Dr. Lukas Krainer
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CEO

Real-world applications of intense light matter interaction beyond the scope of classical micromachining.

Management & Company

Company

- Based in Zürich, Switzerland
- Operational 2006, initial product release Photonic West 2007
- Class ~10‘000 cleanroom facility
- Dec. 2008: Acquisition of Advanced Laser Diode Systems A.L.S. GmbH, Germany
- Operating a world wide distribution and sales representative network

Founders & owners

Dr. Gabriel Spühler, CTO
- PhD & Postdoc at ETH Zürich in high-power lasers
- GigaTera Inc.

Dr. Lukas Krainer, CEO
- PhD & Postdoc at ETH Zürich in high repetition rate lasers
- GigaTera Inc.
- EU FP6 / FP7 evaluation & reviewing

Light Matter Interaction

Intense light matter interaction

=

Interaction between a short optical pulse and any kind of material

- Destructive
- Non destructive

Product Portfolio

Femtosecond lasers — ORIGAMI

UV, visible, IR

Pulse durations 100 fs – 1 ps

Power up to 5 W, 5 μJ pulse energy

Pulse repetition rate: Pulse on demand – 1.25 GHz

Picosecond lasers — GENKI / KATANA

UV, visible, IR

Pulse durations 1 ps – 1 ns

Power up to 15 W, 20 μJ pulse energy

Pulse repetition rate: Pulse on demand – 200 MHz

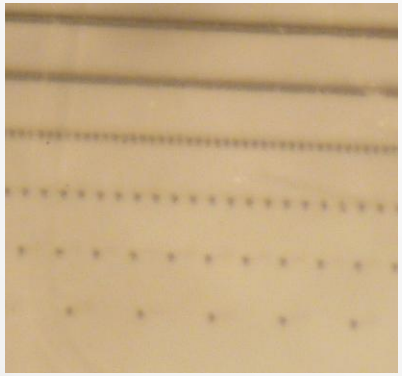
- as easy to use as a laser pointer
- 24/7 operation
- plug & play – life long
- full remote control
- compact, air cooled, light weight
- low power consumption

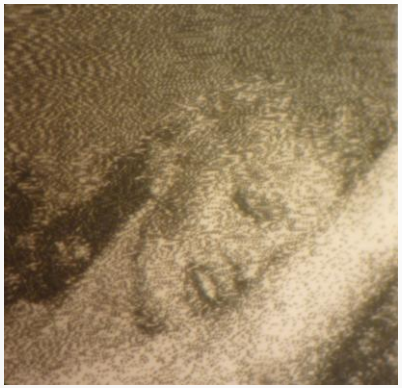
Target Markets

- Micromachining
- Seed lasers for high energy laser systems
- Security & defense (THz, optical sampling)
- Life science
- Optical clocks
- Academics

Applications

“Classical” applications in micromachining





Real world applications outside classical micromachining

Among zillion others...

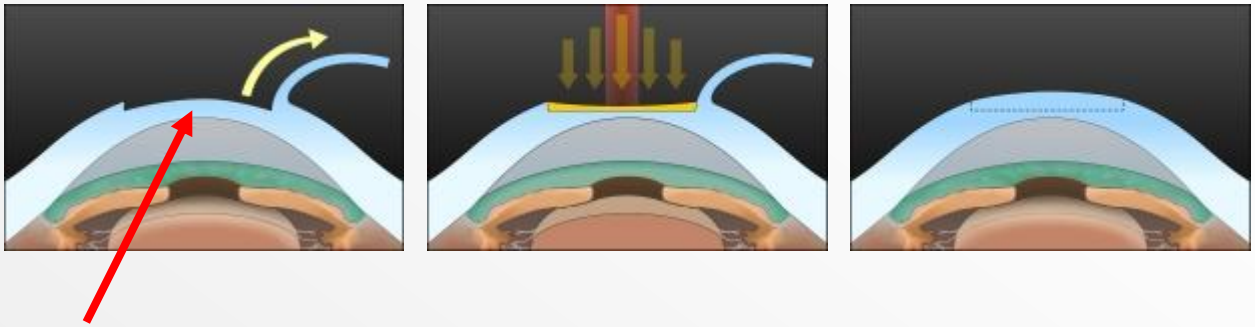
- Vision correction
- THz science
- 3D lithography
- 2-photon microscopy

Statement: No business relation between Onefive and others can or should be derived from the following presentation.

Vision Correction

Bladeless LASIK: laser-assisted in situ keratomileusis with a femtosecond laser

Excimer laser



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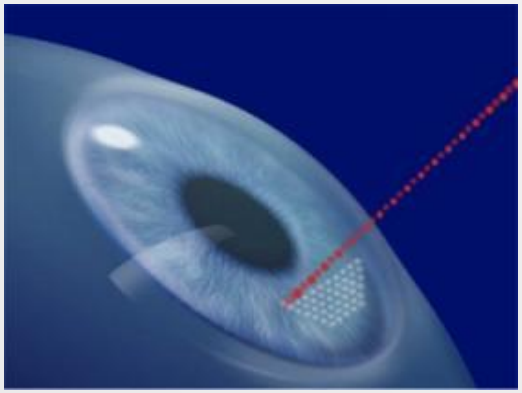
Instead of a sharp knife, a femtosecond laser creats the corneal flap



- Tissue micromachining in transparent media
- High peak intensities in the focal point
- Low peak intensities on the retina

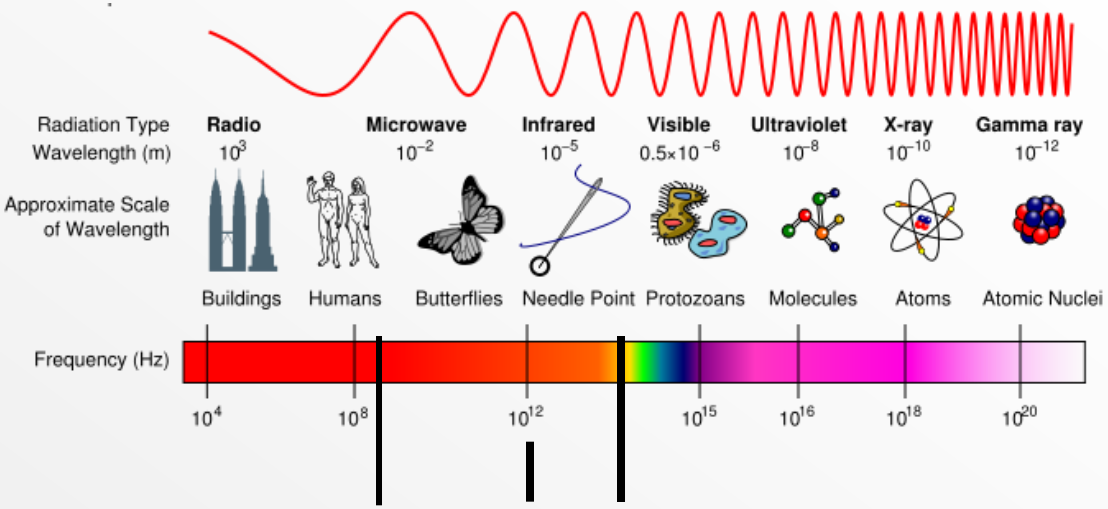
Advantages

- Flap diameter
- Depth
- Hinge location and width
- Side-cut architecture

Vision Correction

- Destructive use of a femtosecond laser
- Wavelength NIR around 1 μm
- μJ pulse energies
- 100 - 1000 kHz repetition rate

THz Science



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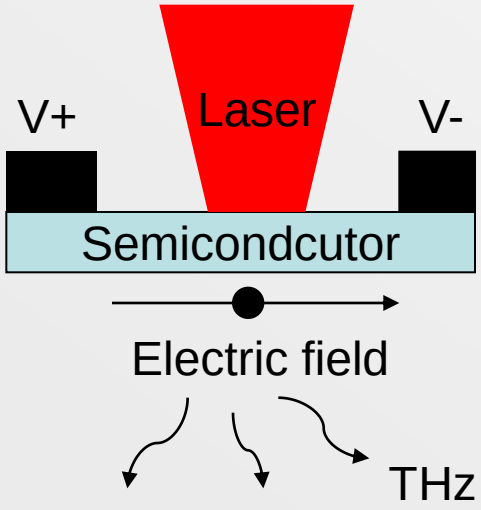
Cell phone **THz** Femtosecond NIR laser

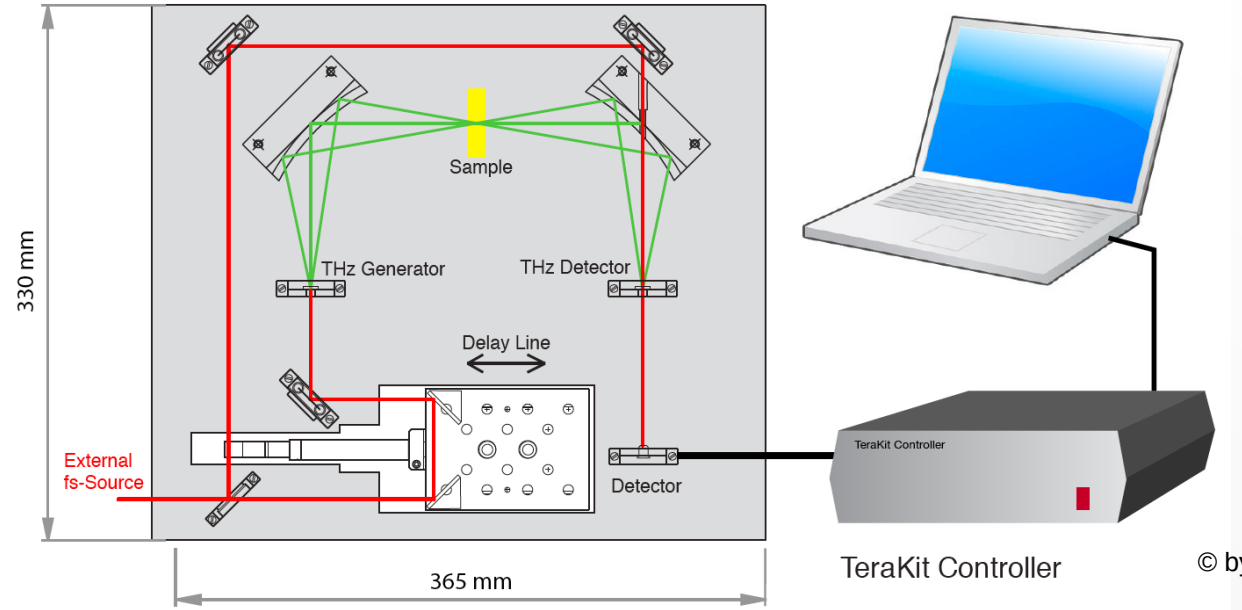
?



1. Excitation of electrons in a semiconductor by an intense light pulse
2. Free electron acceleration by an electric field (voltage)
3. Accelerated electrons emit THz radiation

THz Science

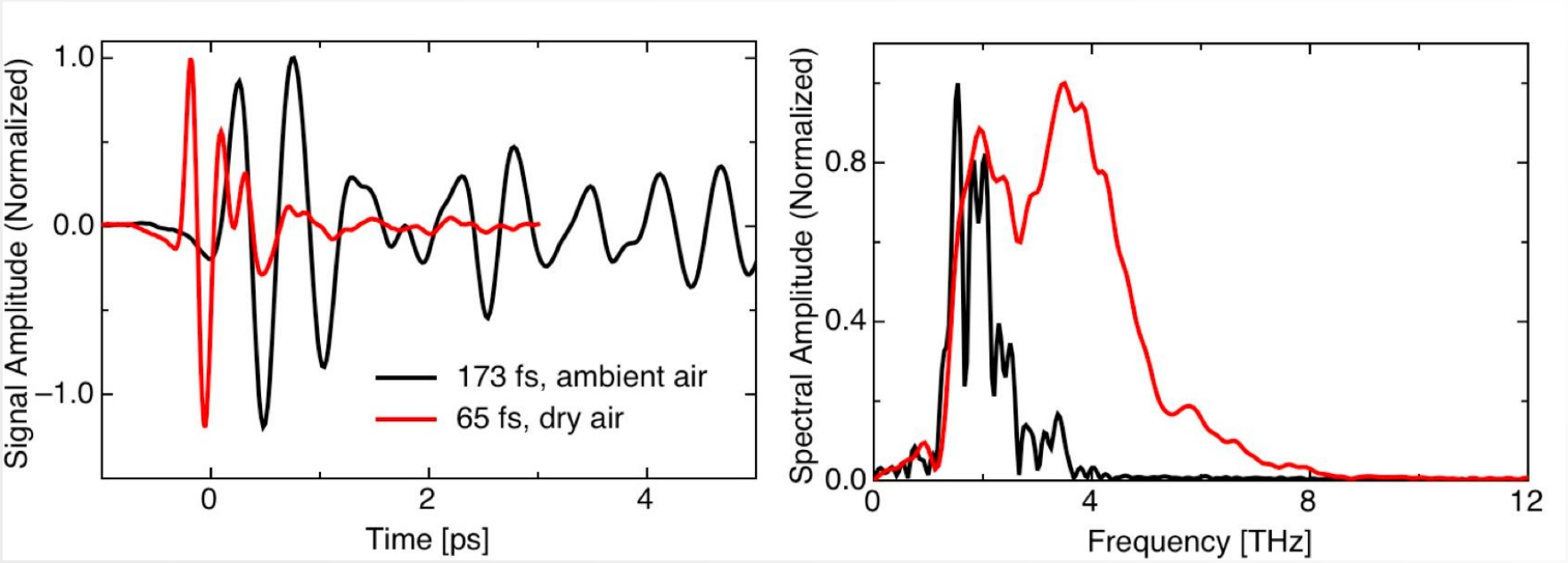
Typical system layout



Commercial system provided by Rainbow Photonics

THz Science

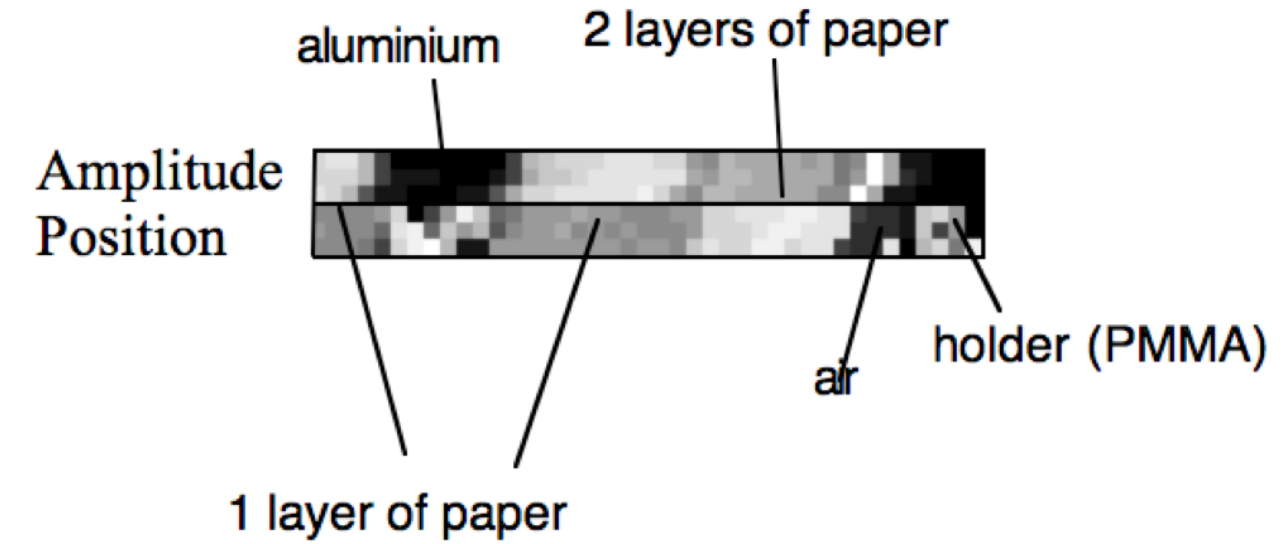
Time domain THz signal



(a) (b)

THz Science

Spectroscopic image

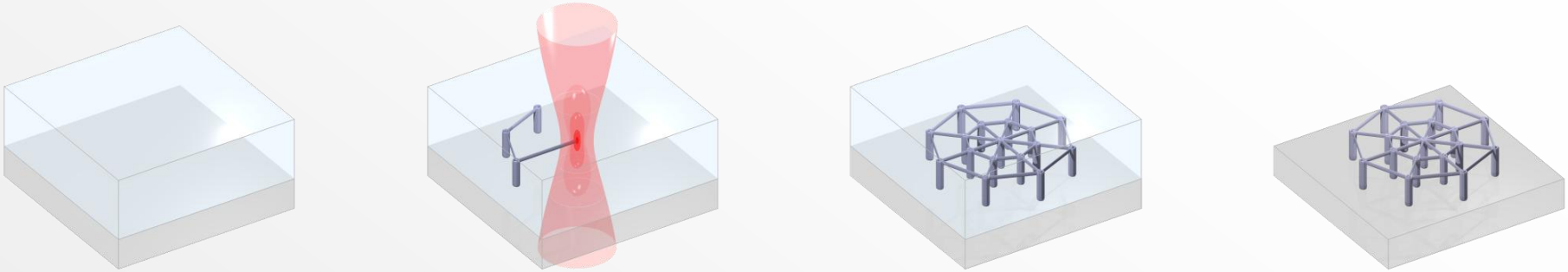


THz Science

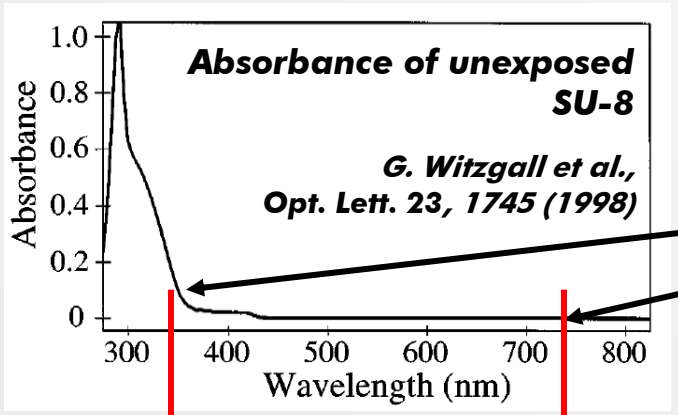
- Non - destructive use of a femtosecond laser
- Wavelength 780 nm up to 1.5 μm
- nJ pulse energies
- 100 MHz repetition rate

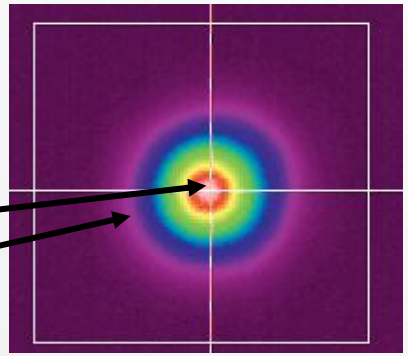
3D Lithography

Principle: Material absorbs light and and becomes solid (polymerization)



Trick: **Using two photon absorption to increase resolution and accuracy in specially engineered materials**



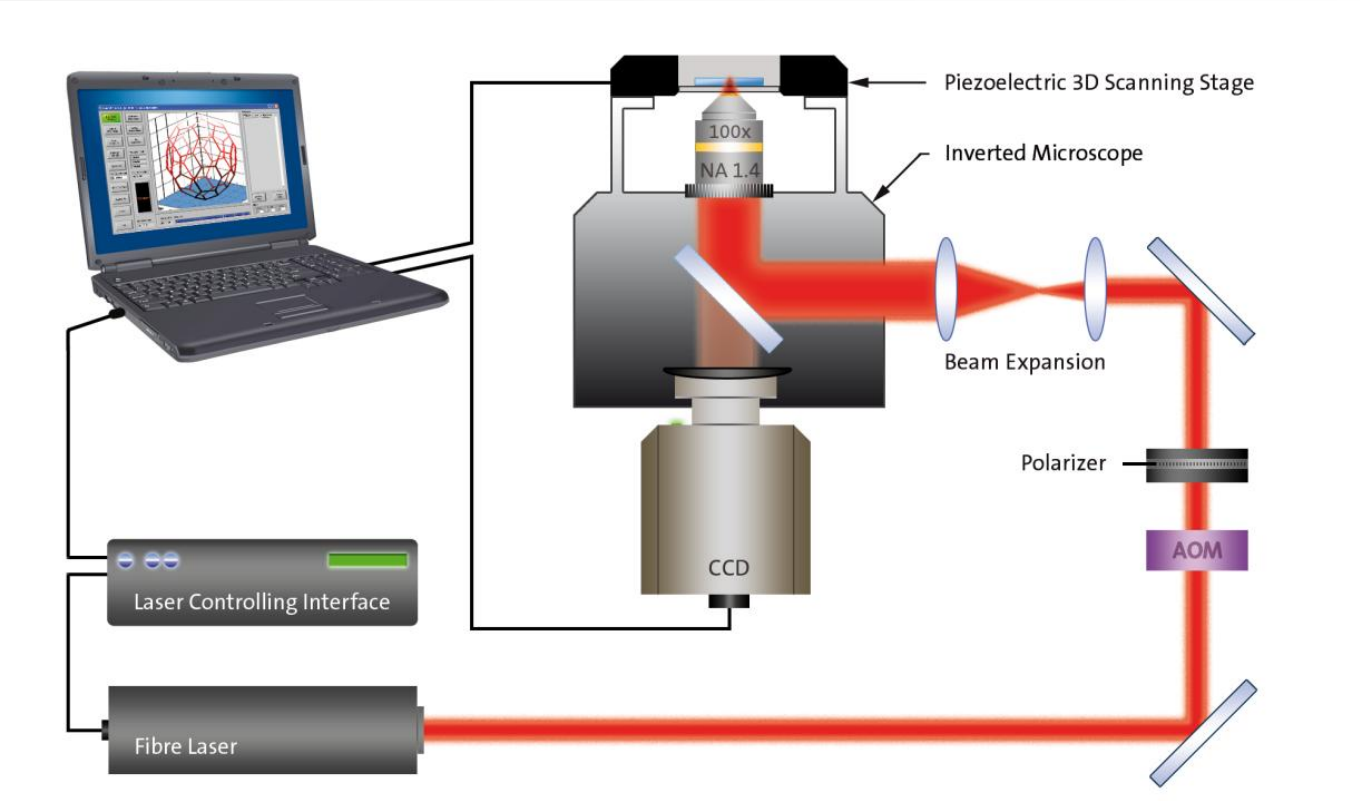


Laser wavelength = photon energy

2 x photon energy

3D Lithography

Typical system layout



Commercial system provided by

nanoscribe

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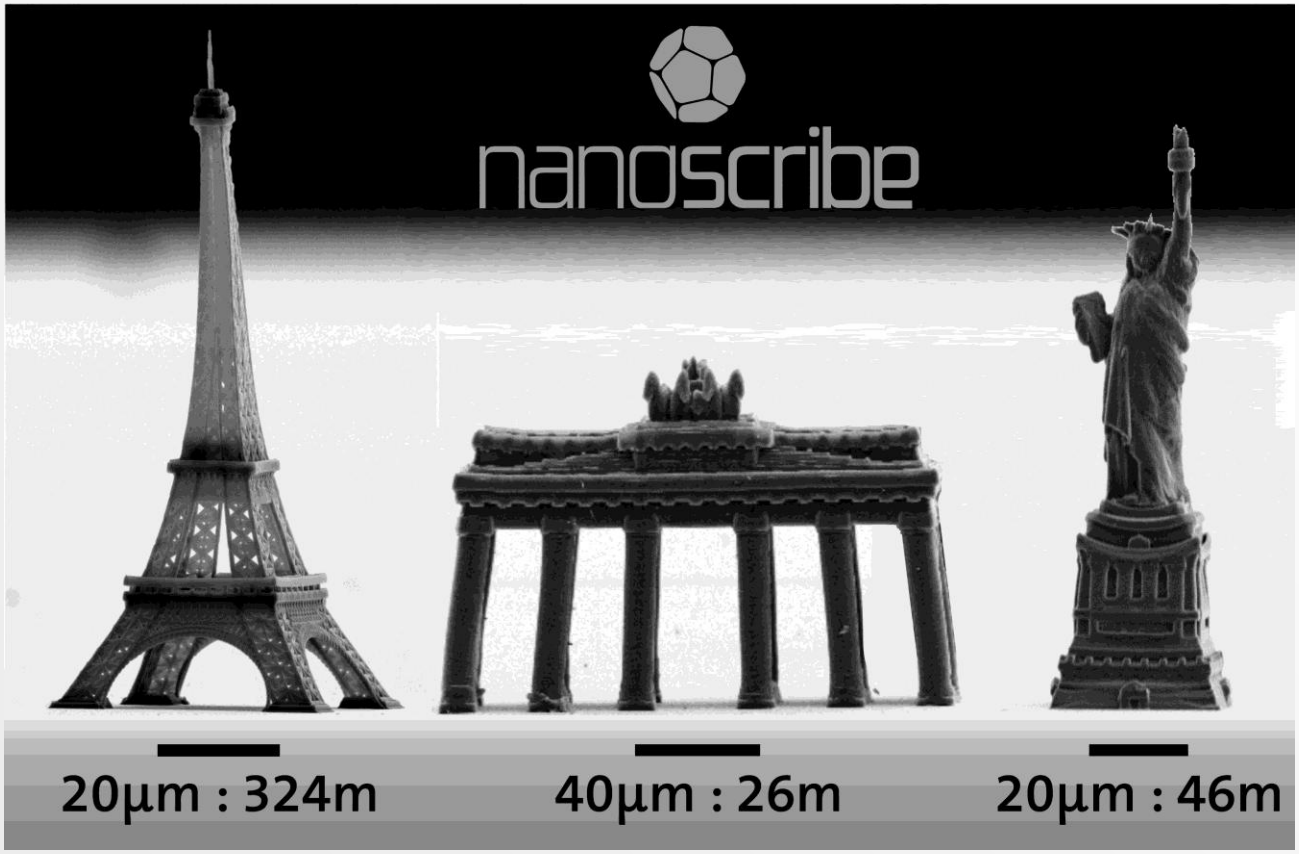
3D Lithography



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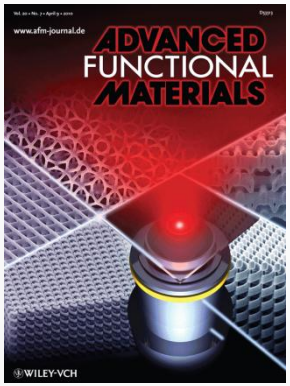
3D Lithography

- Life sciences / biotechnology
  - Stemm cell differentiation
  - Cell growth studies
  - Tissue engineering
  - Gecko- / Lotus-effect



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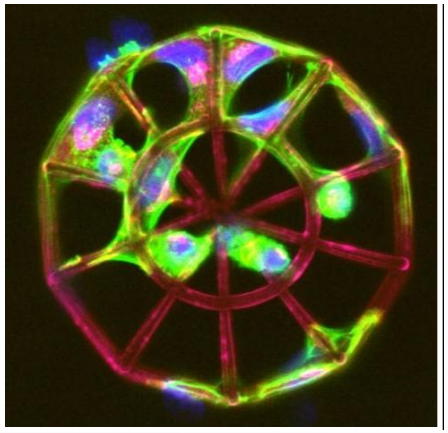
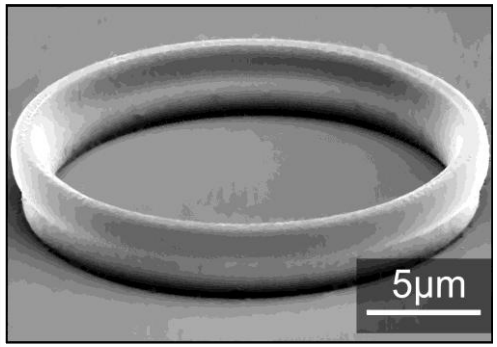
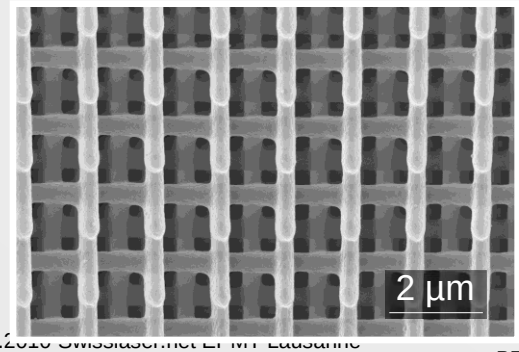
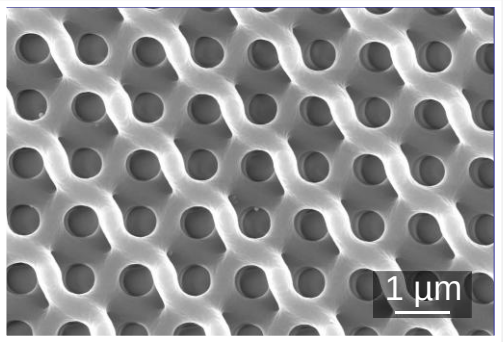
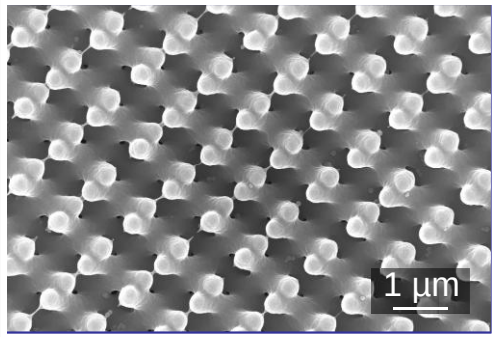


- Photonics
  - Micro optical devices
  - Photonic crystals
  - DFB Lasers including integrated optics









3D Lithography

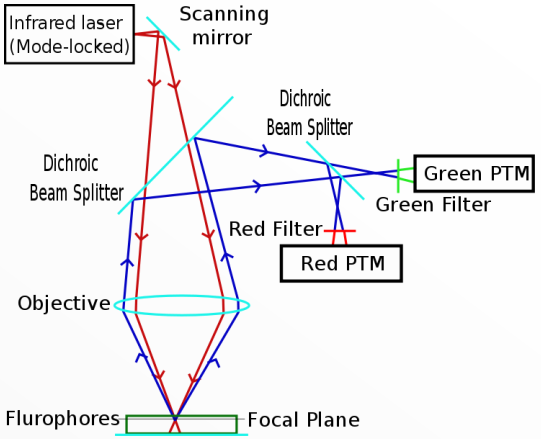
- Destructive use of a femtosecond laser
- Wavelength 532 nm - 780 nm
- nJ pulse energies
- 100 MHz repetition rate

2-Photon Microscopy

Fluorescence molecule is excited by 2 photons

Same principle than lithography, BUT
light emission instead of material change

- High localization (no out of focus photons)
- Simple detection (red/blue separation)
- Suitable for thick samples (less scattering)



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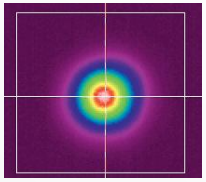
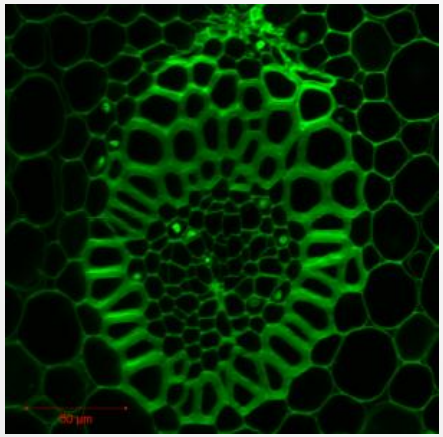
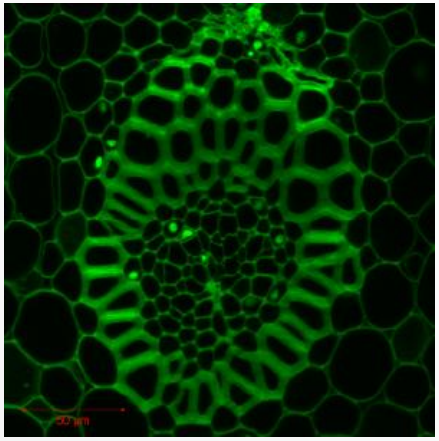


2-Photon Microscopy

Convallaria (lily-of-the-valley)



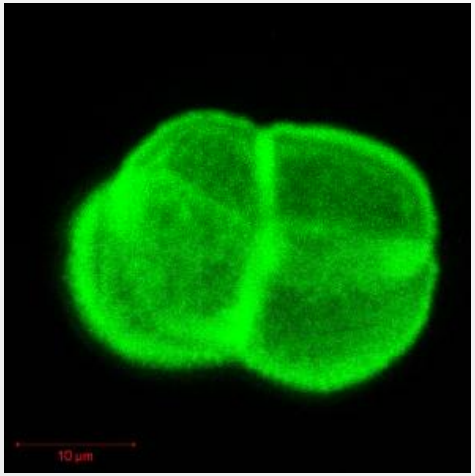
Ti-sapphire laser



Origami-10 laser

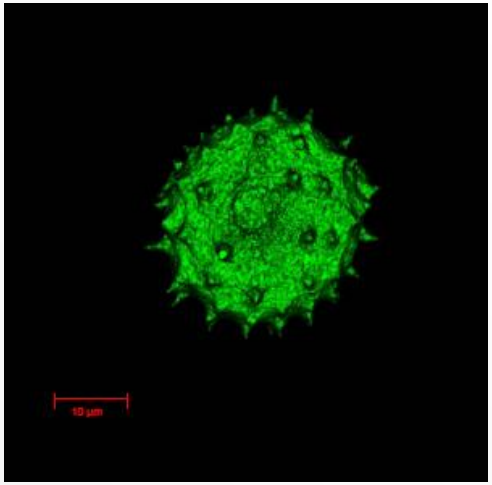
2-Photon Microscopy

Pollen



Origami-10 laser

3D reconstruction



Origami-10 laser

2-Photon Microscopy

- Non - destructive use of a femtosecond laser
- Wavelength visible up to 1 μm (ideally tunable)
- nJ pulse energies
- 100 MHz repetition rate

Take Home Message

Real world applications outside classical micromachining

- Vision Correction
  - Destructive
  - μJ pulse energies, kHz rep rates
- THz Science
  - Non destructive
  - μJ pulse energies, MHz rep rates
- 3D Lithography
  - Destructive
  - nJ pulse energies, MHz rep rates
- 2-Photon Microscopy
  - Non destructive
  - nJ pulse energies, MHz rep rates

Take Home Message

Ultrafast lasers are

- Disruptive tool
- Enabling technology
- Becoming pervasive devices
- Application space is vast and highly fragmented

Ultrafast lasers are NOT

- Simple
- Cheap
- Reliable (compared to consumer electronics)
- Compatible

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