LITHIUM LASERS

Femtoflash, the New Femtosecond GHz-burst Laser for Industrial Micromachining

Alessandro Greborio
CEO

9 January 2024. 16:00 - 17:00 CET

EPIC Members New Product Release

EPIC
EUROPEAN PHOTONICS INDUSTRY CONSORTIUM

Company

Lithium Lasers is an innovative startup focused on the development and the usage of innovative ultra short pulse laser (USPL) technologies

- Founded in 2019
- Spinoff of Politecnico di Milano
- Operational headquarter with laboratories in Polo Meccatronica, Rovereto (TN)

TRENTINOSVILUPPO
IMPRESA INNOVAZIONE MARKETING TERRITORIALE

Products & Support

LITHIUM LASERS

Lithium Six

Scientific USP laser

High power femtosecond laser

80 MHz
150 fs
1050 and 525 nm
up to 7 W

FEMTOFLASH

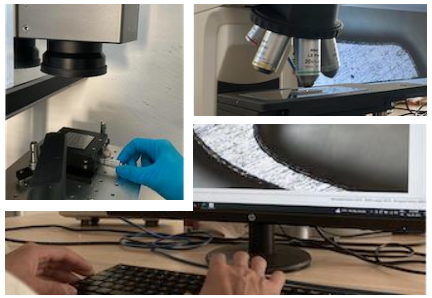
Micromachining USP laser

Femtosecond GHz burst laser

800 MHz
400 fs
1030 and 515 nm
up to 50 W
flexible burst mode

Application Support

Micro-processing Workshop



Your trusted partner in micromachining

Thanks to our expertise in laser technology we offer:

- feasibility studies
- proof-of-concept experiments

Background - Precision meets speed in the GHz era

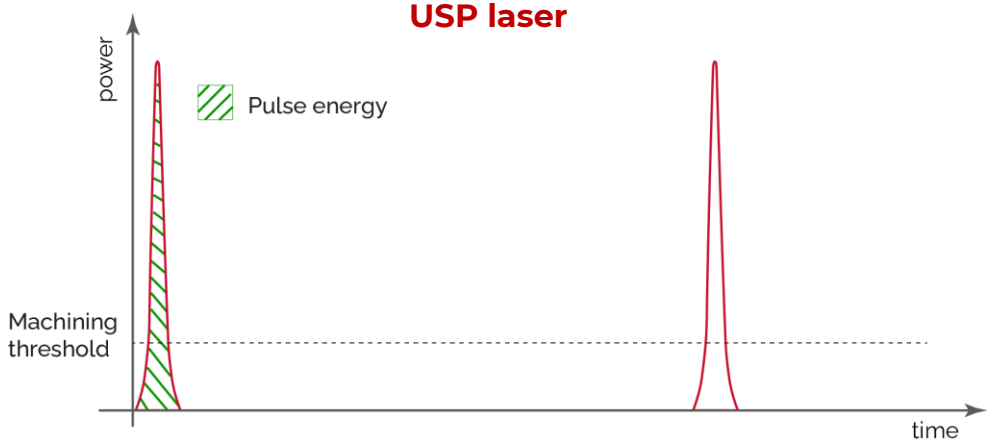
Traditional single pulse USP lasers: individual high-energy pulses at repetition rates up to 10 MHz.

- **Tradeoff speed and precision:** slow machining speed to avoid that surplus energy causes detrimental effects compromising machining quality.

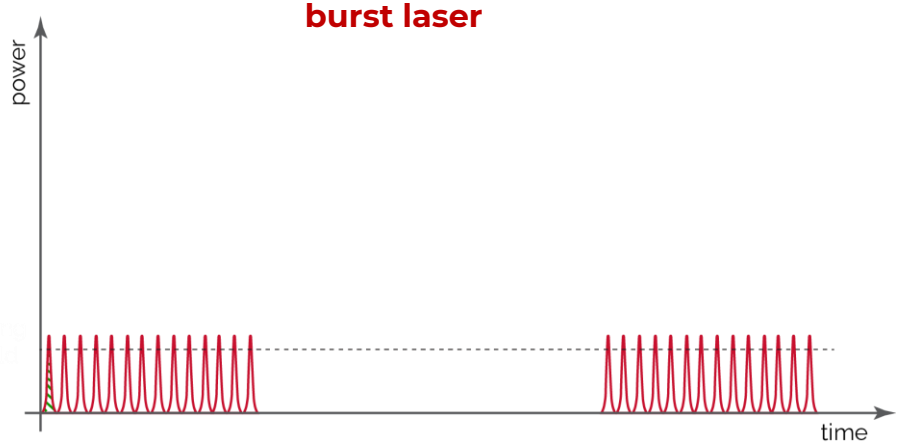
Femtosecond GHz burst laser: bursts of high-frequency pulses.

- **Higher machining speed:** the energy is distributed over many pulses that are clustered in bursts and the pulse frequency is increased a thousandfold (GHz level)
- **Higher machining quality:** strategic energy management with energy of each pulse within the burst just above the machining threshold (few µJ)

Traditional single pulse USP laser



Femtosecond GHz burst laser



FEMTOFLASH

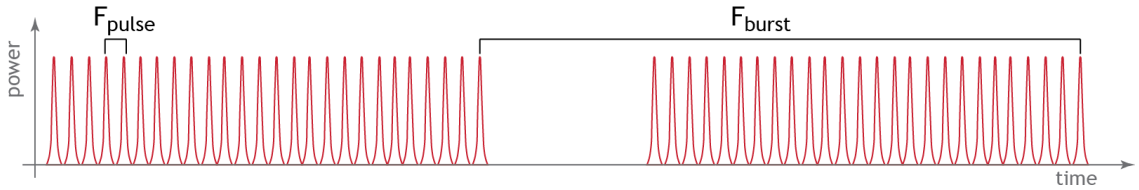
LITHIUM LASERS

KEY FEATURES AND BENEFITS:

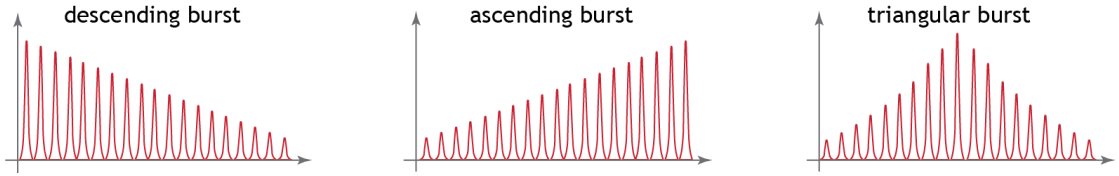
- Bursts of high frequency femtosecond pulses
- New highly efficient machining regime
- Flexible n. of pulses in the bursts (from 25 up to more than 1000)
- Tailorable energy distribution onto the workpiece
- Compact and lightweight industrial design

SPECIFICATIONS:

Center wavelength	1032 nm
Pulse duration	< 400 fs
Average power	Up to 50 W
RMS power noise	0.12 %
Inter-burst frequency (F_{burst})	Up to 10 MHz
Intra-burst frequency (F_{pulse})	0.8 GHz
Beam quality	M2 < 1.2
Beam ellipticity	1.01
Warm-up time	< 10 min
Operational temperature	15 - 35 °C
Tot power consumption	450 W
Laser dimensions	420 X 294 X 159 mm
Laser weight	16 kg



Flexible burst shapes:



Proprietary rugged industrial design

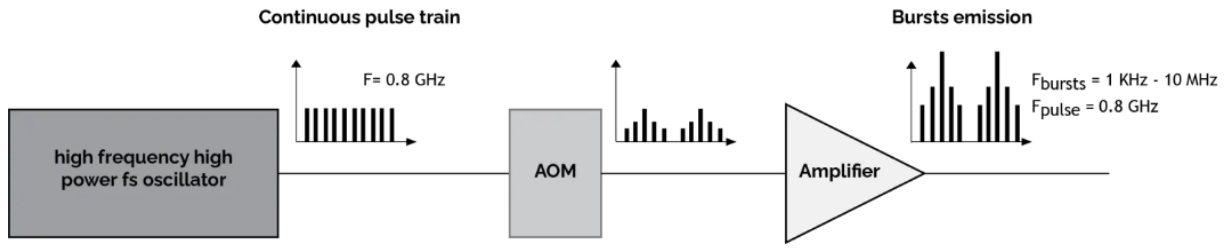
LITHIUM LASERS

NO CPA - ONLY 3 MODULES DESIGN

Traditional USP lasers for material processing that have a complex structure of at least 7 modules based on Chirped Pulse Amplification (CPA) and multistage amplifiers.

FEMTOFLASH boasts a sleek industrial design consisting of just 3 modul**es**:

1. high power soliton mode-locked seed oscillator
2. acousto-optic modulator (AOM)
3. only one high-gain single-stage amplifier



EASY TO HANDLE AND INSTALL

- one single enclosure with control electronics integrated
- weight of only 16 Kg
- dimension of 20 X 294 X 159 mm,
- power consumption of less than 500 W

Single pulse USP laser vs FEMTOFLASH

Material processed: stainless still

Processing: 10 passes milling at 0.1 m/s with a beam spot diameter of 10 µm

Lasers:

- commercially available USP laser: 50 W, 1064 nm, 10 ps, single pulse mode
- FEMTOFLASH: 20 W, 1030 nm, 400 fs, burst mode

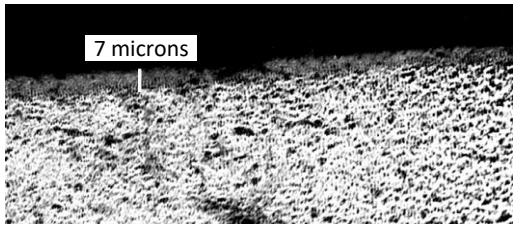
Laser parameters: same average power and rep. rate to compare ablation efficiency

Ablated depth:

- single pulse USP laser: **~ 7 µm**
- FEMTOFLASH: **~ 40 µm**

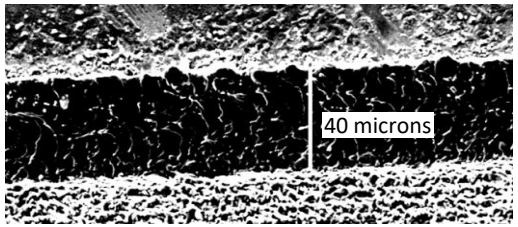
Single Pulse USP laser

E_{pulse} **= 100 µJ**
Average Power: 2 W
Rep. Rate: 20 KHz



FEMTOFLASH

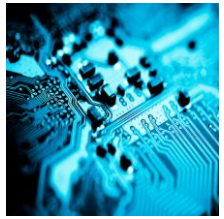
E_{burst} **= 100 µJ**
Average Power: 2 W
Rep. Rate: 20 KHz



	Single Pulse USP laser	FEMTOFLASH	Improvement factor
Ablation efficiency (mm3/Watt/min)	0,15	0,84	**x 6**
Laser footprint (m3)	0,05	0,02	**x 2,5**
Laser weight (Kg)	131	31	**x 4**
Energy consumption (Watt)	2400	460	**x 5**

Applications – industrial manufacturing

ELECTRONICS



PROCESSES:
- cutting
- drilling
- milling
- soldering

MATERIALS:
- semiconductors
- ceramics
- metals

FOR:
- PCB
- wafer dicing
- wire bonding

MEDICAL

PROCESSES:
- cutting
- drilling
- milling

MATERIALS:
- polymers
- nitinol
- glass

FOR:
- medical devices
- microfluidics
- pharmaceutics

AERONAUTICS

PROCESSES:
- cutting
- drilling
- milling
- cleaning

MATERIALS:
- metals
- composites

FOR:
- drones
- airplanes

SPACE

PROCESSES:
- cutting
- drilling
- milling
- marking

MATERIALS:
- composites
- metals

FOR:
- satellites
- spacecraft
- space launch systems

LUXURY

PROCESSES:
- cutting
- drilling
- milling
- marking

MATERIALS:
- metals

FOR:
- watches
- jewellery
- glasses

AUTOMOTIVE

PROCESSES:
- cutting
- milling
- marking
- surface structuring

MATERIALS:
- metals
- alloys

FOR:
- pistons and engines
- lighting
- design

Case Study: sub-micron hole drilling on polyimide

LITHIUM LASERS

SMOOLER PROJECT

Sub-micron holes drilling by flexible burst mode fs laser for nanoparticle analysis

Pulsate

LITHIUM LASERS

KIRANA a beam of light for micromachining

elements enabling technologies for Life Science

Manufacturing of sub-micron hole on polyimide sheet for the production of flow cells used for nanoparticle analysis

PRODUCT:

Flow cell is a disposable containing a sub-micron hole used in the field of nanoparticle analysis. Applications: viral and bacterial detection, food and water analysis and air pollution analysis.

CHALLANGES:

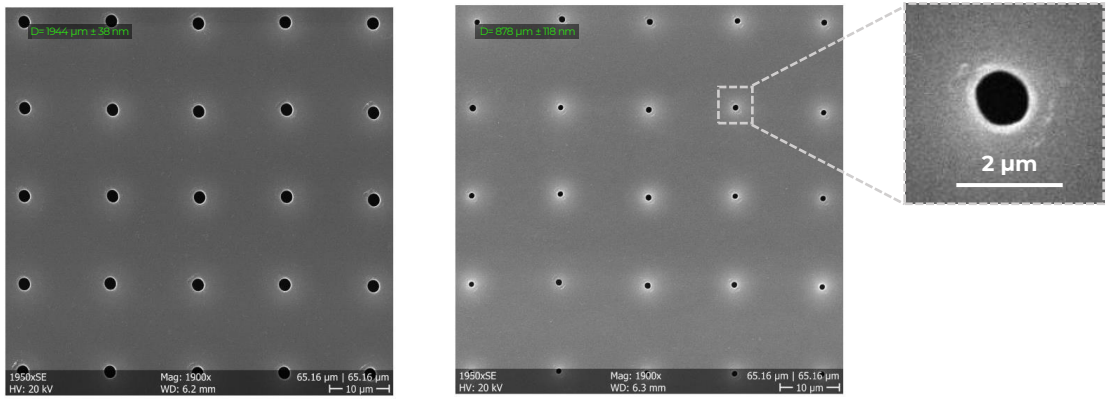
- To high hole-hole diameter variability
- Frequent absence of drilling
- None control on hole geometry
- It cannot sustain large scale production

RESULTS:

- **Minimal HAZ**
- Hole diameter decreased up to **less than 1 µm**
- **Perfectly rounded holes**
- **High reproducibility process:**

Mean diameter ± SD = 933 ± 82 nm
(4 films obtained from different batches with 25 holes each for a total of 100 holes)

Type of laser used: FEMTOFLASH Green (515 nm)



Thank you


agreborio@lithiumlasers.com


/alessandro-greborio-0679a06a/


+39 391 368 6271