OPTEC LSV3 EXCIMER LASER – GENERAL OVERVIEW

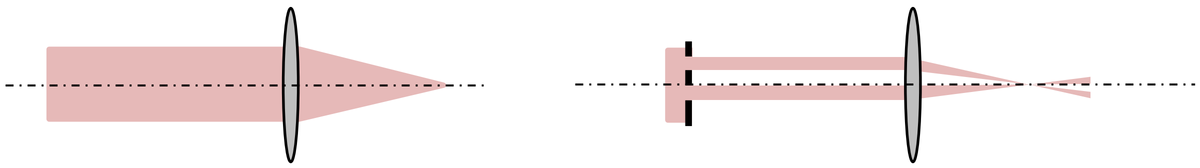
Basics of UV light formation

Excimer lasers use a mixture of noble gases (Argon, Krypton or Xenon) and halogens (Fluorine, Chlorine or Bromine), both added in the order of several 0.1% in a Neon buffer gas. In given conditions of high pressure (several bars) and under electrical stimulation (in the kV range), the excited noble gas moves to an excited state that allows bonding with the halogen gas atoms. The bonding is temporary and the excited molecule quickly relaxes back to ground state. The excess of energy is given back as UV light emission.

A beam shaper converts the undefined mode structure of the emitted UV light into a top-hat beam profile, required for uniform materials machining.

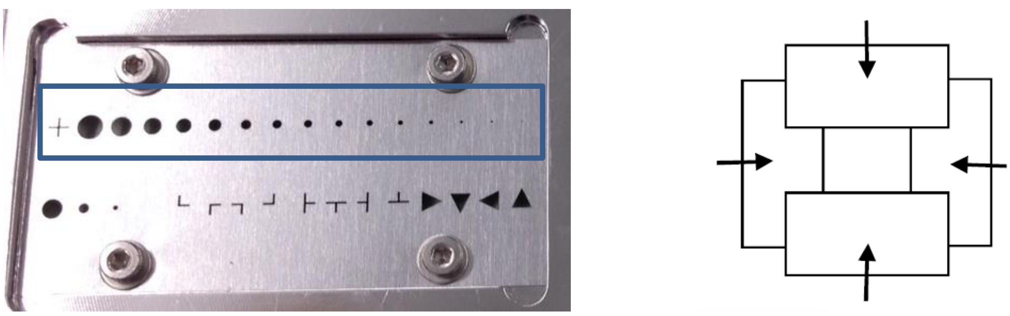
Masks, beam shaping and part handling

Excimer lasers generally have broad spatial profile beams and focal point applications are rare. Most processing is performed using projection optics, where the beam is used to illuminate a mask, whose demagnified image is then focused on the part to be machined. The final machining pattern on the part can be built up from repetition of selected motifs associated with part motion in X,Y and laser firing.



Focal point Vs mask projection with demagnification

The mask may outline various 2D designs which are then projected as a whole onto the part. Multiple static masks may be mounted on a motorized selector carousel. Dynamic masks are possible by the use of motorized slits or apertures.



Beam shapes available by default on CMi LSV3

	Size on the part (um)	
Mask shape	***Demag 10X***	***Demag 16X***
Cross	196x196	124x124
Circle	245	155
Circle	196	124
Circle	172	108
Circle	147	93
Circle	123	77
Circle	98	62
Circle	88	56
Circle	78	50
Circle	69	43
Circle	59	37
Circle	49	31
Circle	39	25
Circle	29	19
Circle	20	12
Circle	10	6
MRA*	Max 200 X 200	Max 125 X 125

*MRA: Motorized Rectangular Aperture

Table of the beam sizes available by default on CMi LSV3

Excimer laser micromachining

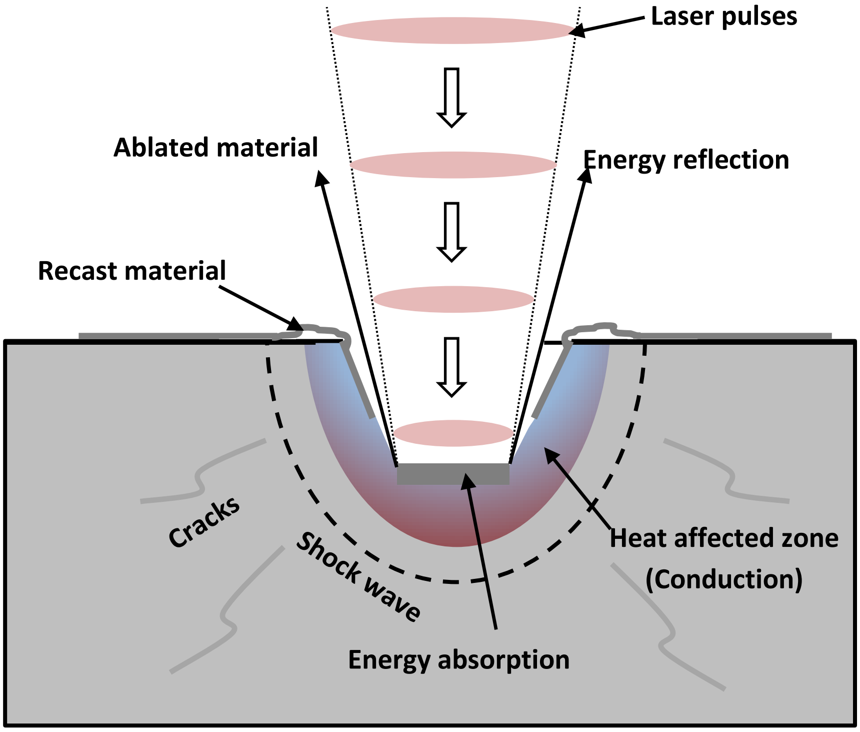
Two main mechanisms may occur during the UV laser ablation process of a material:

- In case of polymers machining, photo-chemical ablation is the predominant mechanism, where intermolecular bonds within the material are broken upon absorption of the laser energy. Material is removed without thermal effect. The penetration depth of the laser energy is inversely proportional to the absorption coefficient of the material at the given wavelength.
- Excimer machining may also involve a photo-thermal mechanism, where the laser energy is transferred within the material by conduction and converts into lattice vibration, resulting in melting and/or vaporization of the material. It is therefore dependent on the thermal diffusivity of the material. A short wavelength and short ns pulse duration allow to minimizing this thermal effect.

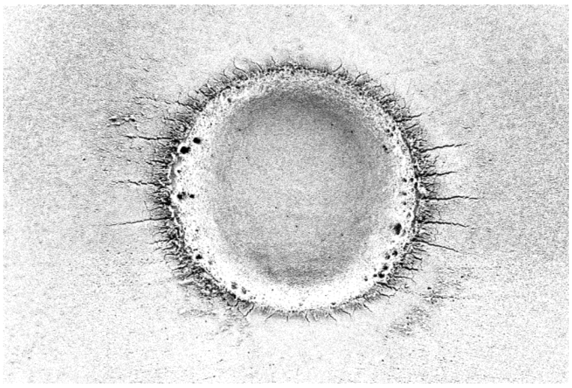
Part of the pulse energy may also be reflected at the sample surface. It occurs according to the reflectance of the material at the given wavelength and according to the surface finish, which may change during the ablation process.

Depending on the predominant mechanism, small residues may redeposit around the ablation zone. A post-cleaning of the substrate with e.g. a sonication bath helps to clean.

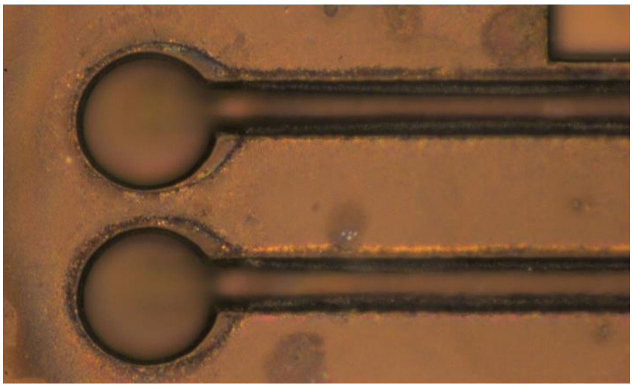
Needed energy densities are typically in the range of 1-10J/cm^2 at repetition rates up to several hundred Hz. Machining etch rates generally reach tenths of µm/shot.



UV laser ablation process



PDMS: 50 pulses - 300Hz - 0.4J/cm^2



Float glass: 20um large, 10um deep channels

Properties of OPTEC LSV3 laser system

Laser

Wavelength	193nm	
Maximum e.d.	10J/cm²	Trade-off adjustment for e.d. vs spot size
Rep rate max	300Hz	
Feature size	5-250µm*	32 motifs on motorized selector(*e.d. limit at 250µm)
Mask demagnification	10-16X	Switchable
UV resolution	1µm	UVFS/CaF2 optics, 0,2n.a.
Focus Range	50mm	Motorized

Part Positionning

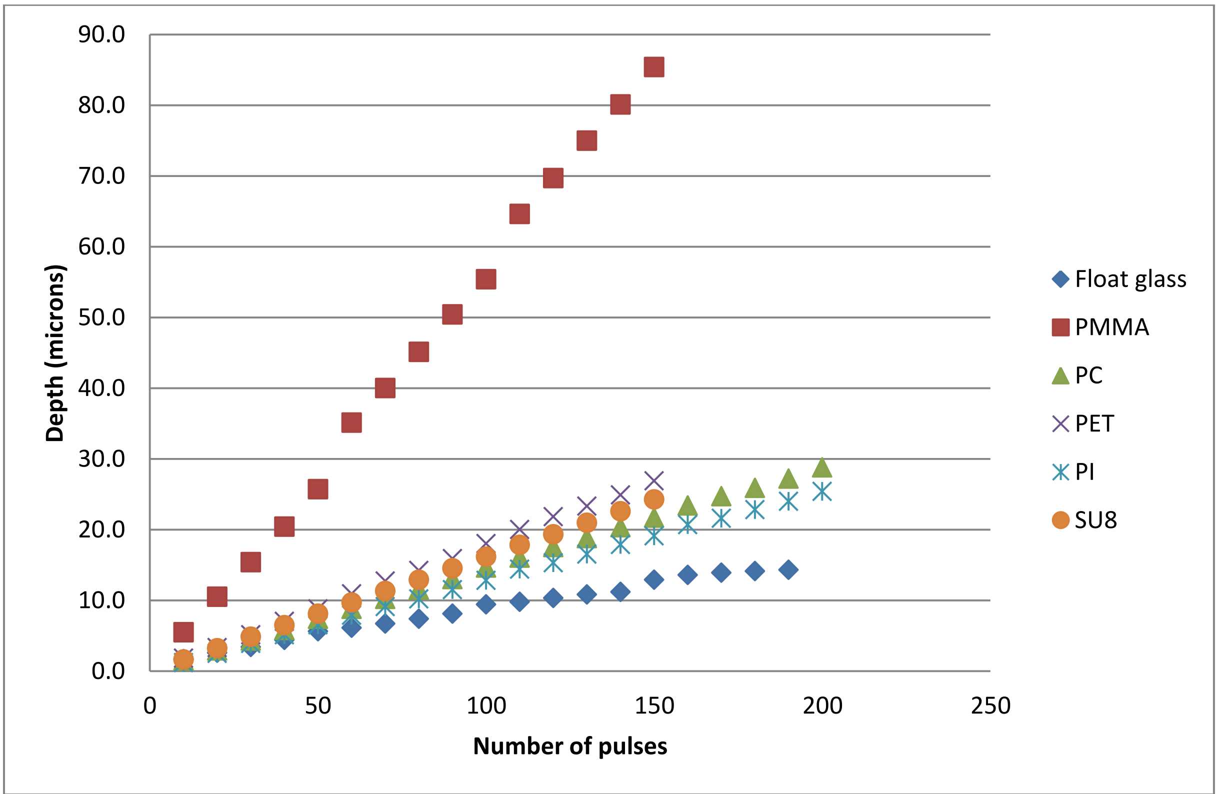
Travel range	100mmx100mm
Resolution	1µm
Repeatability	1-2µm
Absolute accuracy	<10µm

Vision system

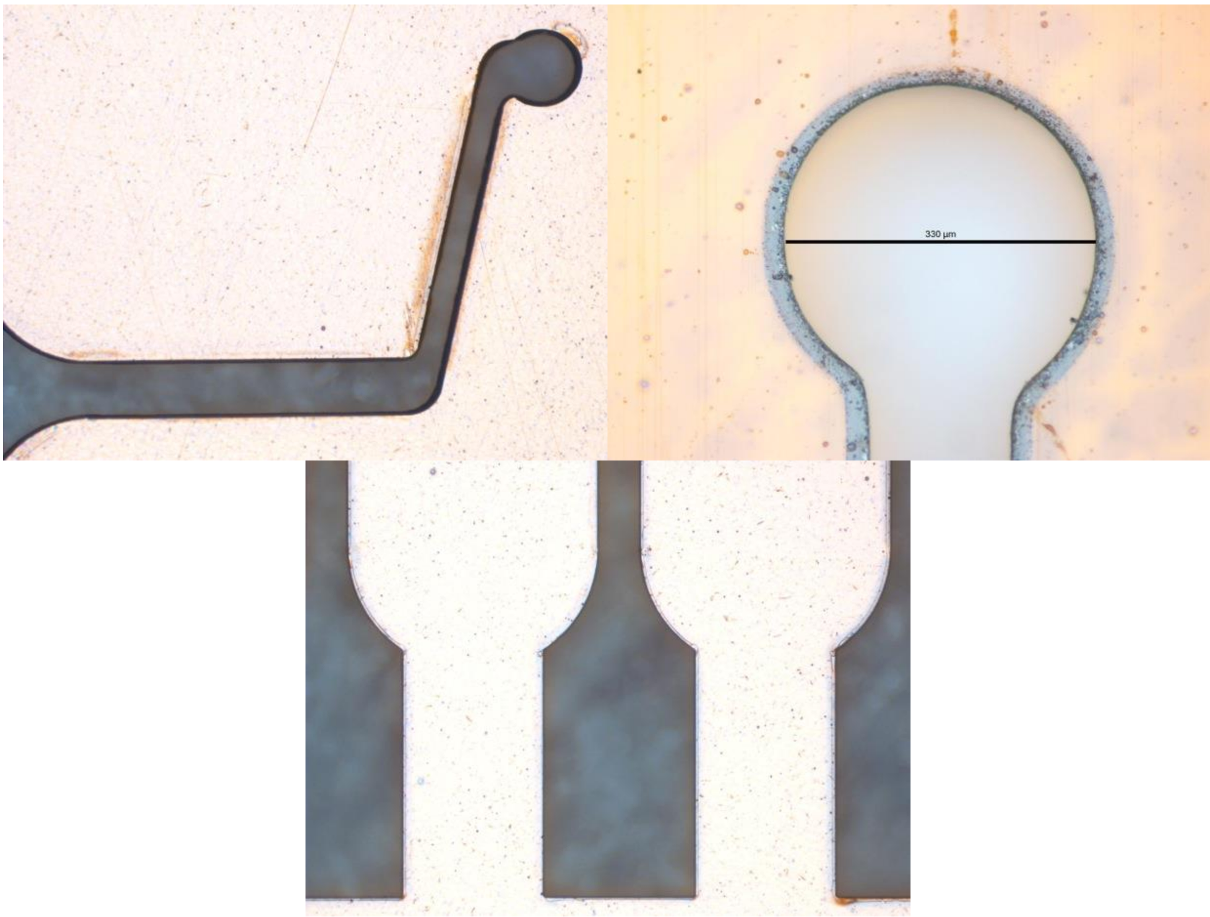
TTL image	colour
Zoom Ratio	12.5X motorized 1000X magnification
FOV	220µm min. 5mm max

Tested materials

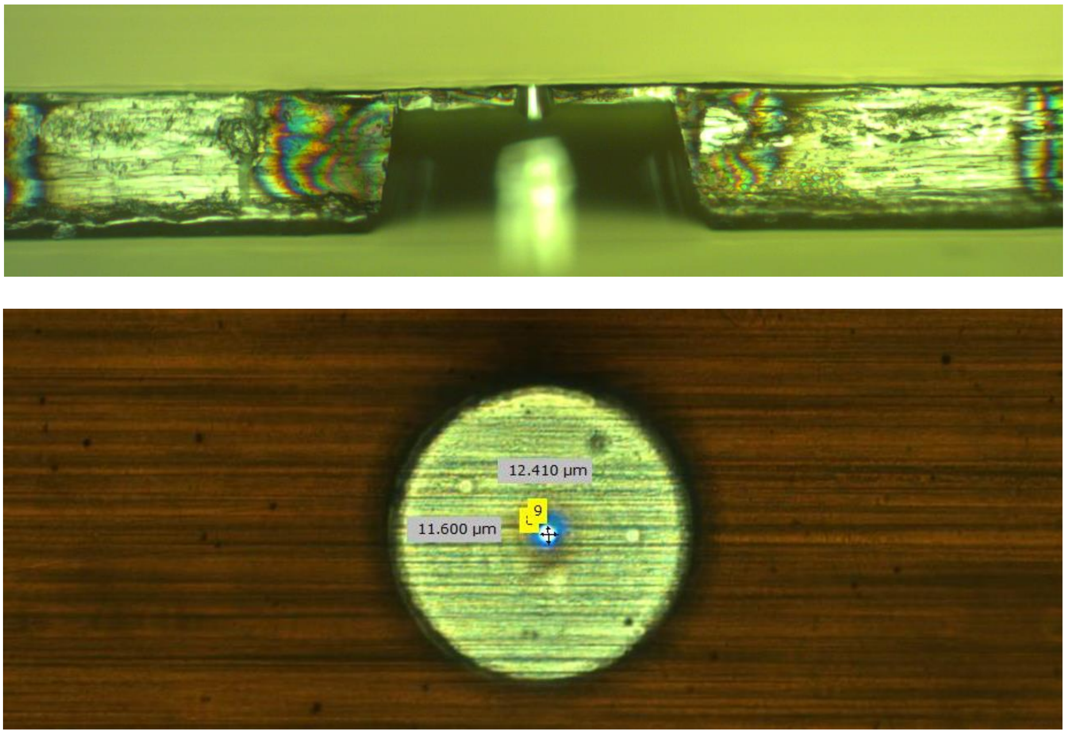
Polyimide, PET, Parylene, PMMA, PC, SU8 and float glass were successfully patterned by the LSV3. Any new material is welcome for tests and development.



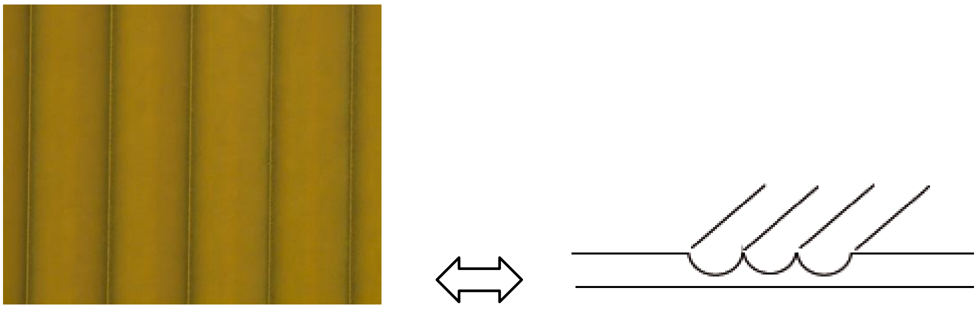
Machined depth of several materials for a fluence of 1J/cm2



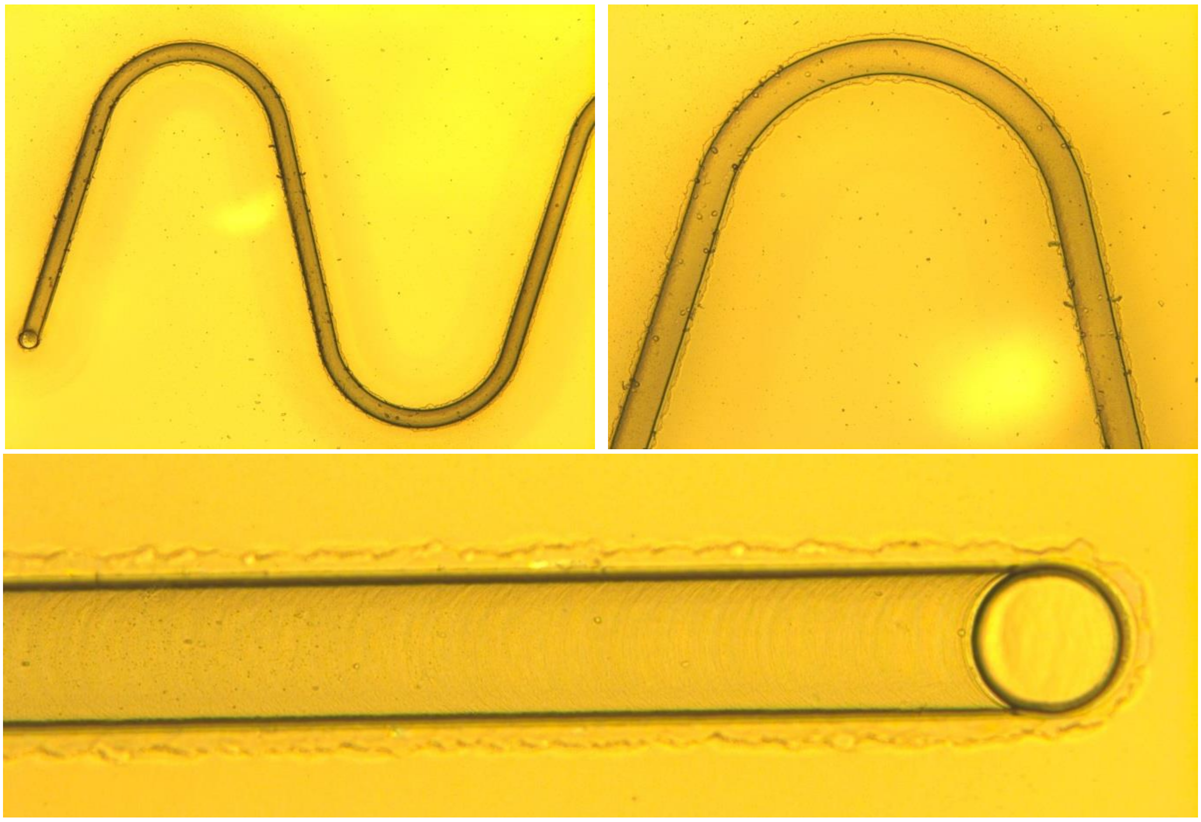
50µm thick flexible Kapton shadow mask



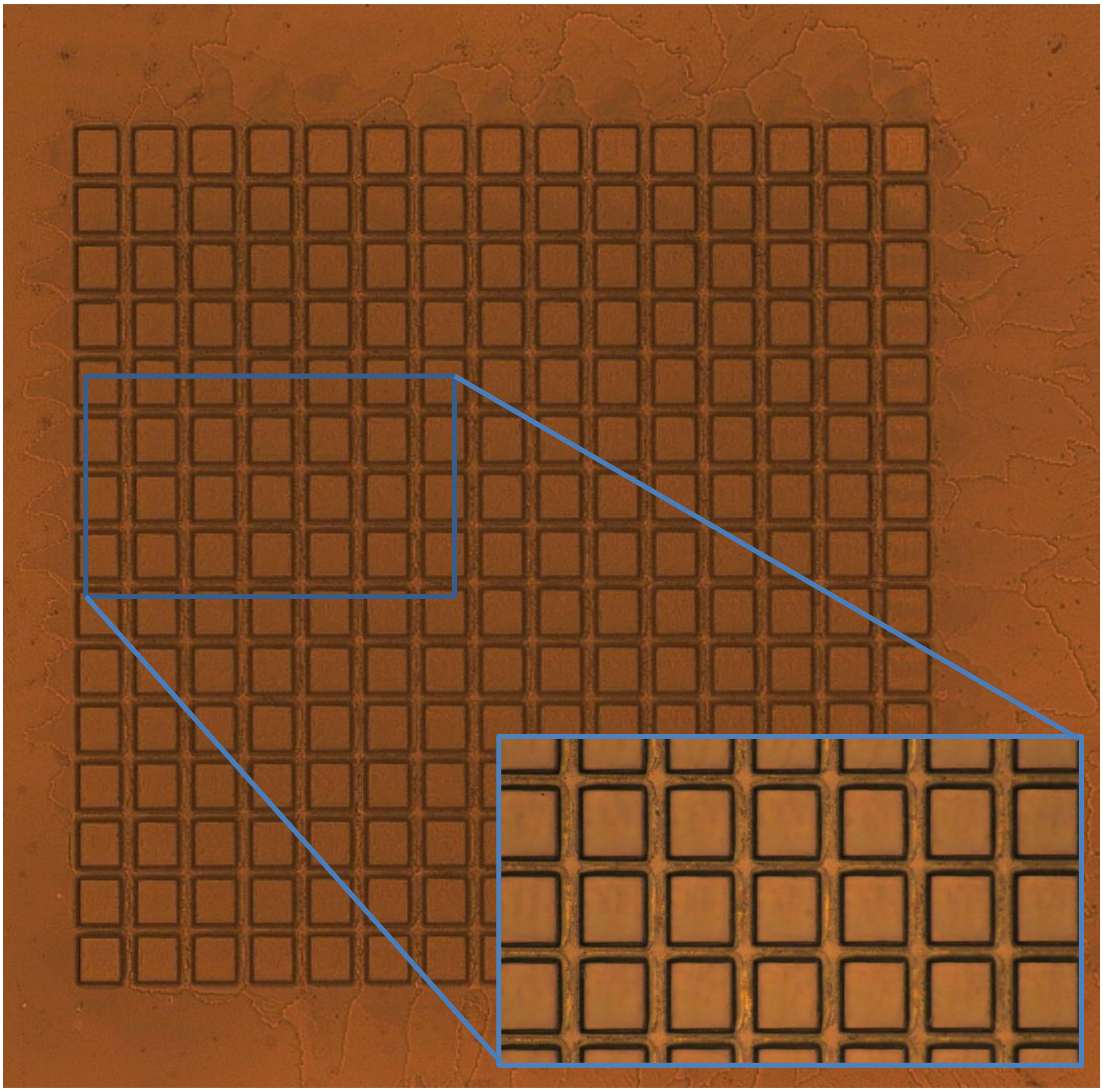
100µm polyimide layer: circular cavity tailoring and small window through



PMMA: 100µm elliptical section grooves array



Float glass: 80µm wide, 10µm deep channel



Float glass: array of 40µmX40µm reservoirs, 10µm deep