

Diffractive Optical Elements – Further Information and Applications

Diffractive Optical Elements can be used to transform high powered laser beams into virtually any shape. Standard beam shapes that have been produced using diffractive optical elements include rectangles, squares, lines, symmetric/non-symmetric spot arrays and character sets. Complex intensity profiles made to the customer's specification can also be generated.

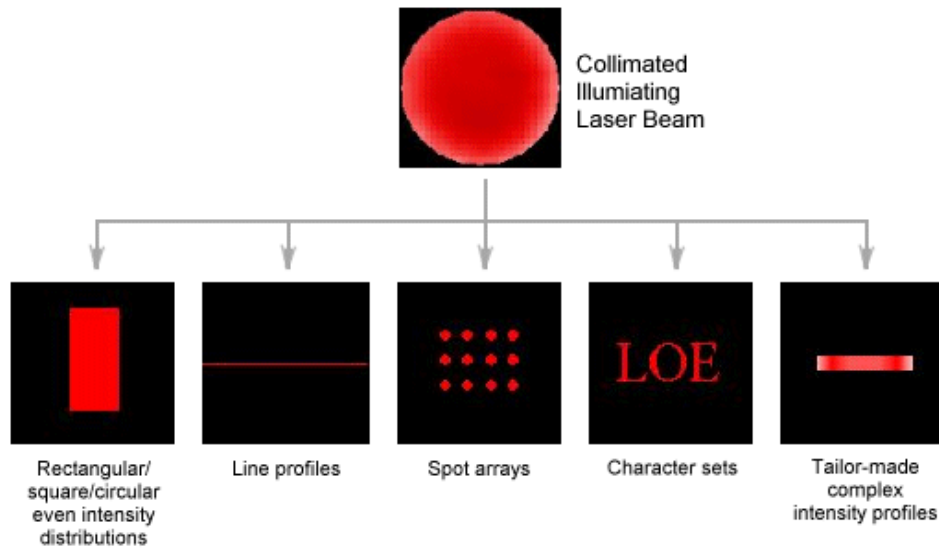
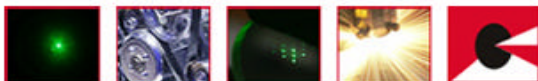
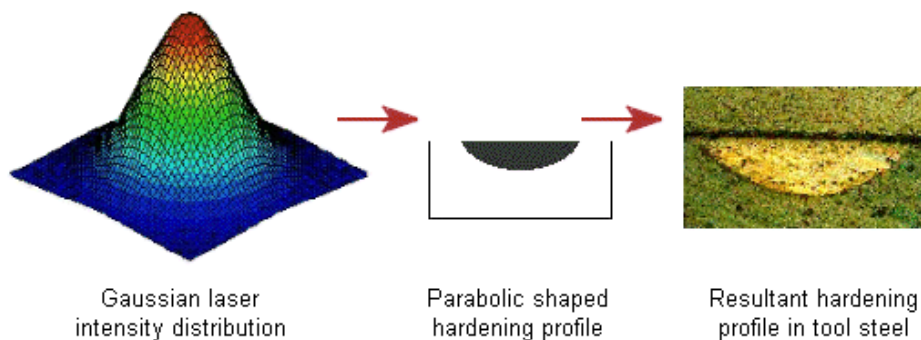


Diagram showing beam shapes that can be generated using diffractive optical elements.

Laser Optical Engineering specialise in the custom design and manufacture of Tailored Diffractive Optical Elements for high powered laser materials processing applications. Thermal models developed at LOE are utilised to design optimised beam shapes which can achieve superior performance and realise processing characteristics unattainable using conventional optics. For example, if laser hardening is undertaken in the conventional manner using a de-focused Gaussian spot, the result is a parabolic shaped hardening profile, as shown below. In many applications the variations in hardness and hardening depth are undesirable. By the use of thermal modelling it is possible to design a beam shape that will generate a uniform hardness profile. A Diffractive Optical Element can then be produced to transform the input laser beam into the optimised beam shape for the particular process. This ability to tailor laser beam intensity profiles is a unique service offered only by Laser Optical Engineering.



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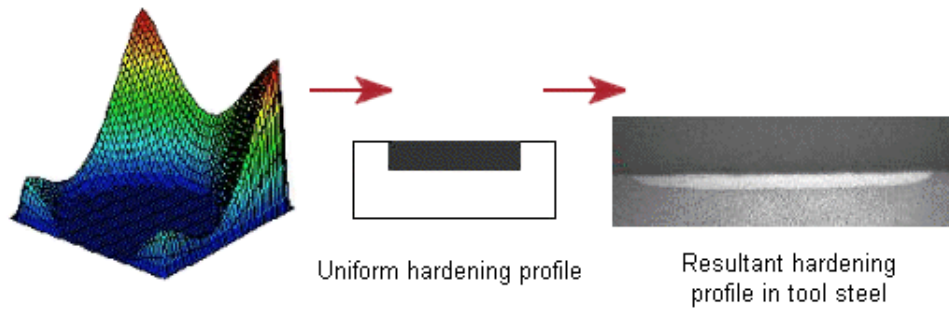
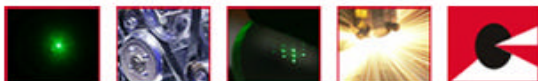
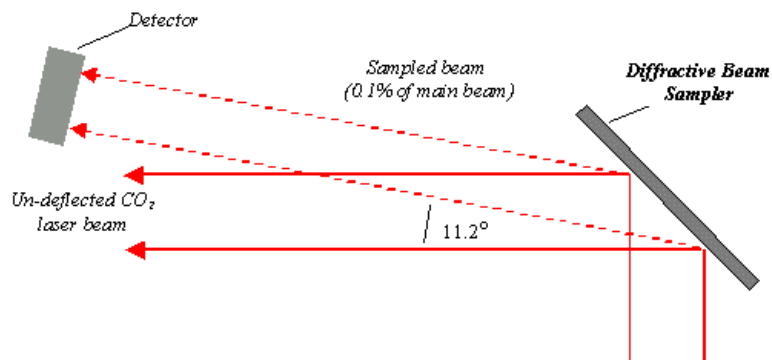


Diagram showing the advantageous application of complex beam shaping in laser hardening, enabling the production of a uniform hardening track.

Additional applications of beam shaping Diffractive Optical Elements that have been successfully demonstrated include:

- Simultaneous soldering of multiple connections on circuit boards, by use of beam splitting optics
- Multiple point simultaneous drilling
- High performance glass cutting using a line intensity distribution
- Single shot component marking/branding by use of diffractively shaped character sets
- Simultaneous production of a weld and a cut for the manufacture of plastic bags
- Production of variable depth, controlled hardening on gear teeth in a single laser shot
- Laser curing of protective coatings using an even intensity distribution generated by a diffractive.

In addition to beam shaping Laser Optical Engineering also produce beam sampling elements for high powered CO₂ lasers (<2kW at present). These Diffractive Beam Samplers divert a small proportion (0.1-0.5%) of the main collimated beam as shown below. The sampled beam can be utilised for the on-line monitoring of laser power and beam shape. The Diffractive Beam Sampler is a reflective element which can replace a standard 45° turning mirror in the beam delivery system.



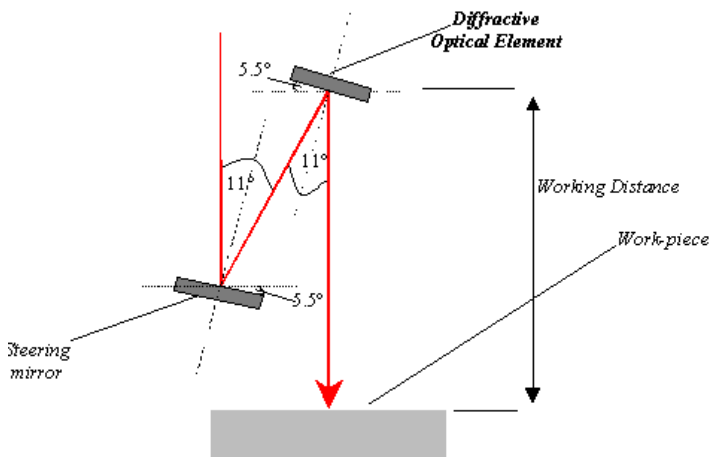
■ Technical Specifications

The mechanical and optical specifications for a standard reflective, beam shaping DOE operating at the CO² laser wavelength are given below. Custom designed optics are also available on request.

General Specifications	
Element Size	50mm diameter, 10mm thick
Element material	silicon substrate gold coated to form reflective surface
Size of diffractive pattern/ reconstruction area	12x12mm up to 35x35mm
Laser beam wavelength	10.6mm
Working distance	150-600mm
Angle of illumination	11° (see optical set-up, alternative arrangements available on request)
Diffraction efficiency	>90% of illumination energy into new beam shape
Element cooling	air/water cooling when operating with laser output in excess of 100W
Maximum CW power	3kW

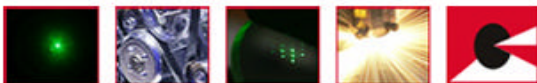
■ Optical Set-up

The diagram shown below shows a standard optical arrangement used for the operation of a reflective, beam shaping diffractive optical element.



Individual mounts and complete optical assemblies for operating DOEs are available. DOE assemblies are available which can be readily integrated into current laser systems. Assemblies include air/water cooling as required, alignment adjustment and provide a sealed operating environment for the DOE. Contamination of the diffractive surface should be prevented as this will reduce the operating performance and lifetime of the device. Provided the diffractive surface is kept free of contamination, no maintenance of the element is required.

For more detailed information on optical assemblies please contact Laser Optical Engineering.



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