

Diffractive Optical Elements (DOE)

— how to select a beam shaping DOE

Introduction

In laser optics, diffractive optical elements (DOEs) are designed to transform collimated Gaussian beams into a desired output pattern. Beam shapers and beam shaping diffusers are commonly used DOEs to shape incoming laser beam into small and homogeneous top hat spots of square, round or line shapes. They have different key parameters and there are some general rules can be used for DOE selection.

Selection of DOE

Before selecting a DOE, the following information and requirements should be prepared.

- Working Wavelength
- Beam quality (M^2)
- Output shape profile (Round; Rectangular; Line)
- Output beam size and EFL

The first consideration is desired image size. A beam shaping DOE is usually used in setups with focusing optics, and the image size is determined by both the effective focal length (EFL) of the focusing optics and the full angle of DOE:

$$\text{Image size} = 2 \times EFL \times \tan\left(\frac{\theta_{\text{full}}}{2}\right)$$

The incoming laser beam quality is also critical to the selection of DOE. For the laser with M^2 less than 1.5, top-hat beam shaper can be used. Otherwise, diffractive diffuser is the optimum choice.

The typical set-up involving beam shaper consists of a laser, a zoom beam expander (BXZ), a beam shaper element, a scanning system and a surface to be treated as shown in fig.1.

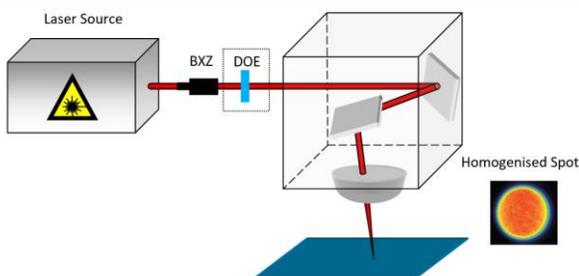


Fig 1. A typical beam shaper set-up

The important parameters and operation requirements of top-hat beam shaper are listed below.

Important parameters:

Materials	Fused Silica, ZnSe, Plastic
Wavelength range	193nm to 10.6um
Minimum full angle of DOE	1.5 times Diffraction Limit

Operation requirements:

Collimated input beam	Gaussian beam (TEM00), $M^2 < 1.5$
Input beam diameter	Fixed
Working wavelength	Fixed
Optical setup	All clear apertures in the beam path must be at least 2x larger than the beam size (1/e2) (optimally > 2.5x)

The typical set-up based on beam diffuser consists of a laser, a zoom beam expander, a beam diffuser element, a focusing system and a surface to be treated as shown in fig.2.

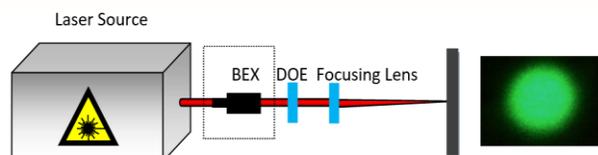


Fig 2. A typical beam shaping diffuser set-up

The important parameters and operation requirements of beam shaping diffuser are listed below.

Important parameters:

Materials	Fused Silica, Sapphire, ZnSe, Polymer on Glass, Plastics
Wavelength range	193nm to 10.6um
Minimum full angle of DOE	Few mRad to 41deg

Operation requirements:

Input beam	Single or multi-mode, $M^2 > 1.5$
Input beam diameter	Any
Working wavelength	Fixed
Optical setup	All clear apertures in the beam path must be at least 2x larger than the beam size (1/e2) (optimally > 2.5x)

Conclusion

As a global enterprise, leading photonics innovation since 2002, WOE has built up customization engineering capability for beam shaper and beam shaping diffuser DOEs.

