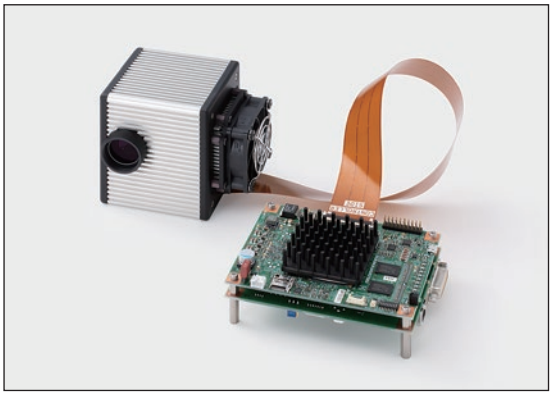
HAMAMATSU

PHOTON IS OUR BUSINESS

Wavefront Shaper
C16353 series

■ Features



- Easy connections to optical components / systems
- Simple control (with various DLL for control)
- Construction of high functioning laser machining / microscopic observation systems
- Control function (for high-power laser machining applications)

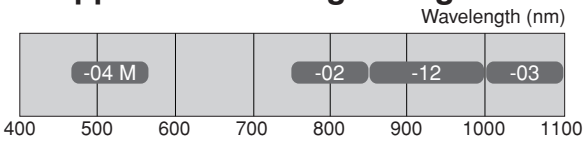
■ Applications

- Optical beam shaping
- Optical manipulation
- Aberration correction
- Optical vortex generation
- Repair / trimming
- 3D simulataneous multipoint laser beam generation
- Simultaneous multipoint processing by multibeam interference

■ Outline

Wave front shaper for easy integration into laser processing equipment and microscopy. It is configured to connect the LCOS-SLM head and the controller with a flexible cable. This is a phase control unit for laser processing and microscopic observations, that is constructed to enable you to shape the beam easily. It is equipped with prism-type mirrors which simplify the construction of the optical system, and electronic cooling systems that improve the operation stability and the power handling capability of optical phase modulators (LCOS-SLM). In addition, it is also fitted with DLL (dynamic link libraries) and applications in the standard to support the design of phase data for beam shaping and phase control.

■ Supported wavelength range



Type no.	Corresponding wavelength	Unit
C16353-04M	460 to 560	nm
C16353-02	750 to 850	nm
C16353-12	850 to 1000	nm
C16353-03	1000 to 1100	nm

* Please contact us separately for other wavelengths.

■ General ratings

Parameter	Value	Unit
Input voltage (with AC adapter)	16	V
Power consumption	35	VA
Operating temperature *1*2	+20 to +35	°C
Storage temperature	-20 to +55	°C

*1 No condensation
*2 The characteristics may change depending on the humidity.

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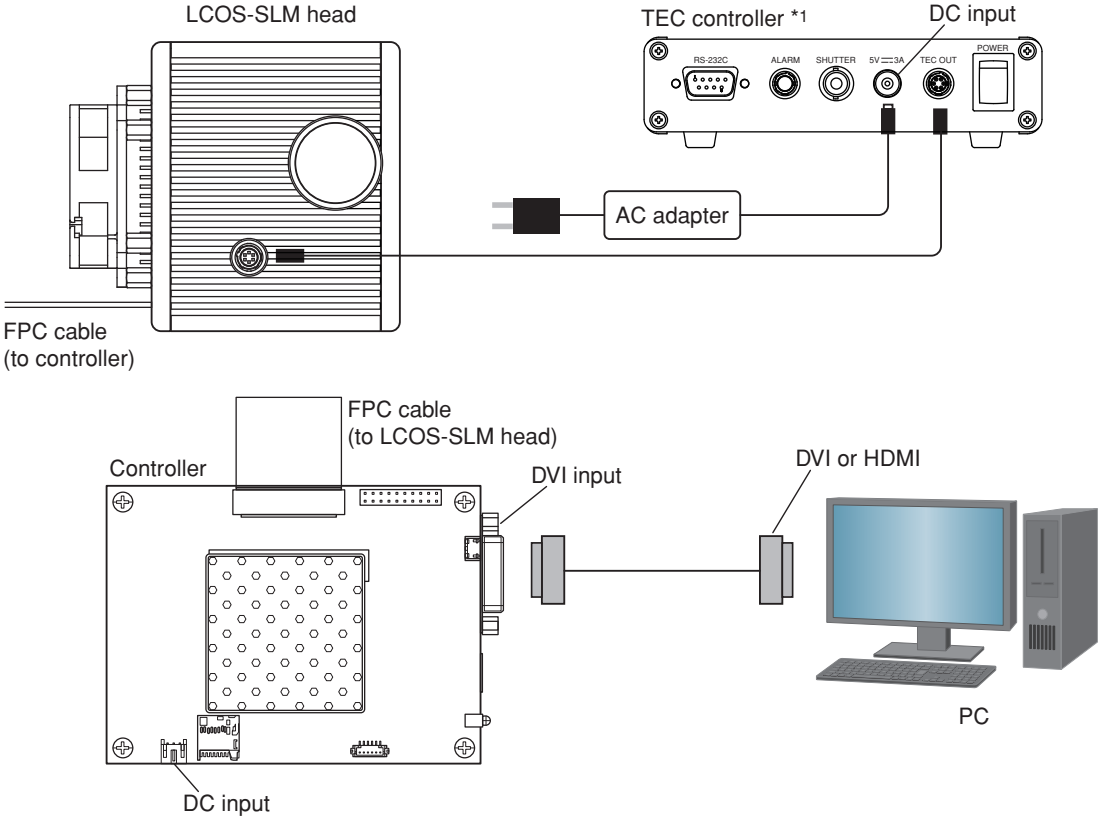
■ Specification

Parameter	Value	Unit
Number of pixels	1272 × 1024	pixel
Pixel pitch	12.5	μm
Interface *1	DVI (digital video interface)	—
DVI signal format	SXGA (1280 pixels × 1024 pixels)	—
DVI frame rate	60	Hz
Input signal gradation value	256 (8 bits)	levels
Effective aperture	12	mm
Throughput	95 (typ.)	%
Polarization direction	Horizontal	—
Weight	0.83	kg

*1 When this product is used, a control PC (with a DVI or HDMI external monitor output terminal) must be prepared separately.
* The TEC controller C14480 is attached to this product.

■ Configuration diagram



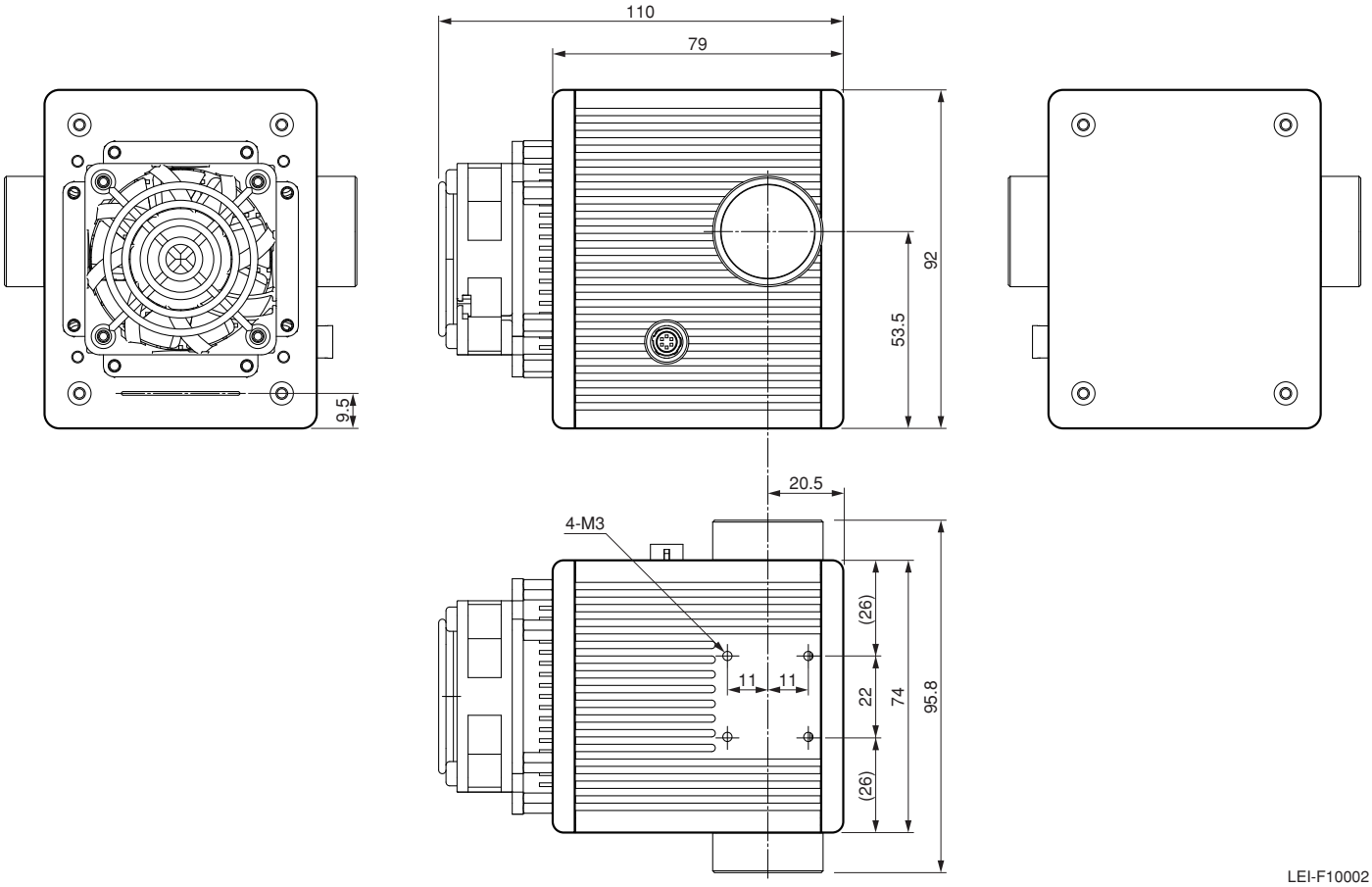
*1 TEC controller C14480 is attached to wavefront shaper C16353 series.

■ Accessories specification (TEC controller C14480)

Parameter	Value	Unit
Control method	PI control	—
Power supply voltage	100 to 240	VAC
Power consumption	15	VA
Storage ambient temperature	-20 to +55	°C
Operating ambient temperature	0 to +40	°C
Dimensions (W × H × D)	140 × 136 × 40	mm
Weight	450	g

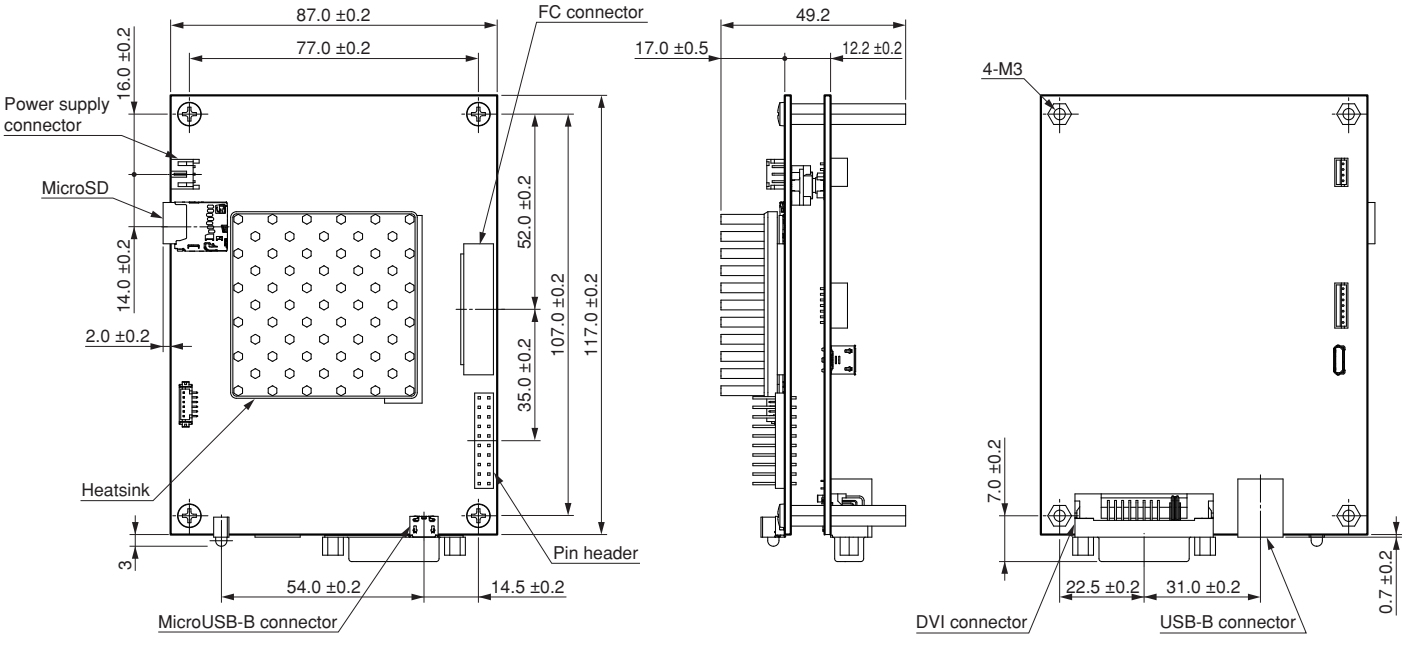
Figure 1: Dimensions (unit: mm)

●LCOS-SLM head



LEI-F10002

●Controller



LEI-F10005

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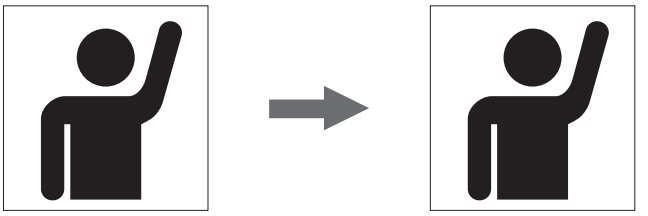
■ Phase control ~ beam shaping ~

The phase control of laser enables "2D simultaneous multi-point irradiation", "3D simultaneous multi-point irradiation", "Aberration correction", etc. By using wavefront shaper, you can control the phase of laser beam with high resolution and precision, then change the beam profile easily and conveniently.

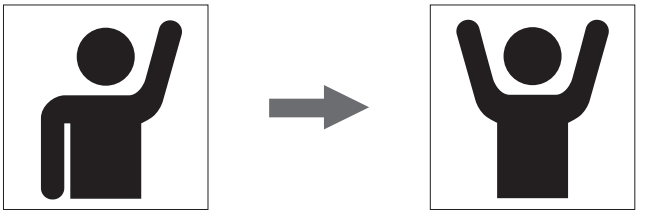
●Comparison with DOE (diffractive optical element)

DOE



Always the same pattern

Wavefront shaper



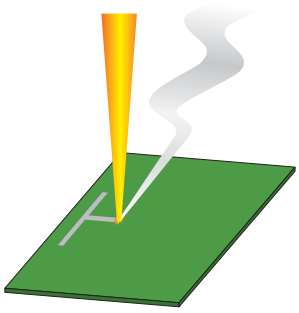
It is possible to switch to any pattern at any time with programming control

■ Phase control ~ improve processing efficiency ~

It is well known technology to scan laser with galvano mirror to perform micro-processing, However, the problem is that processing takes time in the mass production process. Wavefront shaper has high-power handling capability and can control the phase of laser beam, so high-intensity pulse laser more than the processing thresholds can be used. By branching laser to multiple points or genarating a desired pattern, high-tact processing with high-power laser can be performed.

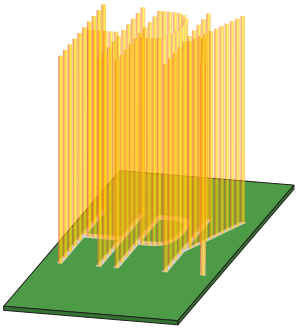
●Comparing laser scans and simultaneous irradiations

• Scanning



Taking extra tact time
The output power more than processing threshold cannot be used

• Simultaneous multipoint irradiation (with wavefront shaper)



Shortening takt time
Using high-power laser effectively

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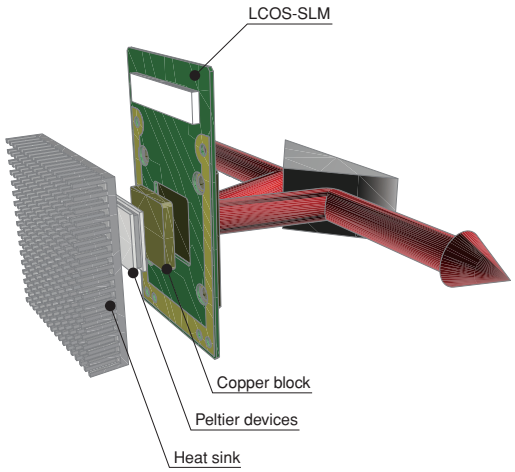
■ Utilization of high-power laser ~ cooling the LCOS-SLM ~

The temperature is controlled by peltier devices elements to ensure that LCOS-SLM, which is the key device, is driven reliably. This prevents phase modulation change due to temperature rise and enables stable phase control. It also improve the power handling capability for high-power laser (which prevents damage to LCOS-SLM due to the temperature-rise of the liquid crystal).

●Temperature control to liquid crystal in LCOS-SLM



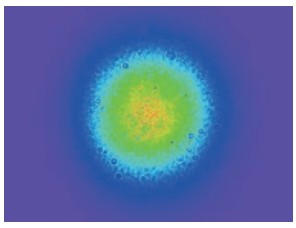
Controlling the temperature of liquid crystal in LCOS-SLM stably

Stabilizing of characteristics of phase modulation and supports high-power laser

■ Utilization of high-power laser ~ optical density reduction by homogenizer ~

Homogenizer produces the spacial-uniform intensity within the beam profile. Uniform beam profile enables to use higher power laser with LCOS-SLM effectively. Without homogenizer, typically, the intensity within beam pattern of the laser places gaussian distribution, and the most high intensity point restrict the power handling capability of LCOS-SLM. On the other hand, uniform beam pattern with homogenizer can reduce the density of irradiated point and relax the concentration of energy. Therefore, it is possible to use higher power laser as the light source of LCOS-SLM, and give great advantage to do simultaneous multi spot processing.

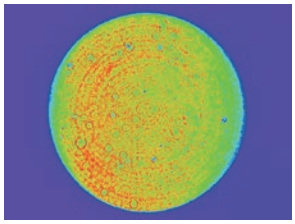
Beam profile of incident light



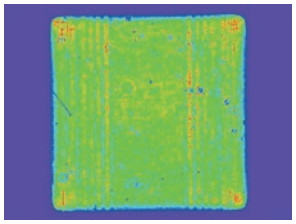
$\phi 1/e^2$=8.3 mm

With homogenizer

Uniform beam profile

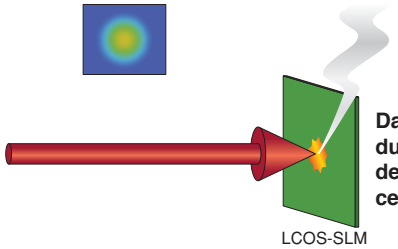


$\phi 1/e^2$=11 mm



*** Compatible with rectangular shapes**

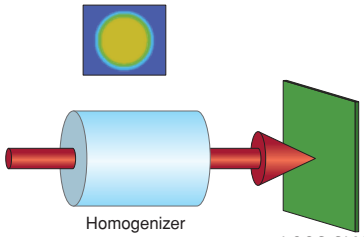
• Gaussian beam



Damaged LCOS-SLM due to high-power density around the center

LCOS-SLM

• Uniform beam profile (with homogenizer)



Improving power handling capability

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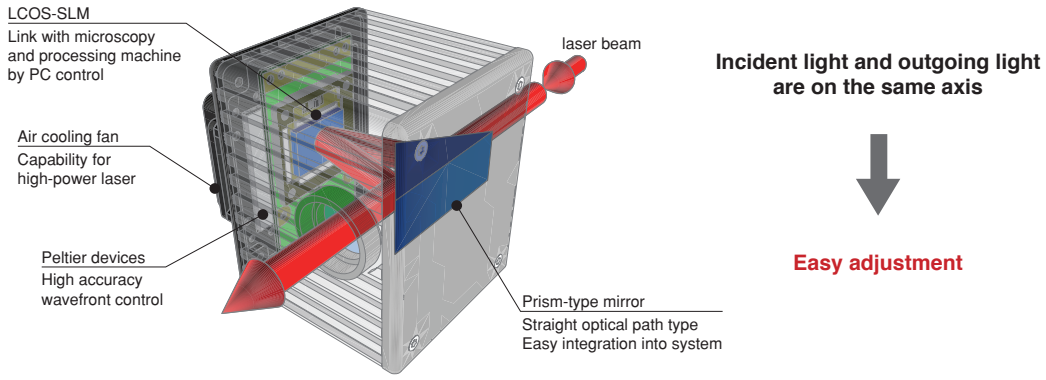
■Improved usability ~pseudo transmissive optical configuration~

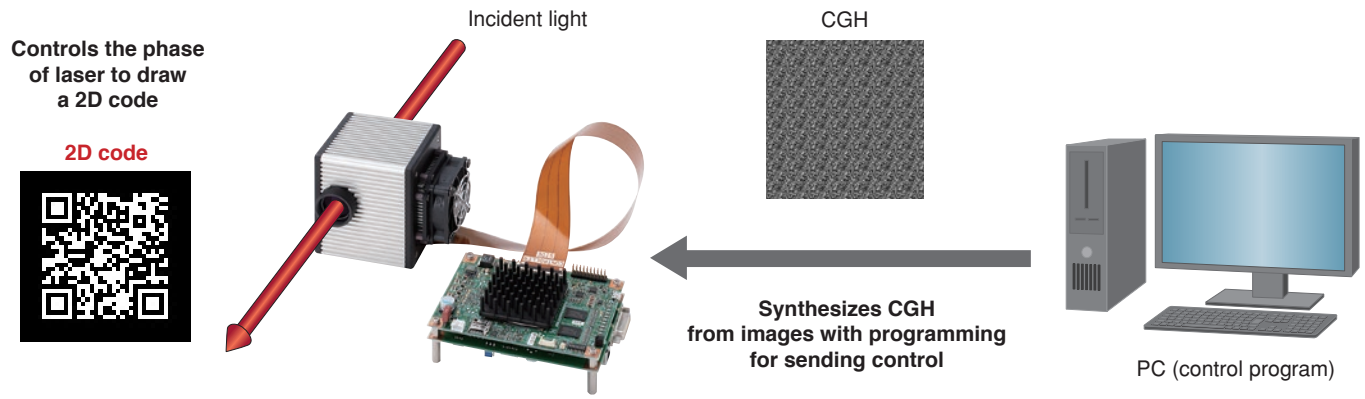
The dedicated prism-type mirror enables in-align optical path for input and output beam. There is no need to do complex optical alignment, and make it easier to install into laser machining instruments.



■Improved usability ~control program~

Since realization of phase control requires a complex process, software to make phase pattern has been developed.The software can be realized to easy phase control. Wavefront shaper includes the control software, and it gives great insight for the user to use LCOS-SLM. The sample software includes the function to generate CGH (computer generated hologram) to mark 2D pattern at multiple point easily.

●Program for data generation operation image



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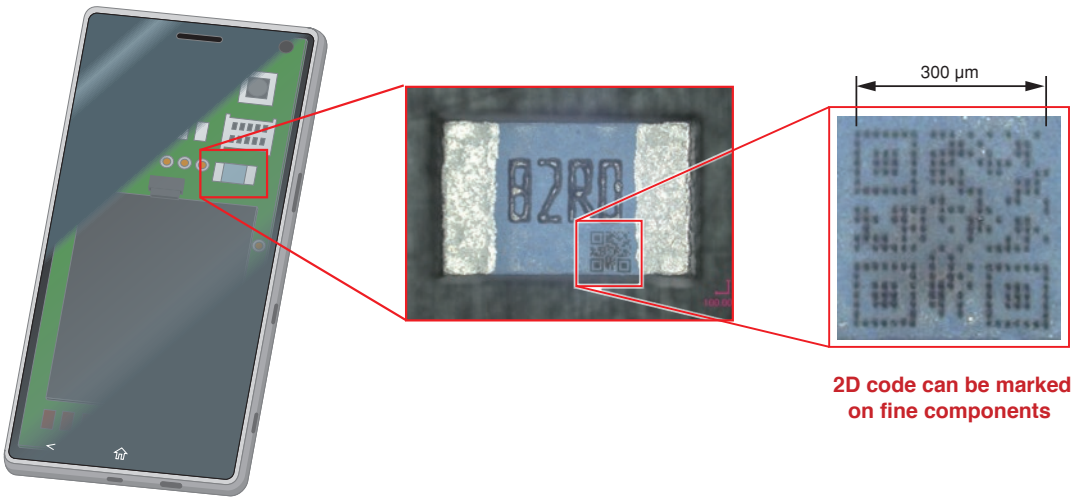
■Simultaneous multipoint irradiation processing ~ 2D code ~

Minute 2D codes are required to achieve traceability management for such as tiny electro-components. By using wavefront shaper together with short pulsed laser, you can make small workpieces marked finely at once.

●Processing image (2D code marked on electronic components of smartphones)

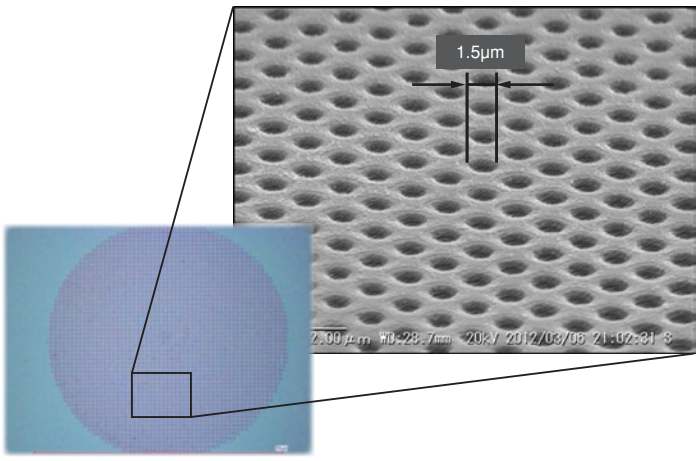


2D code can be marked on fine components

■Simultaneous multipoint irradiation processing ~ holographic interference machining ~

Wavefront shaper achieves to form fine pitch interferometric structure in the scale of micrometer when combined with ultra-short pulsed laser. In addition, wavefront shaper helps to improve takt time with simultaneous multi point irradiation.

●Processing example (micro-periodic drilling of ITO thin films deposited on glass substrates)



Realizes micro periodic holes with uniform shape and depth over the entire processing area

< Processing conditions >
Number of holes: approx. 2500 (simultaneous)
Diameter: approx. 1.5 μm
Interval : approx. 1.5 μm

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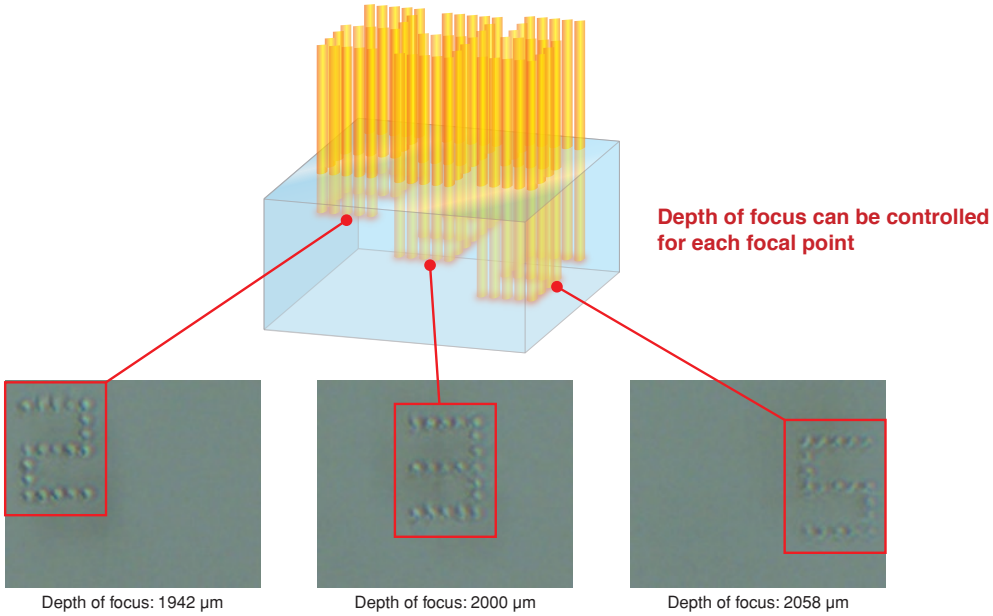
■ Stereoscopic / internal processing ~ 3D simulataneous multipoint irradiation ~

Simulataneous irradiation can be applied to stereoscopic marking with different focal lengths. It is possible to generate multi-point 3D pattern without moving focusing lenses or the workpieces since the phase controlling can achieve to control focal length.

●Example and conceptual diagram of multipoint laser beam generation

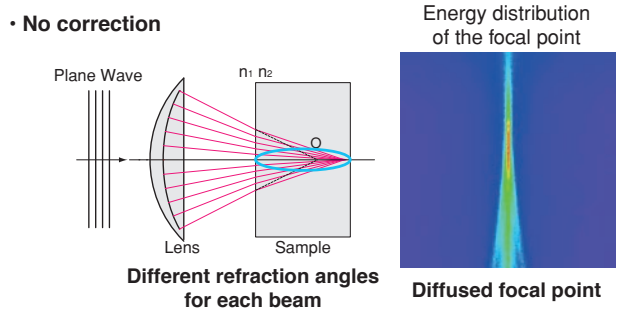


■ Stereoscopic / internal processing ~ optical aberration correction for internal processing ~

Wavefront shaper can correct the spherical aberrations that occurs when conducting internal processing for transparent materials.

●Aberration correction

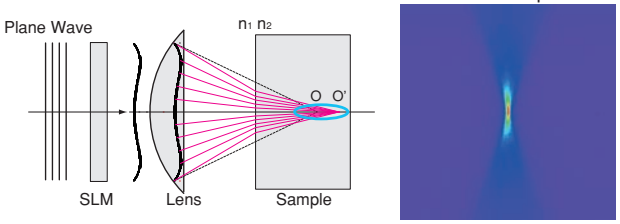
・No correction



Different refraction angles for each beam

Diffused focal point

・With correction

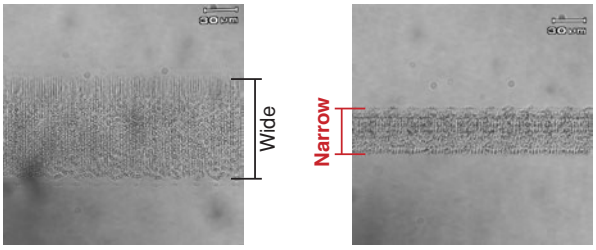


Control the wavefront beforehand

The focal point is gathered in a narrow range

●Processing example (internal processing of sapphire)

・No correction **・With correction**



Optical aberration correction allows small pitch processing

< Processing condition >
Center wavelength: 800 nm
Pulse width: 50 fs
Pulse energy: 45 µJ

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