Intense Pulsed Light Technology versus Laser Technology in Dermatology

Essay

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تكنولوجيا الضوء النبضي المكثف مقارنة بتكنولوجيا الليزر في علاج الأمراض الجلدية

رسالة
توطئة للحصول على درجة الماجستير
في الأمراض الجلدية و التناسلية

مقدمة من

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List of Abbreviations

ALA	Amino-levulonic acid
Co_2 laser	Carbon dioxide laser
Cu	Copper
CW	Continuous wave
EMLA	Eutectic mixture of local anesthetics
Er: YAG laser	Erbium:Yutrium-Aluminuim-Garnet
GaAlAs laser	Gallium aluminum arsenide laser
GaAlP laser	Gallium aluminum phosphate laser
Ga As laser	Gallium-Arsenide laser
He-Ne laser	Heluim-Neon laser
HIV	Human immunodeficiency virus
IPL	Intense pulsed light
J/cm^2	Joule/centimeter^2
KTP	Potassium Titanyl Phosphate
LASER	Light amplification by the stimulated emission of radiation
LP-Alex	Long- pulse alexandrite laser
LPDL	Long-pulsed pulsed dye laser
MPE	Maximum permissible exposure
ms	Millisecond
mw	Milliwatt
Nd :YAG laser	Neodymium Yttrium Aluminum Garnet
nm	Nanometer
NOHD	Nominal ocular hazard distance
PDL	Pulsed dye laser
PIH	Post-inflammatory hyperpigmentation
P-n junction	Positive-negative junction

PPIX	Protoporphyrin IX
Q-switched	Quality switched
QS laser	Quality switched laser
ROYGBIV	Red, orange, yellow, green, blue, indigo and violet
SP-Alex	Short- pulse alexandrite laser
UVB	Ultraviolet-B
W/cm^2	Watt/centimeter^2

Chapter 1
Laser

Definition

The word Laser is an acronym for light amplification by the stimulated emission of radiation ***(Reis and Powitzky, 2002).***

History

The concept of stimulated light emission was initially introduced by Einstein in 1917.He proposed that a photon of electromagnetic energy could stimulate the emission of another identical photon from atoms or molecules that are in an excited state ***(Baxtor, 1994).***

The first laser was developed by Maiman in 1959 using a ruby crystal to produce red light with a 694.nm wavelength ***(Berns et al., 1992).***

In 1963 Dr Leon Goldman pioneered the use of lasers for cutaneous applications by promoting ruby laser treatments for a variety of cutaneous pathologies ***(Baxtor, 1994).***

The development of the Argon and carbon dioxide lasers soon followed and served as the focus for cutaneous laser research during the next 2 decades ***(Baxtor, 1994).***

Cutaneous laser surgery was revolutionized in the 1980 with the introduction of the theory of "selective photothermolysis" by Anderson and Parrish. Application of their theory effects specific destruction of a target in the skin with minimal unwanted thermal injury ***(Dougherty and Ryan, 2002).***

Idea of Laser

Laser systems are sources of high intensity of electromagnetic energy fluxes, with high monochromaticity and high spatial and temporal coherence. Therefore, laser radiation differs from other types of electromagnetic radiation in that it travels via a very narrow beam ***(Baxtor, 1994).***

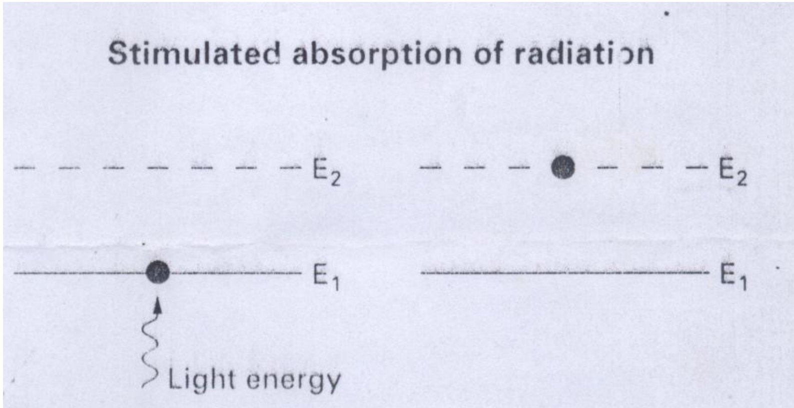
When a laser beam strikes the skin, there are four possible interactions: It can be reflected, absorbed, scattered or transmitted. A tissue effect can only occur if light is absorbed. Only 4 – 7% of light is reflected off the skin. Neither this nor transmitted light has a tissue effect ***(Reis and Powitzky, 2002).***

Spontaneous and stimulated emission

Electrons surrounding an atom or molecuole can exist at more than one energy level. They are usually found at the lowest energy level or resting states where they are stable. Einstein in 1917 added the concept of stimulated emission to the known effect of spontaneous emission and stimulated absorption ***(Berns et al., 1992).***

In stimulated absorption an electron absorbs photons of energy and is raised to a higher energy level. In spontaneous emission photons of energy are released and the electrons return to the lower energy level. (Fig 1) ***(Langigan, 2000).***

In stimulated emission an atom or molecuole is stimulated by an absorbed photon and after excitation emits a photon of the same frequency as the exciting photon. If the released photon collides with another atom in the excited state, another photon identical in phase, frequency and direction will be released as the atom returns to its stable state (Fig 2) ***(Reis and Powitzky, 2002).***



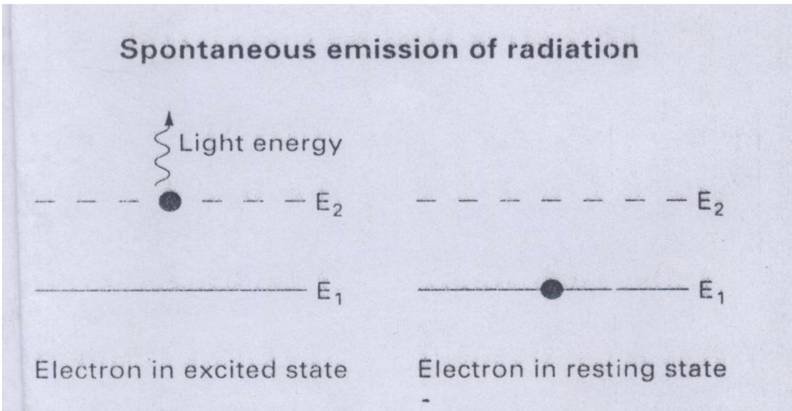
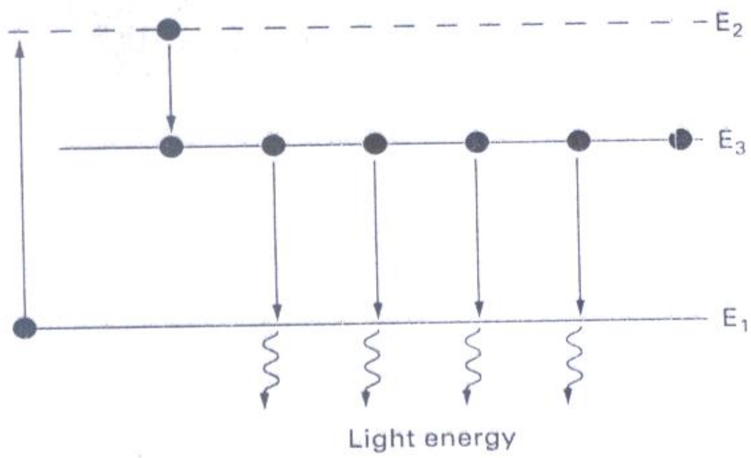


Fig. (1): Spontaneous emission ***(Langigan, 2000).***



Metastable energy level (E_3) with population inversion and light emitted by stimulated emission

Fig. (2): Stimulated emission ***(Langigan, 2000).***

In a laser it is necessary to have a large number of atoms in the excited state to be present. This occurs if there is a metastable energy level in which excited atoms remains in an excited state for sometime ***(Baxtor, 1994).***

Once the population of electrons in the metastable excited state exceeds those in the stable state a population inversion has occurred. Photons emitted by electrons in this population in turn stimulate the release of further photons as electrons return from metastable to stable state. All the photons released by these events would be of the same wavelength and in phase ***(Langigan, 2000).***

To amplify these events in a laser; a resonating or optical cavity containing the active medium has reflective mirrors at