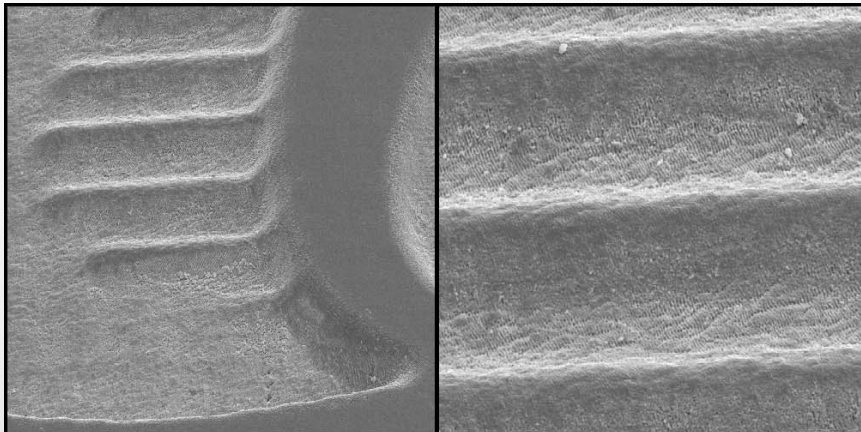


Laser Micromachining

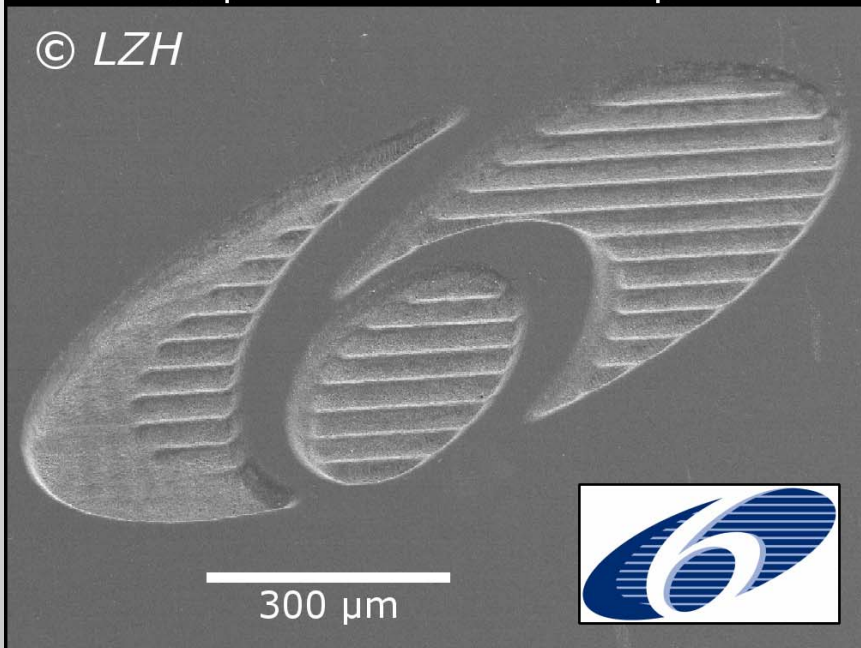
Laser Micromachining



60 µm

25 µm

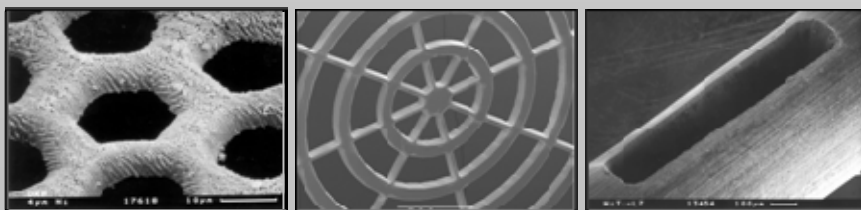
© LZH



300 µm

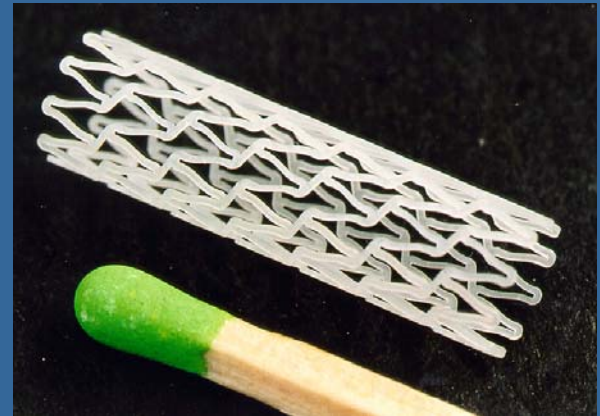


FP6 logo, steel

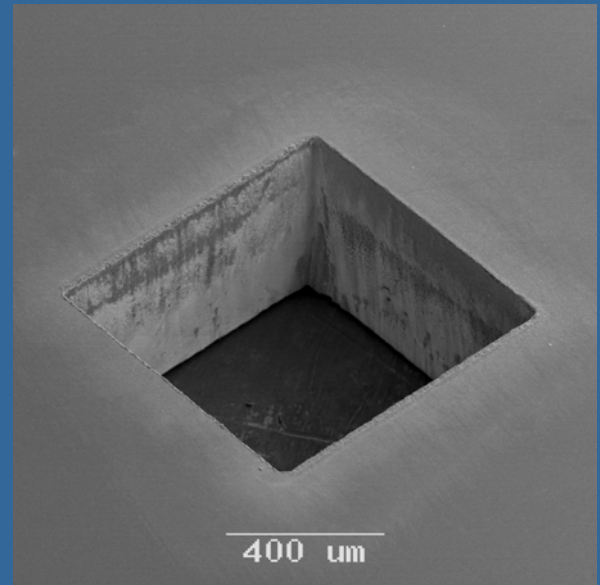


different cutting applications

Laser Micromachining using ultrashort pulsed lasers



PHB stent



400 µm

silicon

LAUNCH-MICRO IP
 Contract n° 011795
 Project financed under the FP6 – NMP

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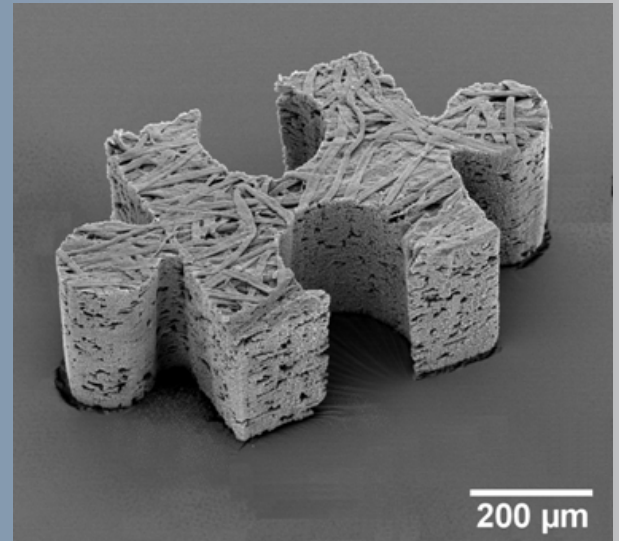
WHAT IS IT? ... FUNCTIONALITY

Laser machining means material removal accomplished by laser material interaction. The processes include laser drilling, laser cutting and laser grooving, marking or scribing. Using ultrashort pulsed lasers, lasers with pulse lengths in the pico- to femtosecond range, enables high-resolution high-quality micro-machining of almost all solid materials .

HOW DOES IT WORK? ... DESCRIPTION

A laser machine consists of the laser, some mirrors or a fiber for beam guidance, a focusing optic and a positioning system. The laser beam is focused onto the workpiece and can be moved relatively to it. The laser machining process is controlled by switching the laser on and off, changing the laser pulse energy and other laser parameters, and by positioning either the workpiece or the laser focus.

Laser machining is localized, non-contact machining and is almost reacting-force free. Photon energy is absorbed by target material in the form of thermal energy or photochemical energy. Material is removed by melting and blow away (long pulsed and continuous-wave lasers), or by direct vaporization/ablation (ultrashort pulsed lasers). Any material that can properly absorb the laser irradiation can be laser machined. The spectrum of laser machinable materials includes hard and brittle materials as well as soft materials. The very high intensities of ultrashort pulsed lasers enable absorption even in transparent materials.



jigsaw puzzle, paper

WHY TO USE IT? ... ADVANTAGES

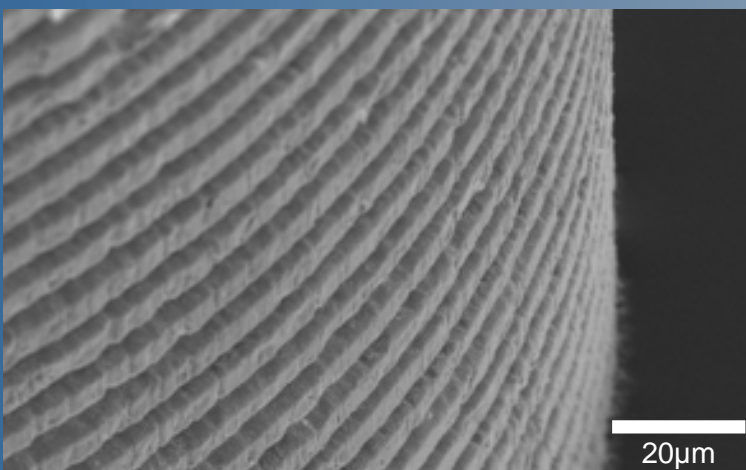
The advantages of laser machining over traditional machining are:

- much wider range of machinable materials
- non-contact machining, almost reacting-force free
- no tool wear
- material removal rate controllable down to the nanometer scale
- smaller heat affected zones
- final quality level machining results achievable in one process

The short laser pulse lengths and high pulse intensities of ultrashort pulsed lasers are the reasons for further advantages:

- machining of nearly all solid and soft materials
- efficient, fast and localized energy deposition
- minimal thermal and mechanical damage of the substrate material
- well-defined ablation thresholds
- structure sizes down to the lower sub-micrometer range
- high-quality machining, burr-free drilling and cutting

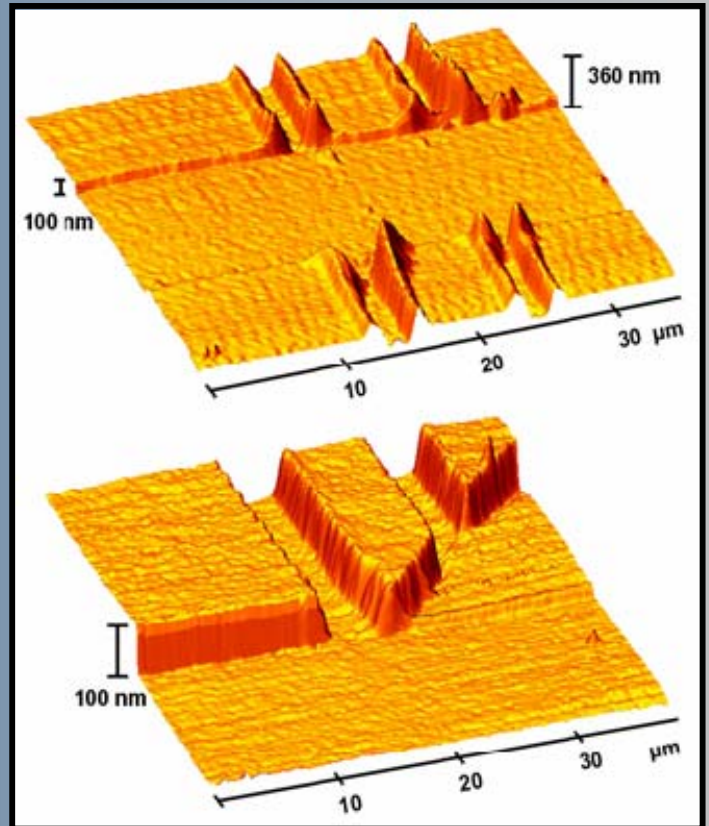
Ultrashort pulsed lasers are excellent and universal tools for direct ablative microstructuring of solid materials.



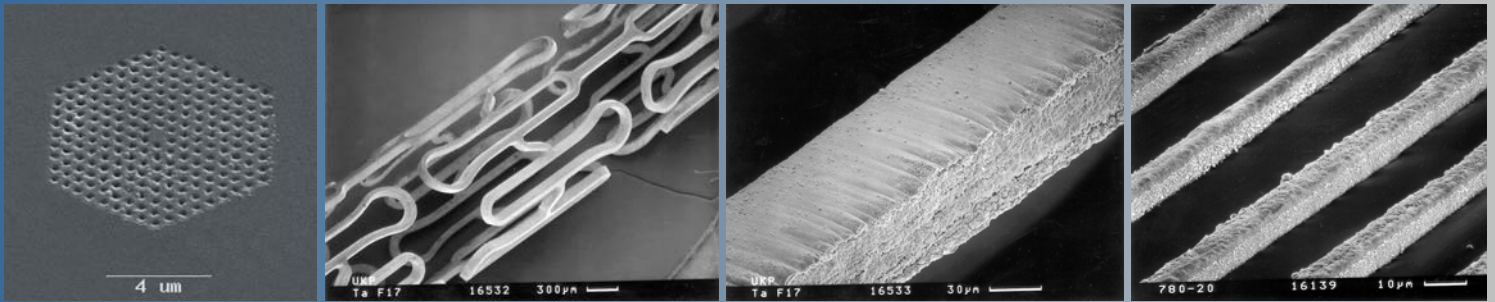
structured platinum tube

APPLICATIONS

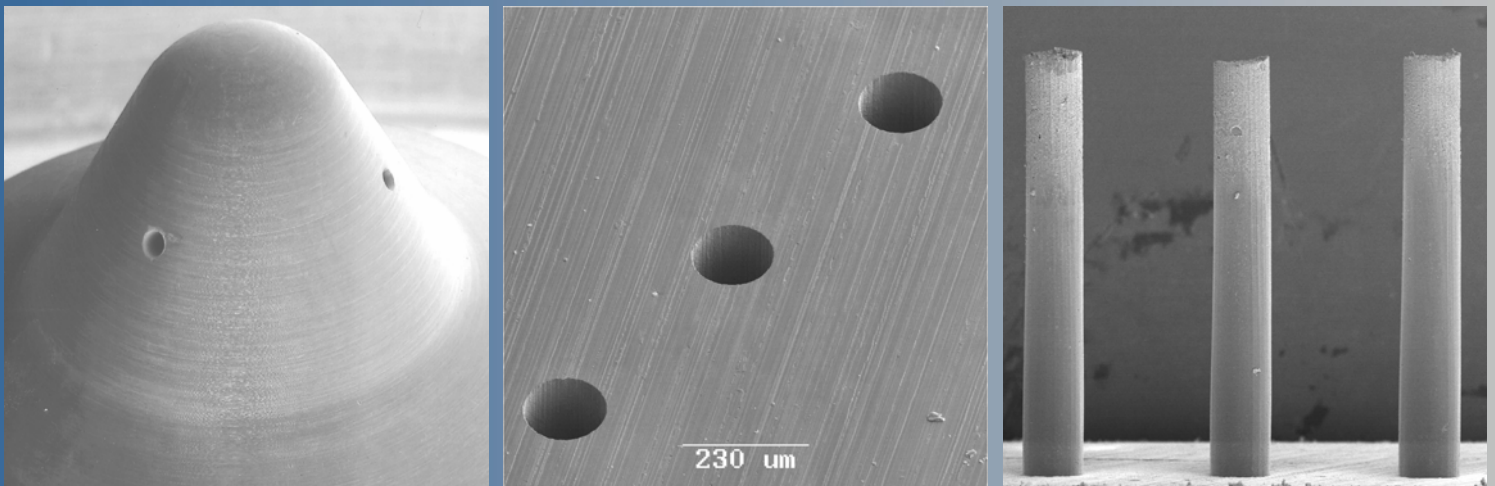
Laser machining has significant applications in the automobile, aerospace and electronics industries for cutting, drilling and milling. Nowadays, CO₂, Nd:YAG and excimer lasers are used for most industrial laser applications. However, the use of these conventional lasers with pulse durations in the range from nanoseconds to microseconds for precise micromachining is limited due to thermal and mechanical damage (melting, formation of burr and cracks, changes in the morphology etc.). Ultrashort pulsed lasers can overcome these limitations. Using ultrashort pulsed lasers enables an extremely precise processing of nearly all kinds of materials, ranging from metals to semiconductors and dielectrics, with minimal damage. With these advantages over conventional laser processing, a wide variety of applications have opened up for ultrashort pulsed lasers.



ablation of a chromium film on glass using a nanosecond laser (*top*) versus using an ultrashort pulsed laser (*bottom*), note the different height scales



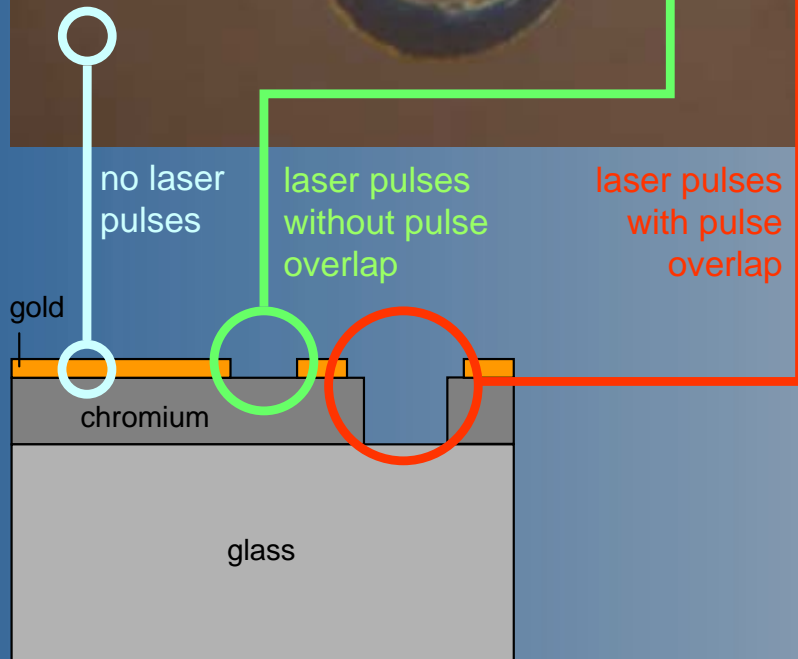
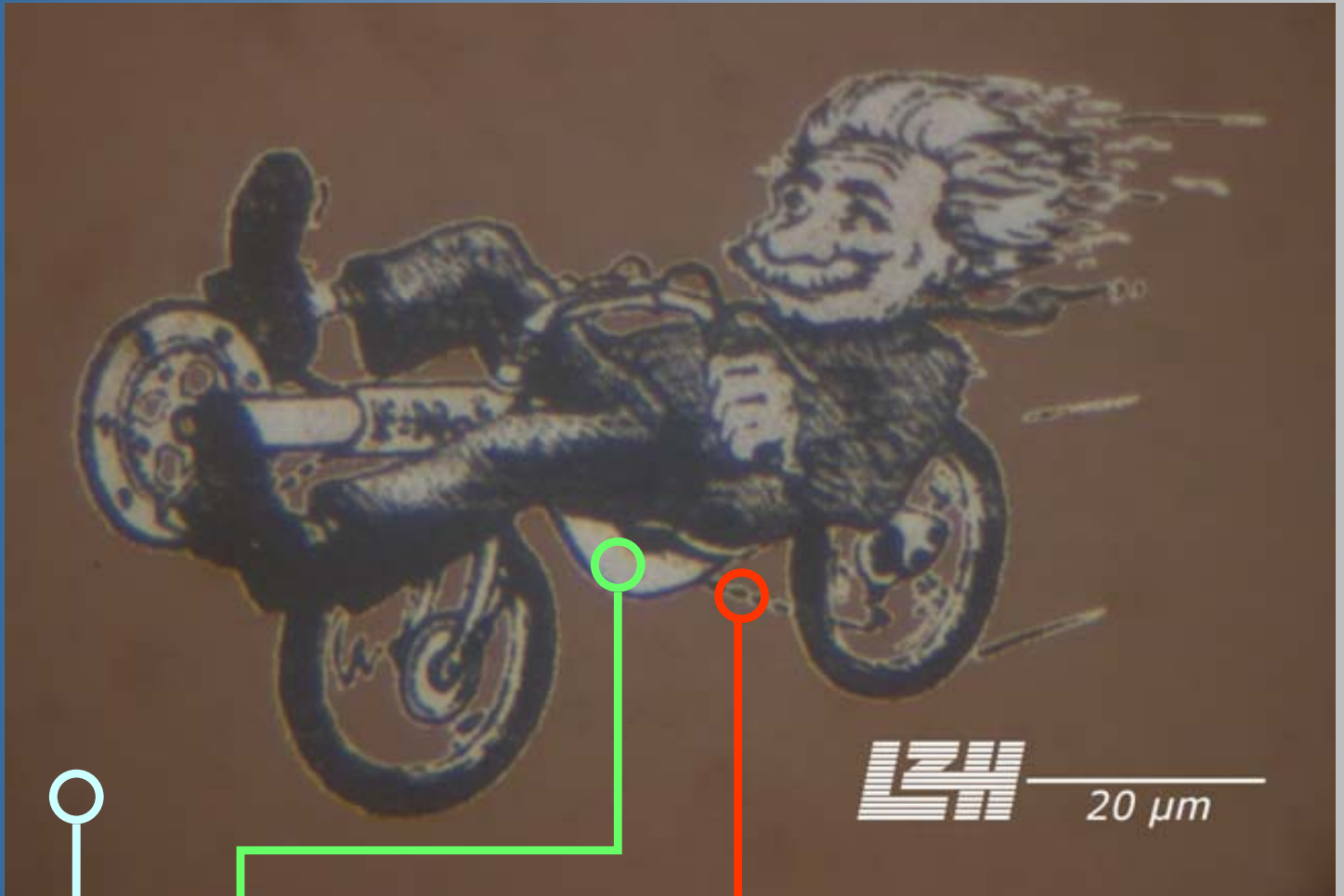
texturing and cutting for different applications



laser drilled holes in steel and their replicas

EXAMPLES OF ONE APPLICATION

Ultrashort pulsed laser ablation features well defined laser energy thresholds for the onset of ablation. This enables material specific machining. A material layer with a lower ablation threshold can be removed from a substrate material with a higher ablation threshold without damaging the substrate. Since the threshold depends on the number of applied laser pulses per area, overcoming an ablation threshold can also be controlled by the pulse overlap.



workpiece, cross section

two-colored micro picture
 microscope image, illuminated from above
 original: drawing by Jacques Choppinet, Belgium