

Minimally Invasive Surgery

3mikron™ - High-power, diode pumped laser technology (2 - 3 µm)

3mikron™ is the technology platform for compact, efficient, fast and reliable lasers for a wide range of potential applications in the field of medical engineering. It enables a new generation of innovative mid-IR lasers based on diode-pumped solid-state technology, operating at wavelengths of 2 to 3 µm using different types of laser crystals (e.g. Er:YAG, Er:YSGG, Tm:YAG, Er:YLF).

Compared to mechanical tools, traditional laser technologies (e.g. flash lamp pumped Er:YAG laser, CO₂ lasers) and RF technology 3mikron™ offers several benefits regarding treatment of soft and hard tissue:

APPLICATION BENEFITS

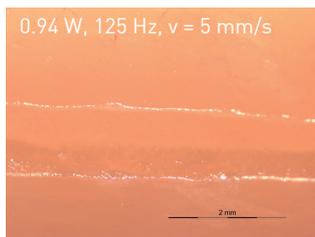
- . Precise treatments (cutting width < 100 µm)
- . Controllable thermal impact by laser parameters
- . Cold ablation (cut like a scalpel)
- . Hot ablation (coagulation) by stacked pulses
- . Limited lateral thermal damage
- . No unwanted vibrations to the patient
- . Short operation time
- . Fast healing
- . Combines benefits of flash lamp pumped Er:YAG and CO₂ lasers
- . Optimized for soft and hard tissue treatment

This work was done in cooperation with the Institut für Lasertechnologien in der Medizin und Meßtechnik at the University of Ulm, Germany

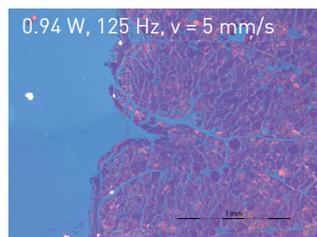
Soft Tissue

DPM-15 Laser Module

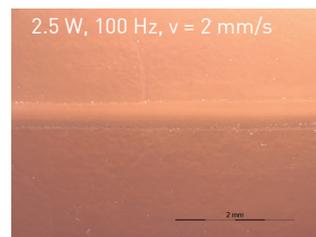
Cold Ablation



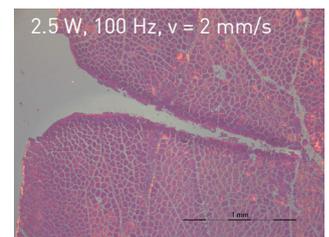
Chicken breast, Treatment without waterspray



Histology, Chicken breast, Treatment without waterspray

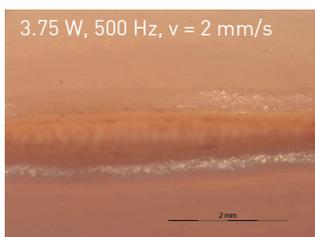


Chicken breast, Treatment without waterspray

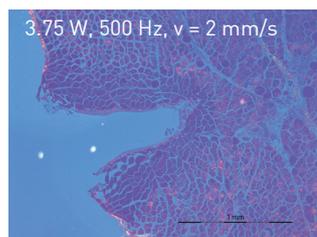


Histology, Chicken breast, Treatment without waterspray

Coagulation



Chicken breast, Treatment without waterspray



Histology, Chicken breast, Treatment without waterspray

RESULTS

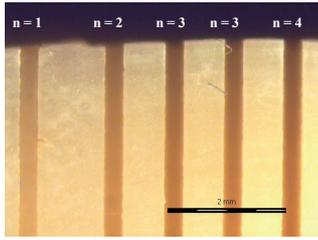
- . Constant speed and power, but higher repetition rate at lower pulse energy leads to lower depth of cut and more thermal impact
- . Cuts with very high quality
- . Thermal impact (cold / hot ablation) and depth of cuts (10 µm to 6 mm) is controllable by laser parameters and cutting speed

Hard Tissue

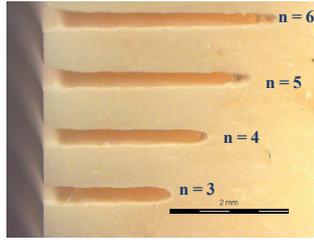
Efficient bone cutting: Results for \varnothing 330 μ m, increasing number of cycles (n)

DPM-30 High Brightness Laser Module

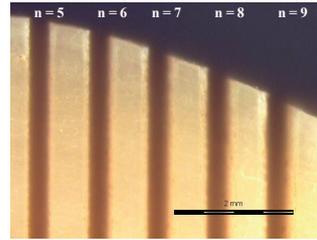
14.5 W, 72.5 mJ, 200 Hz, v=10mm/s



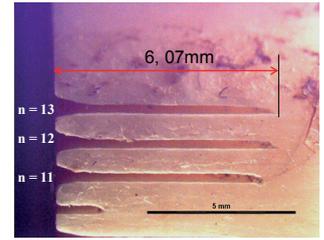
Bone, Treatment with waterspray



Bone, Treatment with waterspray



Bone, Treatment with waterspray



Bone, Treatment with waterspray

RESULTS

- . Good ablation quality (smooth groove walls, sharp edges, no carbonization)
- . High cutting depth: > 6mm
- . High ablation / drilling speed: e.g. 34.4 mm/s
- . High ablation efficiency: e.g. 0.141 mm³/J



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Optical parameters	DPM-15 (HE)	DPM-30 (HE)
Technology	Monolithic DPSSL	
Wavelength	2940 nm	
Average Output Power (max)	15 W	25 W
Pulse Energy (max)	75 mJ (HE: 150 mJ)	150 mJ (HE: 300 mJ)
Pulse Repetition Rate	up to 2 kHz	
Pulse Duration	1 to 250 μ s (HE: 1 to 400 μ s)	1 to 300 μ s (HE: 1 to 400 μ s)
Duty Cycle (max)	10 %	
Mode of Operation	Pulsed	
Ideal Fiber Diameter	\leq 200 μ m	
Beam Quality	$M^2 < 15$	$M^2 < 15$
Efficiency (optical-optical)	~ 10 %	
Divergence (half angle) (mrad)	< 20 mrad	< 16 mrad
Beam Diameter	1.6 mm	
Beam Shape (focus)	top hat like	



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