

OPTICS

## Diffractive Optical Elements



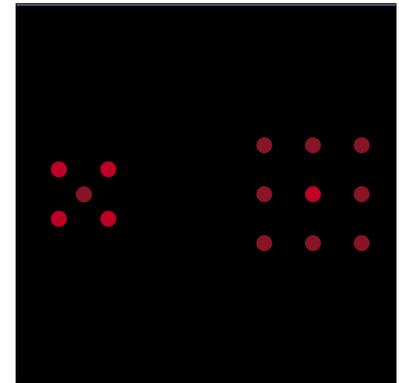
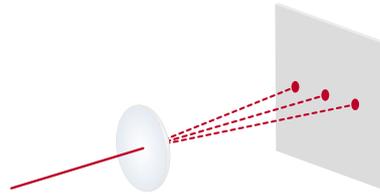
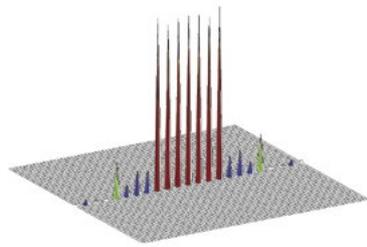


Holo/OR Ltd. develops and manufactures diffractive optical elements (DOEs). These products are primarily used in combination with high-power lasers to split the laser beam or change the beam profile. Through the use of a single diffractive optic, expensive lens systems can often be avoided: This guarantees high precision and saves time in the setup of the entire system. Modified beam profiles can yield significant performance increases and contribute to production efficiency.

In 1989 Holo/OR was founded by Israel Grossinger; Grossinger is considered a pioneer in the development of efficient DOEs for industrial applications with an excellent price-performance ratio. Very few companies worldwide are able to manufacture DOEs with a high damage threshold that can withstand the energy of high-power lasers. Holo/OR manufactures DOEs for wavelengths from 193 nm to 10.6  $\mu\text{m}$  made of fused silica, sapphire, ZnSe, polycarbonate, and PMMA.

This know-how comprises not only the design and production of DOEs, but also the simulation thereof with, in part, their own software. Further development of products is carried out in constant exchange with the customer. Our customer base includes the largest laser manufacturers from Germany, the U.S.A., Japan, China, and Korea.





## DOEs for Beam Splitting

### Beamsplitter

Beam splitter DOEs divide a laser beam into several partial beams. The beam profile and the characteristics of the partial beams are identical to the original beam; only the intensity and propagation are different.

#### Features

- Partial beams with equal or different intensity
- Beams can be arranged in almost any order: on a line ( $1 \times N$  beams), in a matrix ( $N \times M$  beams), on a circle, or hexagonally

### Beam Sampler

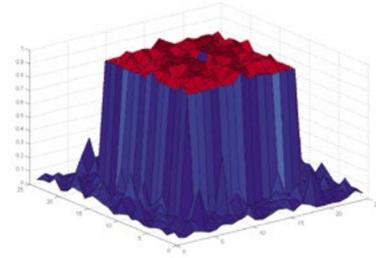
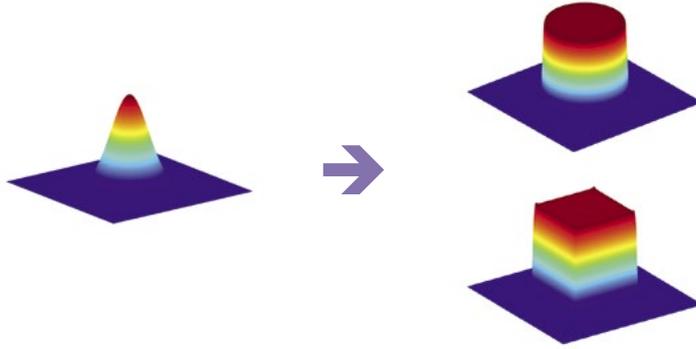
Beam samplers bend a small part of the input beam into a higher order, thereby producing an identical copy of the main beam. While 99% of the main beam passes the DOE without any effect, the partial beams can be used for online measurements. They primarily aid the monitoring of high-power lasers to immediately recognise losses and wave-front deformations in the processing beam.

#### Features

- Partial beams with low intensity
- Reflected beam angle according to customer specifications

### Applications

- Parallel material processing
- Medical and cosmetic laser treatment
- Laser structuring, e.g. of solar cells
- Glass cutting, e.g. of LCD displays
- Laser displays and illumination
- Industrial image processing and 3-D sensors
- Fibre optics
- In-line process monitoring / beam profile monitoring



## DOEs for Beam Shaping

### TopHat Elements

TopHat beam shapers convert a Gaussian beam into a defined spot with a homogeneous intensity distribution. TopHat DOEs have an energy profile with very narrow transition regions, providing a well defined beam shape for accurate treatment of a work surface.

Generally, circular or square beam profiles are required but the imagination knows no bounds. For example, the M shaper was developed based on a customer's request and guarantees a homogeneous intensity distribution in linear scanning applications.

### Features of TopHat DOEs

- Typical efficiency: 95%
- Excellent homogeneity
- Reacts very sensitively to
  - X/Y positioning
  - Defocusing
- Requires a defined input beam diameter
- For a single-mode laser  $M^2 < 1.5$

### Standard DOEs

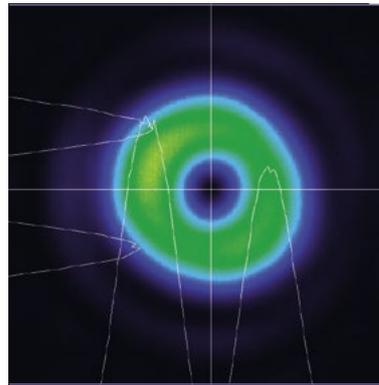
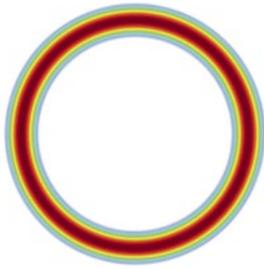
- Beam shape:
  - round, square, M shaper

### Homogenizer

A homogenizer shapes laser beams into a desired form and homogenizes the intensity across the beam's cross-section. Unlike TopHat elements, the homogenizers are used, in particular, with multi-mode lasers or if a large surface has to be illuminated.

### Homogenizer Features

- Typical efficiency: 80%
- Equal distribution of homogeneity across the entire surface
- Non-sensitive reaction to
  - X/Y positioning
  - Defocusing
  - Input beam diameter
- For multi-mode lasers (single mode possible)



### Doughnut/Ring-Profile DOEs

Depending on the laser and expansion, different DOEs are used to form a ring profile.

**Vortex** elements are used in single-mode lasers:

These spiral-phase plates (SPPs) convert a TEM<sub>00</sub> Gaussian beam into a circular Doughnut profile.

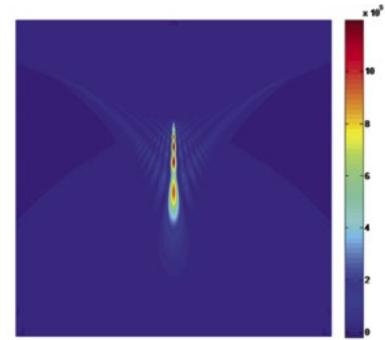
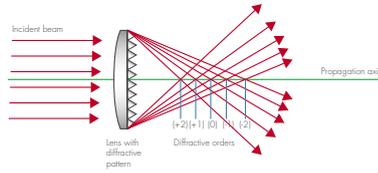
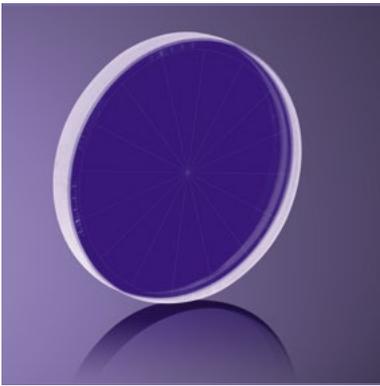
**Axicon** DOEs transform each and every input beam into a ring profile; therefore, they are also suited for multi-mode lasers.

**Multi-ring** DOEs form concentric circles; the customer specifies the number of circles and the distance between them.

### Applications

- Laser material processing (welding, cutting, drilling, scratching, ablation, and perforation)
- Biomedical applications
- Medical and cosmetic laser treatment
- Laser displays
- Marking and printing
- Hot-spot reducers and homogenizers
- Lithography
- Quantum optics





## Elements for Beam Focusing

### Dual-Wavelength DOE

Dual-wavelength DOEs are used in achromatic correction to focus two laser beams with different wavelengths at the same level:

for example, in CO<sub>2</sub> lasers that include a visible pilot laser. The wavelength differences result in different focal planes; the DOE adjusts the focal length of the pilot laser to suit the CO<sub>2</sub> laser.

### Features

- Hybrid element based on planoconvex lenses
- DOE is designed for a given wavelength

### Applications

- Medical laser systems (operations)
- Industrial applications with CO<sub>2</sub> lasers

### Multi-Focus DOEs

These elements, which are also known as multifocus lenses, focus the input beam simultaneously in several spots along the propagation axis. The number of focal points is also specified by the customer, as well as the distances between each point and the intensity distribution.

### Applications

- Ophthalmology
- Optical sensors
- Parallel zoom systems
- Material processing:  
Glass cutting, microprocessing

### DOEs for Extended Focus

Depth of focus and spot size are competing effects in laser technology, even though small spot diameters with a large depth of focus are often required:

These DOEs fulfil the requirements, achieving focal ranges that are up to 10 times longer than the Rayleigh length.

### Applications

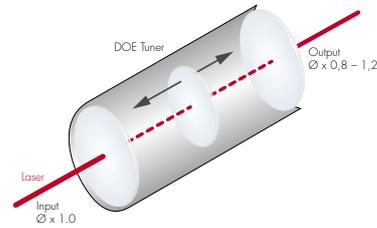
- Cutting
- Drilling
- Microscopy



Split beam  
before mask



Split beam  
after mask



## Accessories

### UDOB

#### Undesired Diffractive Order Blocker

Compact System for Blocking  
Undesired Higher Orders

#### Dielectric Aperture

Glass substrates with a dielectric  
coating: Masks allow certain ranges  
of the DOE structure to be suppressed.

#### ! Suited for

Multi-spot DOEs  
Homogenizers

### DOE Tuner

Depending on the arrangement, the  
size of the individual spot diameters  
and the size of the entire matrix in  
multi-spot elements can be used and  
changed in front of or behind a DOE.

#### DOE-Expander

This module both increases and de-  
creases the full angle of the DOE with  
a magnification factor.

#### ! Suited for

All DOEs



## OEM Products

Customized products are available  
in almost any shape. Not only the  
shape of the beam profile can be  
changed, but the distribution of  
intensity can vary depending on  
the position.

# Get in Contact



LASER COMPONENTS USA, Inc.  
116 South River Road, Building C  
Bedford, NH 03110  
USA

[info@laser-components.com](mailto:info@laser-components.com)  
Tel.: +1 (603) 821-7040  
[www.laser-components.com](http://www.laser-components.com)