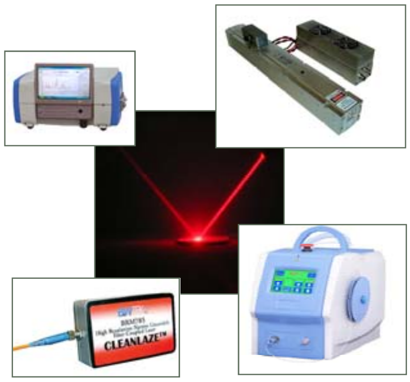
pacer advancing technology

Lasers for medical and diagnostic applications:

the cut and thrust of cells and photons.

Andrew King

Pacer International



pacer advancing technology

Interactions between cells and photons

Photochemical -
- Photodynamic therapy (PDT)
- Photostimulation
- Cytotoxicity of UV light

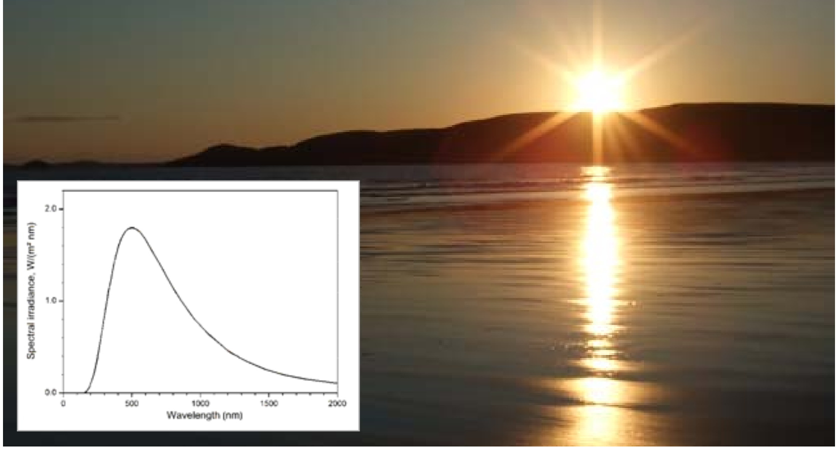
Photothermal -
- Heat generation
- Thermal damage to tissue

Photomechanical -
- Shock and acoustic waves
- Vibrational spectroscopy (molecular level)

Dielectric breakdown -
- Laser ablation

The Sun

High emission in near-UV, Visible and NIR



Suntan

Photochemical reaction

UV-A causes the oxidation of melanin, leading to a darkening of this pigment

Melanin is a good absorber of UV-A

Sunburn

Photochemical reaction

Direct damage of DNA by UV-B

Main damage is tymine-thymine dimer

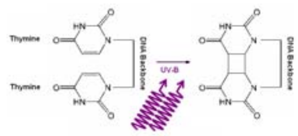


Photo damage of DNA triggers increased production of melanin

UVB - 290 to 320 nm
UVA - 320 to 400 nm

Skin cancer

Photochemical reactions

UV light

- directly damages the DNA
- produces free-radicals in the skin
- suppress immune response
- suppress apoptosis (cell death)

Wrinkles (photoaging)

Photochemical reaction

UV light breaks down collagen faster than normal aging process

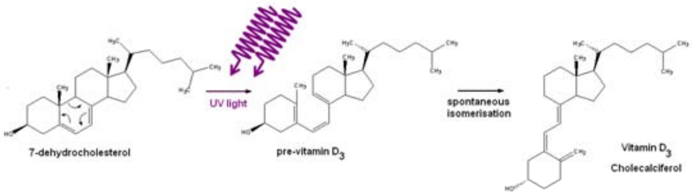
Cellular response is to remodel sun-damaged skin by making and reform collagen

Imperfect remodelling results in wrinkles

Vitamin D3

Photochemical reaction in the skin

UVB



Vitamin D regulates calcium and phosphorus levels in the blood by promoting their absorption from food

Vitamin D deficiency causes Rickets (in children) and Osteomalacia (in adults); and, possible links to Osteoporosis

pacer
advancing technology

Lasers for medical applications:

pacer
advancing technology

Laser surgery using carbon dioxide lasers

Water has a high absorption coefficient at 10.6 μm

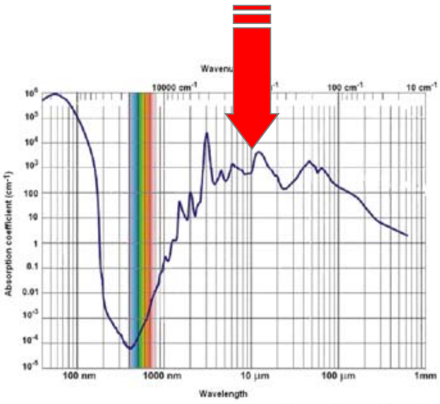
Super-pulse capability
-High pulse energy / compact design

-Less thermal damage / no charring

-Precise

- Sterile

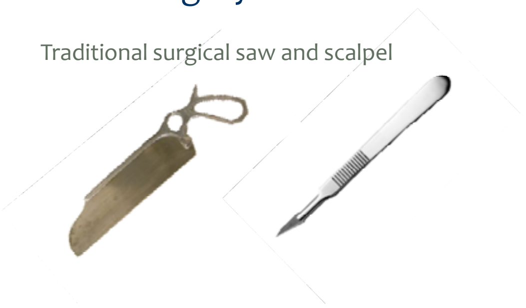
-Rapid healing times (?)



www.lsbu.ac.uk/water/vibrat.html

Laser surgery

Traditional surgical saw and scalpel



Carbon dioxide laser

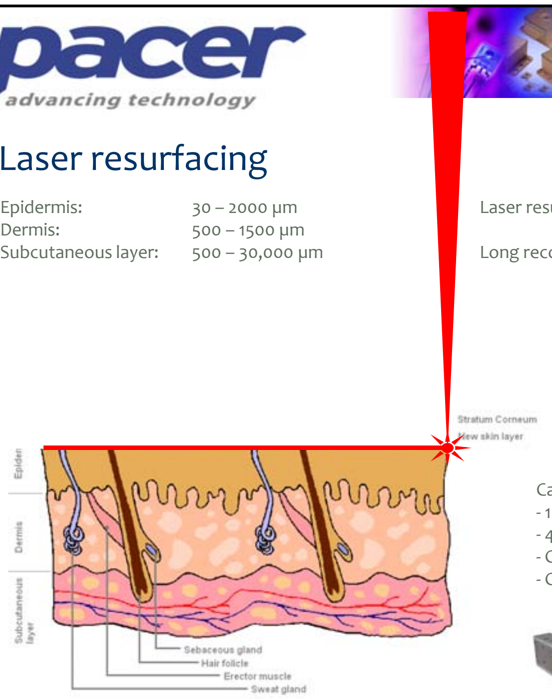
Many surgical techniques now use CO_2 lasers for human and veterinary procedures, such as:
- ophthalmic surgery
- tumour removal
- Key-hole surgery
- amputation
- cosmetic surgery

Access Laser Company

Laser resurfacing

Epidermis:	30 – 2000 µm
Dermis:	500 – 1500 µm
Subcutaneous layer:	500 – 30,000 µm

Laser resurfacing:	10 – 200 µm deep
Long recovery time:	several weeks/months



Carbon dioxide lasers
- 10.6 µm
- 400 mW – 20W
- CW, pulsed and super-pulsed
- Compact size

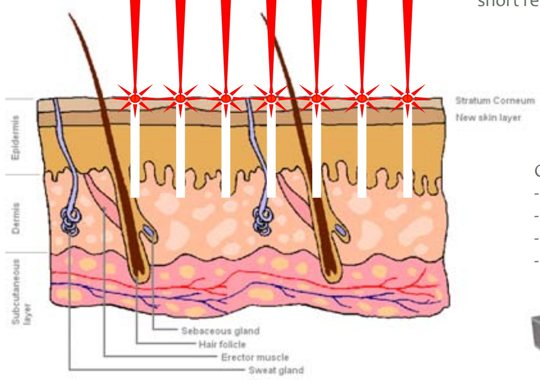
Access Laser Company

Fraxel laser resurfacing

Epidermis: 30 – 2000 µm
Dermis: 500 – 1500 µm
Subcutaneous layer: 500 – 30,000 µm

Fraxel laser resurfacing:
(superficial) 10 – 70 µm deep
(non-ablative) 600 – 1000 µm deep
(ablative) 600 – 1000 µm deep

short recovery time: a few weeks



Carbon dioxide lasers
- 10.6 µm
- 400 mW – 20W
- CW, pulsed and super-pulsed
- Compact size

Access Laser Company

Direct diode lasers for medical applications

NIR laser package

Photostimulation / photothermal process

Treatment of pain, inflammation and swelling of soft-tissue damage

Tissue repair accelerated by increase blood flow and oxygenation of cells

Laser power up to 10 Watts (approved for medical applications)

Wavelengths available:
810, 940, 980 and 1080 nm, power 5 W – 50 W
635 – 690 nm, power 1 – 4 W

B&WTEK INC.

Lasers for Diagnostics

Diagnostic techniques

autofluorescence
- Confocal microscopy
- Flow cytometry
- Retinal scanning

Raman spectroscopy
- Cancer diagnosis
- Bone analysis
- Disease diagnosis

Optical Coherence Tomography (OCT)

Oximetry

Doppler velocimetry

B&WTEK INC.

pacer
advancing technology

Fluorescence excitation

Flow cytometry
- cell analysis and sorting

Confocal microscopy
- cell imaging

Traditionally, use argon / krypton ion lasers

Then DPSS lasers.

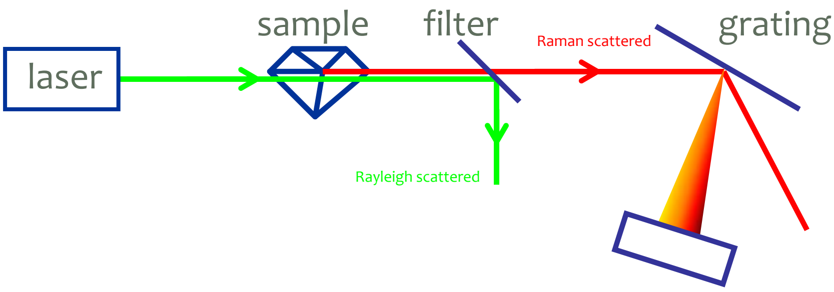
Now, diode laser wavelengths and higher powers are becoming more common

405 nm lasers – developed for DVD mastering

B&W TEK INC.

pacer
advancing technology

Raman spectroscopy

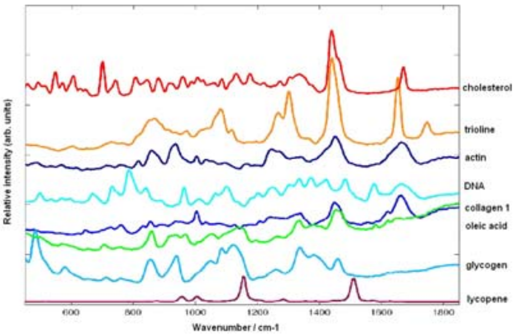


Raman scattering: inelastic collision between photon and molecule
Energy is transferred between photons and molecular bonds
Amount of energy is specific to the molecular bond

Raman spectroscopy for medical diagnostics

Raman spectroscopy has very high specificity

Water is a weak scatterer, so is good for biological materials

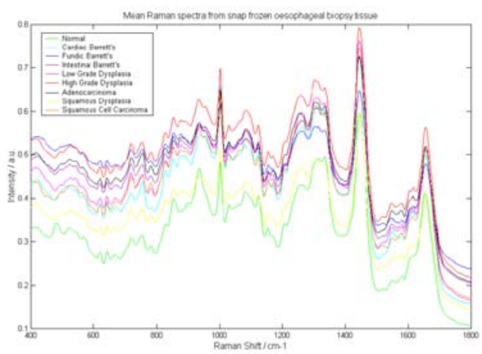


Data courtesy of N. Stone, Biophotonics Group, Gloucester Royal Hospital

Raman spectroscopy for medical diagnostics

Raman spectroscopy is able to identify cancerous cells

Chemometric analysis can detect small features that are not immediately visible

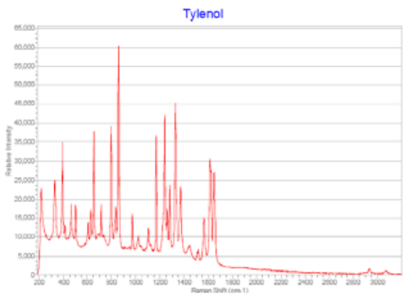


Data courtesy of N. Stone, Biophotonics Group, Gloucester Royal Hospital

pacer
advancing technology

Raman spectroscopy for pharmaceuticals

Raman spectroscopy can be used to analyse material inside packaging



pacer
advancing technology

Portable Raman spectroscopy

Cleanlase technology
Wavelength stabilised
100 mW – 1W power at 785 nm

i-Raman

miniRam

Visible and NIR laser options
Battery or mains
Fibre probe & microscope accessory
Standard spectral range 175 – 3200 cm-1

miniRam-II

pacer
advancing technology

… and the future?

Fibre lasers
- Fibre laser technology is growing rapidly

Pulse control
- ability to control pulse shape and pulse train, may enable techniques to be refined for better performance.

More direct diodes
- High volume applications drive the demand for different wavelengths

Combined laser techniques
- imaging and ablation
- diagnosis and treatment

PYROPHOTONICS

ALFALIGHT

COHERENT.

pacer
advancing technology

See more at booth D22

PerkinElmer, TT electronics OPTEK Technology, TAOS, BRIMROSE, HANVISION, Judson, CorActive, epitex, FT, Knowledge*on, RMD, r·p·m·c, CORELASE, BWTEK, VERTILAS, SAMSUNG SDI, LightPath, KODENSHI, COHERENT, ORIENT DISPLAY, ROHM, VARITRONIX, MITSUBISHI ELECTRIC, Access Laser Company, QIOPTIQ, DMC, nextwindow, PLANAR, ALFALIGHT, Auxora, SANYO, ZYTRONIC, WINMATE, edt, ENFIS, PYROPHOTONICS