Micro Nano Patterning

Laser Material Processing @ Karlsruhe

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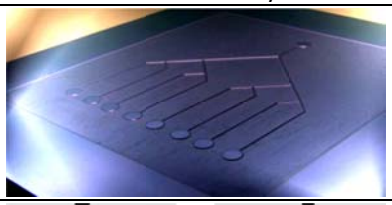
Material class:	Silicon	Polymer	Metal	Ceramic	Glass	Organic	Other
	X	X	X	X	X	X	composites

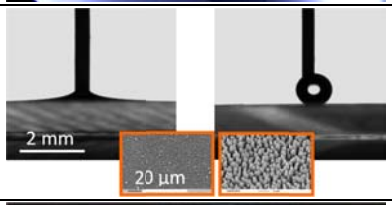
Short technology description:

Our laser technologies are appropriate for precise processing all kind of materials such as metals, ceramics, polymers, composites and thin films. The types of laser material processing are micro- and nano-structuring, micro-drilling, cutting, micro-welding, transmission welding, brazing, surface modification, cladding and surface alloying, respectively.
An appropriate choice of laser and process parameters is used to control the interaction between laser radiation and material on µm- and nm-scale. The actual smallest structure size which can be achieved, each according to the process and material, lies in the range of 100-400 nm using femtosecond laser radiation or laser-interference methods. Aspect ratios up to a maximum of 50 can be realized. Ultraviolet laser radiation and short pulse laser radiation have a particularly high potential for precision micro- and nano-ablation, due to its selective material removal with very low thermal load.

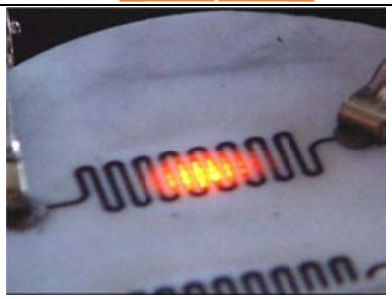
Typical structures and designs:



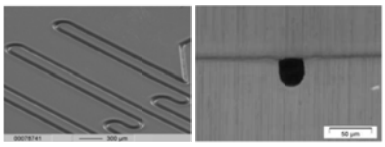
Laser structured mould insert made of steel for replication of micro-fluidic chips
- channel structure width 50 µm



Hydrophilic (left) and superhydrophobic (right) behaviour of laser modified polymer surfaces



Laser modified cordierite:
heating element made of tungsten
- channel structure width 3000 µm



Laser structured fluidic chip (left) and cross section (right) of laser welded micro-channel

Special features:

- Structuring of polymer materials and thin films with high repetition rate and short pulse laser radiation
- Structuring of metals and ceramics
- Cutting of metals, ceramics and polymers
- Laser welding of polymers and metals
- Laser brazing
- Laser LIGA
- Laser alloying and cladding of ceramics
- Surface modification of polymers and thin films

Limitations, constraints:	– Structure size 200 nm; AR=50 for drilling; AR=10 for ablation and cutting – Resolution 2-10 µm – Cutting width ≥ 5-50 µm – Covering of micro-structured polymers (structure size ≥ 20 µm); – Joining of thin metal foils with small weld seam width (100 µm, AR 3-5) – Ceramic-ceramic or ceramic-steel joints; thickness of brazed seam 10-300 µm – Surface roughness Ra=60 nm; edge radius of 1 µm; AR=5 – Structure width ≥300 µm – Adjustment of wettability/surface energy/biocompatibility with structure width ≥ 200 nm
Material examples:	– PMMA, PS, PEEK, PI, PSU, thin films (amorphous carbon, SnO_2, $LiCoO_2$) – Steel, Ni, brass, WC, Al_2O_3, ZrO_2, SiC – Steel, Ti, NiTi, quartz, Al_2O_3, PMMA, PI, PS – PMMA, PS, aluminum, steel, titanium – Ceramics: Al_2O_3, Al_2O_3-ZrO_2, SiC – Steel: 100Cr6, C45E – Nickel – Substrate: Al_2O_3, Cordierite, LTCC – Additives: W, Cu, Ni, Ni/Cr – PS, PC, PMMA, amorphous carbon thin films