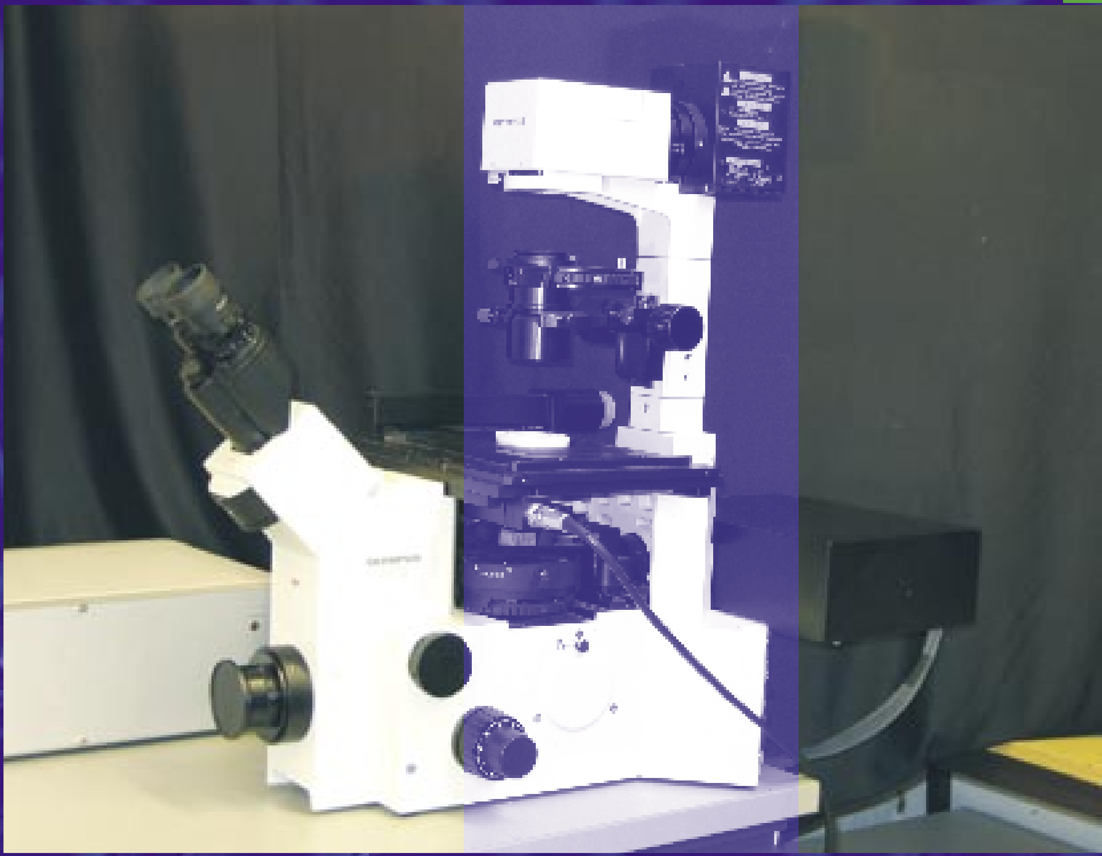
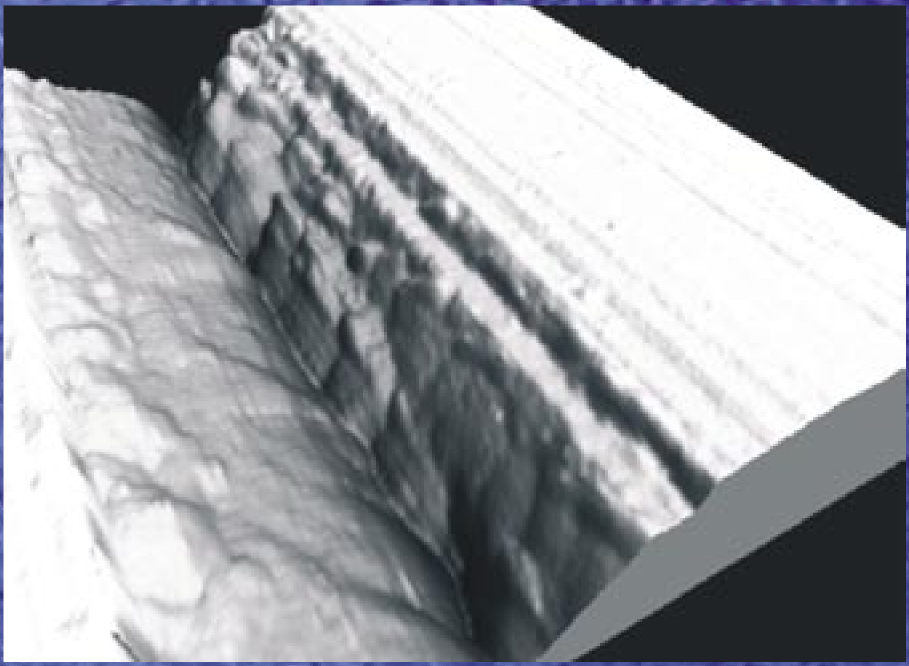
femt-O-cut®

Nanoprocessing with femtosecond near infrared laser pulses



Ultraprecise cutting and hole-drilling combined with high-resolution non-invasive 3D imaging:

- Targeted transfection for optical gene transfer
- Intra-cellular chromosome dissection
- Separation of single cells from histological sections
- Optical knocking-out of cellular components
- Nanoprocessing and optical waveguide writing
- Optical data storage

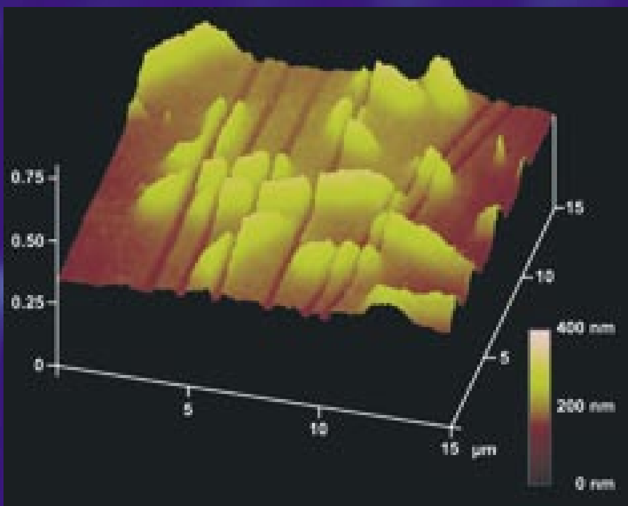


femt-O-cut®

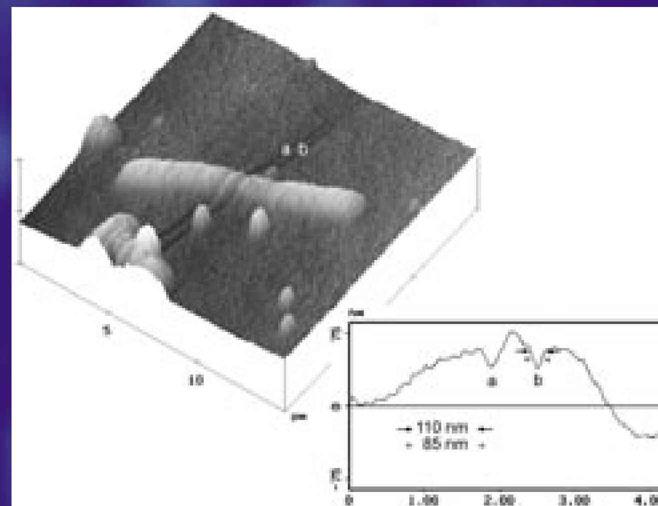
A system for 3D nanoprocessing in transparent materials and living cells

Product description

The system femt-O-cut® uses compact femtosecond NIR lasers for 3-dimensional nanoprocessing in transparent materials. Low energy (sub-nanojoule to nanojoule) pulses at high repetition rates of up to 90 MHz are focused by high numerical aperture (NA 1.3) optics for optical breakdown in sub-femtoliter volumes. The beam intensity is regulated by a motorized attenuator. Several TW/cm² can be reached in the focal region to enable ultraprecise ablation with a minimum cut size below 70 nm (FWHM) by multiphoton ionization.
The device is based on a conventional microscope which is equipped with a high-speed galvoscanning unit. Full-frame scans, region-of-interest (ROI) scans, line scans as well as single point ablation (spot scan, drilling) can be performed with submicron accuracy. A motorized stage is used for large area processing. For vertical positioning the focusing optics are mounted on a piezo-driven stage with an accuracy of 40 nm.
femt-O-cut® also represents a diagnostic tool for non-invasive tomography. This allows for the observation of the samples by high-resolution imaging to select the target area as well as to monitor the result of the ablation procedure.

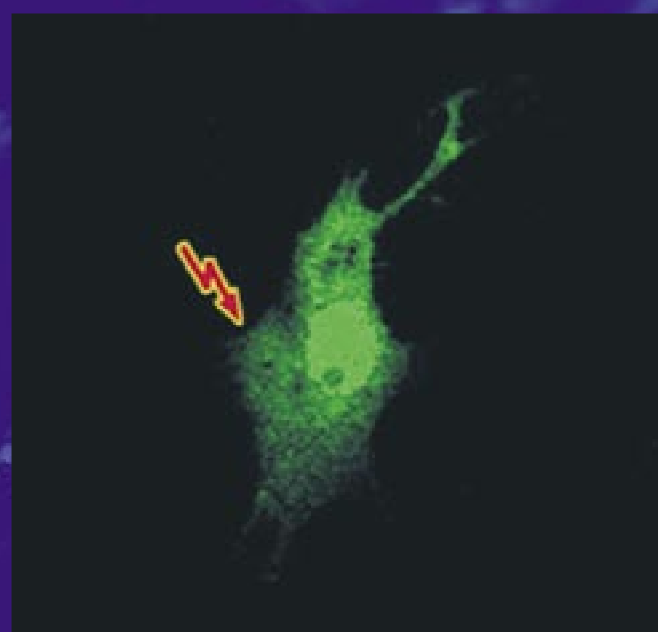


Chromosome dissection with femtosecond laser pulses



Nanoprosessing of the human chromosome 1

Intrachromosomal hole fabrication



Targeted transfection of a CHO cell. GFP plasmid was introduced through a transient sub-micron hole in the cellular membrane

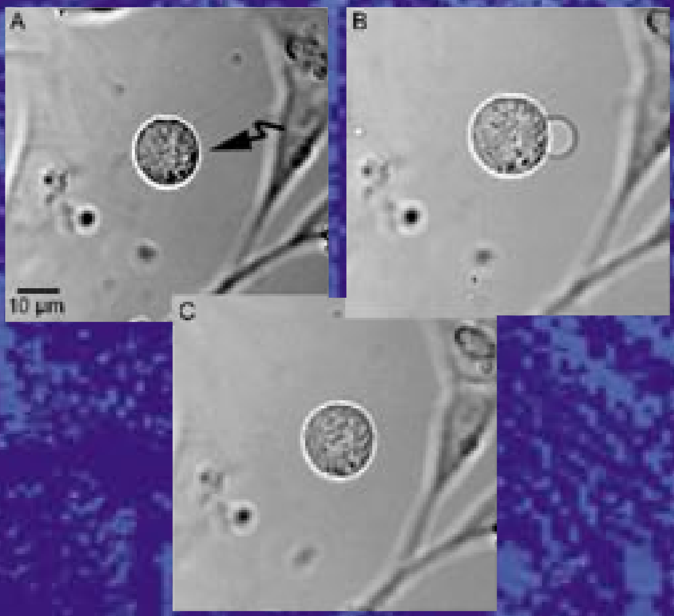
Applications

Ultrashort pulsed lasers have been demonstrated to be a powerful tool for nanostructuring in semiconductors, metals, dielectrics, polymers, and tissues. Because of the strong linear absorption in most materials, UV-laser based systems provide only surface patterning. In contrast, femt-O-cut® offers real three-dimensional processing even in depths of more than 100 µm with submicron cut width. By multiphoton ionisation in the focal region, cut sizes below the diffraction limit can be achieved. The system can be used for direct writing of nanoscale structures in NIR-transparent materials and opens a wide field of industrial and medical as well as scientific applications.

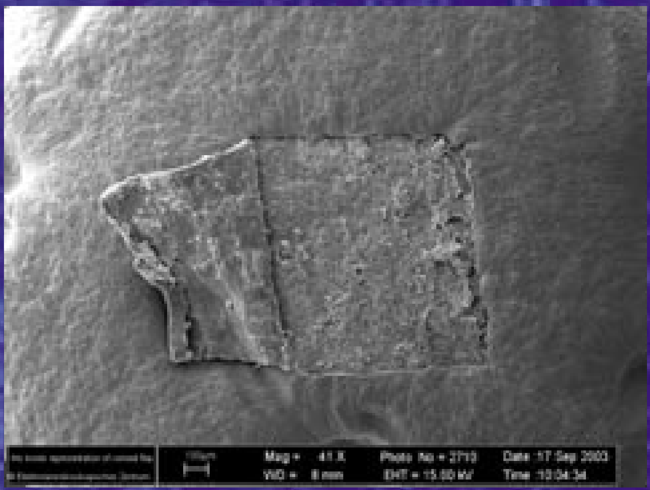
Nanoscale structuring by femtosecond laser pulses is used for waveguide writing, photomask fabrication and to improve the surface quality of certain components. Further, drilling of microscopic holes into a variety of materials is possible.

The interaction of ultrashort pulsed lasers with biological materials has been found to be strongly limited to the focal volume minimising the harm to nearby tissue regions. It is therefore possible to disconnect mutant tissue from living cells. The high resolution of femt-O-cut® enables knocking-out of single organelles without any visible deleterious effect.

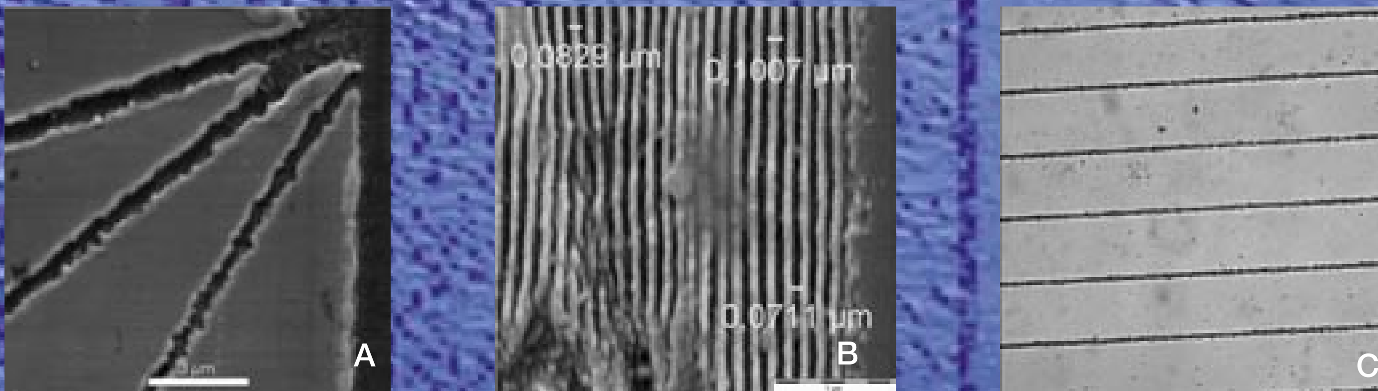
With its extremely localised working area femt-O-cut® has the potential to be a powerful tool for DNA manipulation. It can be used for optical deactivation of certain genomic regions in chromosomes. Femtosecond laser pulses have been shown to be applicable for sectioning of human chromosomes and for highly localised gene and molecule transfer.



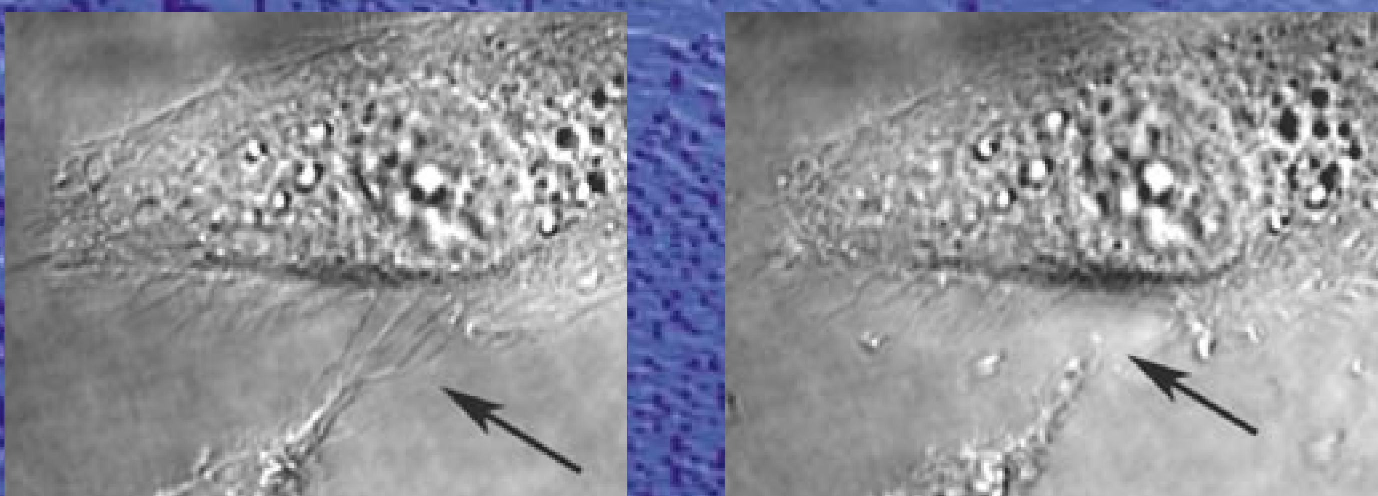
Laser induced transient changes in the cellular membrane



Nanosurgery in ocular tissue: Creation of corneal flap



femt-O-cut® structured materials: A: gold, B: silicon, C: glass



Laser processing of cell-cell connections

References

K. König, I. Riemann, W. Fritzsche, Optics Letters 26(11), 819-821 (2001)

K. König, I. Riemann, O. Krauss, W. Fritzsche, SPIE Vol. 4633, 11-22 (2002)

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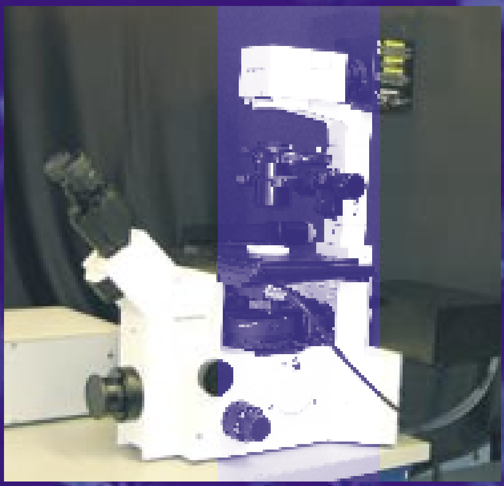

Technical data

- compact femtosecond laser (typical data)

  laser pulse duration: < 100 fs
  repetition frequency: 80 MHz
  mean laser output: 1.5 W
  wavelength: 710 ... 990 nm
- full-frame scanning, region-of-interest (ROI) scanning, line scanning, single-point illumination (spot scan, drilling)
- typical beam scan range: 350 x 350 µm (horizontal), 200 µm (vertical)
- stage range: 120 x 102 mm
- spatial resolution: < 1 µm (horizontal), < 2 µm (vertical)
- focusing optics: magnification 40×, numerical aperture (NA) 1.3
- video adapter for visualization with CCD-camera
- operating temperature: 15 ... 35 °C (59 ... 95 °F)
- relative humidity: 5 ... 95 % (non-condensing)
- power requirements: 230 VAC (50 Hz) or 115 VAC (60 Hz)

System dimensions

• stand:	490 × 280 × 480 mm^3	16 kg
• scan module:	280 × 190 × 90 mm^3	6 kg
• control unit:	450 × 300 × 130 mm^3	8 kg
• laser (typical):	600 × 370 × 180 mm^3	42 kg (laser head)
	450 × 440 × 270 mm^3	41 kg (power supply)
	270 × 200 × 380 mm^3	20 kg (chiller)

Air-conditioning is recommended for laser operation.

Note: These specifications are subject to change without notice.

JenLab

Experts in femtosecond laser technology for biomedical applications

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