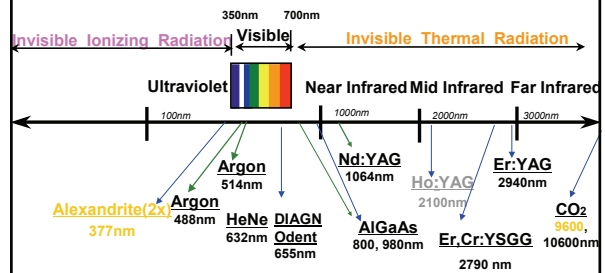
$$\lambda \times \nu = c$$

- **Wavelength x Frequency = Speed of Light**
  - Speed of Light=300,000 Kilometers per second
  - Photon energy is proportional to its frequency and inversely proportional to its wavelength.
- **Common wavelength measurements:**
  - micron ( $\mu$ )=  $10^{-6}$  meters
  - micrometer ( $\mu\text{m}$ ) =  $10^{-6}$  meters
  - nanometer (nm) =  $10^{-9}$  meters

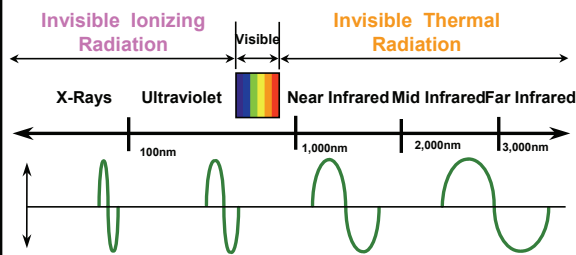
## Safe Radiation

- **All Dental Lasers emit light energy that is *non-ionizing* radiation. Ionizing radiation is damaging to cellular DNA.**
- **All Dental Lasers emit light energy that is either visible or invisible *thermal* radiation. Those wavelengths range from 350 to 10,600 nm.**

## Dental Laser Wavelengths on the Electromagnetic Spectrum



## Electromagnetic Spectrum



The Active Mediums “names” the device and also emits a specific color or wavelength of light

- Argon Gas
- Diode Solid
- Nd: YAG Solid
- Er: YAG Solid
- Carbon Dioxide Gas
- (YAG = Yttrium Aluminium Garnet, a garnet crystal found in nature and “doped” with rare earth metal atoms, eg Neodymium, to form prescribed active medium)

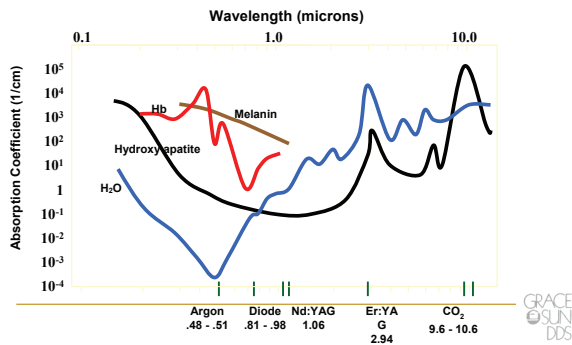
## Active Medium

- **Solid State Laser:** Active medium is suspended in a transparent crystal. The host material is grown in or "doped" with atoms that will create the desired wavelength. *Erbium, Neodymium, Holmium, etc.*
- **Gas Lasers:** Have a hollow tube filled with the appropriate gas or mixture of gases. *Carbon dioxide, argon.*
- **Liquid Dye Lasers:** Have the dye dissolved in methanol or water solvent.
- **Diode Laser:** Semiconductor crystals. Pumped electronically.

## Absorption Characteristics of Dental Lasers

Alexandrite (2x)	377nm	Calculus
Argon	488&515nm	Hemoglobin, Melanin, Resin Catalyst
HeNe	632nm	Melanin
Diode	810-980nm	Melanin, Water
Nd:YAG	1064nm	Melanin, Water, Dentin
Ho:YAG	2120nm	Water, Dentin
Er,Cr:YSGG	2780 nm	Water, Hydroxyapatite
Er:YAG	2940nm	Water, Hydroxyapatite

## Approximate Absorption Curves of Tissue Compounds

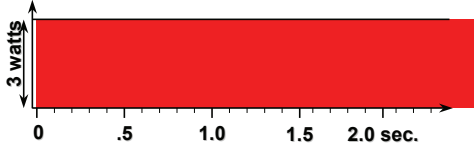


## Laser Delivery Systems

- Articulated Arm (Hollow tube, Fixed lens and 45° mirror)
- Hollow Waveguide (Semi-rigid tube, reflective interior)
- Optical Fiber (Quartz-silica flexible fiber)

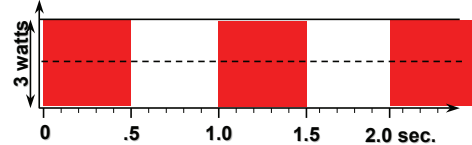
## Continuous-Wave Mode

LASER Settings ... Power: 3.0 watts  
Pulse Length: n/a  
Rep Rate: n/a  
AVERAGE POWER = 3.0 Watts



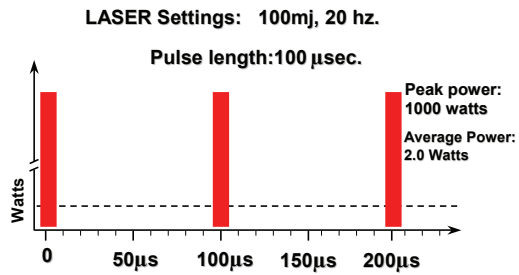
## Gated (Pulsed) Mode

LASER Settings ... Power: 3.0 watts  
Pulse Length: 0.5 seconds  
Rep Rate: 1 per second  
AVERAGE POWER = 1.5 WATTS



"One Fish, Two Fish, Red Fish, Blue Fish..." -Dr.Seuss

## Free Running Pulsed Mode



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## Thermal Effect of Laser on Tissue

Tissue Temp (°C)	Observed Effect
40-50	Hyperthermia
60	Coagulation, Protein Denaturation
70-90	Welding
100	Vaporization
200	Carbonization

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## CO<sub>2</sub>

- 10,600 nm wavelength
- Gas laser
- Continuous, gated
- Super Pulsed
- Non-contact
- Soft tissue procedures
- DEKA
- Lumenis/OpusDuo



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## Nd: YAG

- 1,064 nm wavelength
- Solid state laser
- Free running pulsed
- Contact/non-contact
- Soft tissue procedures
- Incisive
- Millennium
- Lares



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## Argon

- 488, 514 nm wavelengths
- Gas laser
- Continuous, gated
- Contact/non-contact
- Soft tissue procedures
- Photopolymerization
- Bleaching



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## Diode

- 800-900 nm wavelengths (830)
- Solid state semiconductor chip laser
- Continuous/gated
- Contact/non-contact
- Soft Tissue/ LLLT
- Various models available



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## Diode Lasers Manufacturers/Models

- LaserSmile
- Odyssey 2.4G
- DioLase
- BioLitec
- ConBio
- Opusdent
- ZAP



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## Er: YAG Laser

- 2940nm
- Optic Fiber
- Pulse Mode
- Hard & Soft Tissue Procedures
- Hoya Conbio Continuum, Er:YAG



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## Er, Cr: YSGG

- 2780 nm
- Solid state laser
- Pulsed
- Contact/non-contact
- Soft tissue/hard tissue/Bone
- Biolase



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## Soft Lasers

- Near Infrared and Infrared Spectrum
- Anti-inflammatory
- (Kinins, histamines, and prostaglandins)
- Wound healing
- Acupuncture points
- Muscle insertions



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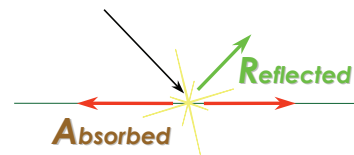
## Laser Classification

- Examples:
  - Class I
    - Self-Contained
    - CD-ROM Players / Readers, Laser Printers
  - Class II
    - Low-Powered Visible Light
    - Laser Pointers, Supermarket UPC Scanners
  - Class III
    - Requires special training, eye protection
    - Dental Argon Curing Lasers, Cold / Soft Lasers
  - Class IV
    - Potentially Hazardous, specific safety measures
    - Dental and Medical Surgical Laser Systems

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## Laser Safety

- Cornea, Lens, and Retinal Damage from various wavelengths



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## Soft Tissue Procedures In Laser Dentistry

- Purpose:
  - Incision, Excision, Vaporization, Ablation and Coagulation of Oral Soft Tissue
- Mechanism:
  - Thermal Tissue Interaction
    - Please be aware that specific wavelengths has specific absorption coefficient curves with different composition of the oral soft tissue

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## Soft Tissue Procedures In Laser Dentistry

- Clinical Applications:
  - Frenectomy
  - Vestibuloplasty
  - Hemostasis
  - Pulpotomy
  - Biopsy
  - Gingivectomy & Gingivoplasty
  - Soft tissue crown lengthening (check biological width)

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## Soft Tissue Procedures In Laser Dentistry

- Clinical Applications:
  - Gingival troughing (Sulcular preparation to facilitate prosthodontic impression)
  - Operculectomy to aid eruption of impacted tooth
  - Implant recovery and Flapless implant surgery access
  - Sulcular debridement (Removal unhealthy tissue and thermal bactericidal effect, will promote healing)

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## Soft Tissue Procedures In Laser Dentistry

- Clinical Applications:
  - Degranulation of extraction socket and periapical area
  - Treating of oral pathologies – Aphthous ulcers, herpes labialis, leukoplakia, lichen planus



## Hard Tissue Procedures In Laser Dentistry

- Tooth Structures:
  - Cavity Preparation
  - Caries removal
  - Root canal preparation and debriment
  - Roughing and etching to aid bonding strength
  - Caries therapy, hard tissue conditioning, sterilization, sealing of tubule desensitization
  - Apicoectomy and retrofil preparation

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## Hard Tissue Procedures In Laser Dentistry

- Bone:
  - Osteoplasty
  - Aiding osteotomy and ostectomy (implant and graft surgery)
  - Osseous crown lengthening (Flap? Mini-Flap? Intrasulcular? Flapless?)



### Low Level Laser Therapy (Biostimulation)

- Increase ATP, constitute cell's fuel & energy store
- Increase cell metabolism and collagen synthesis in fibroblasts
- Stimulate formation of DNA and RNA in cell nucleus
- Increase microcirculation
- Increase serotonin level
- Increase Lymphatic drainage

Continued→



### Low Level Laser Therapy (Biostimulation)

- Dental Indications:
  - Pulpitis
  - Post-op (Injection site, working site)
  - TMJ
  - Aphthas (Canker Sore)
  - Analgesics
  - Gingivitis



### Advantages of Laser Dentistry

- Efficiencies
- Precision
- New Modalities
- Hemostasis
- Antisepsis
- Atraumatic Procedure
- Reduced Stress and Fatigue
- Reduced Need for Local Anesthesia
- Decreased Postoperative Discomfort



### What to look for in a Laser

- ✓ Fit your Own Needs
- ✓ Clinical Applications
- ✓ Features
- ✓ Portability
- ✓ Safety
- ✓ Comparisons
- ✓ Training and Support
- ✓ Value



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### Resources:

#### Textbooks

- *Lasers In Dentistry*
  - Leo Miserendo/Robert Pick Quintessence books  
[www.quintpub.com](http://www.quintpub.com)
- *Dental Clinics of North America Oct 2000 Lasers and Light Amplification in Dentistry*
  - Elsevier/Saunders [www.theclinics.com](http://www.theclinics.com)
- *Dental Clinics of North America Oct 2004 Lasers and Light Amplification in Dentistry*
  - Elsevier/Saunders [www.theclinics.com](http://www.theclinics.com)
- *Laser Therapy Clinical Practice and Scientific Background*
  - Jan Tunér and Lars Hode, Prima books [www.sundds.com](http://www.sundds.com)



## Laser Company Web Addresses

- [www.biolase.com](http://www.biolase.com)
- [www.biotec.com](http://www.biotec.com)
- [www.conbio.com](http://www.conbio.com)
- [www.dekalasers.com](http://www.dekalasers.com)
- [www.GetOdysseyLaser.com](http://www.GetOdysseyLaser.com)
- [www.incisivelaser.com](http://www.incisivelaser.com)
- [www.laresdental.com](http://www.laresdental.com)
- [www.lumenis.com](http://www.lumenis.com)
- [www.millenniumdental.com](http://www.millenniumdental.com)
- [www.zaplasers.com](http://www.zaplasers.com)

## Powerful Topical Anesthetic Gel

- Very useful for all soft tissue procedures
- **Sources:**
  - Profound Topical Anesthetic Gel, Steven's Pharmacy, Costa Mesa, CA . 714-540-8911,800-352-drug
  - TAC 20%, Professional Arts Pharmacy, Lafayette, LA. 888-237-4737