WAVELENGTH OPTO-ELECTRONIC

Beam Shapers – *Shaping the beam from DUV to MIR*

Introduction

Laser beam shaping is a potential technique to optimize laser-material processing applications, especially in improving the surface quality and throughput of 3D additive manufacturing (AM), depth control and edge profile control of machining.

There has been some commercially available beam shapers to manipulate the spatial profile. For system integrators or end users, it serves as a module to redistribute laser energy in order to improve the beam utilization efficiency, especially in machining applications. However, the beam quality control is mostly done by estimation, due to the absence of the characterization tool and quantification parameter. Moreover, in several other manufacturing applications, such as additive manufacturing or high resolution imaging, customized beam shaping is required. A systematic beam design approach is essential for laser material processing applications.

Operation Principle

The overall design concept of a beam shaper falls under two categories, namely refractive and diffractive. One of the "popular" applications of a beam shaper is to redistribute the energy from Gaussian to top-hat as shown in Figure 1.

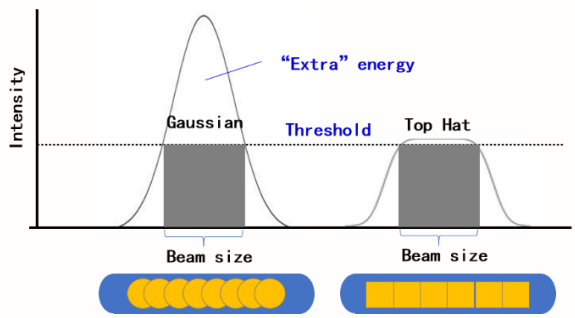

Figure 1. Top-hat beam shaper

The beam shaper is usually a customizable optical device. We list here the customization specifications.

Uniform intensity profile	+/-5%
Maximum power	customized
Transmission efficiency	>90%
Sensitivity to X-Y displacement	5% of the input beam
Rotation insensitive	round shape output beam
Sensitivity to working distance	<50% of the spot size

Table 1. Key specifications of a top-hat beam shaper

Applications

(a) Diffractive beam shaper for top-hat laser @1940nm

Within the Mid-IR wavelength regime, the 1940nm fiber laser has demonstrated unique advantages in transparent polymer processing. In the case where uniform energy distribution is needed to avoid air-bubbles, a top-hat beam shaper is designed as shown in Figure 2. A dedicate design software has been developed through the collaboration with the Agency of Science Technology and Research (A*STAR).

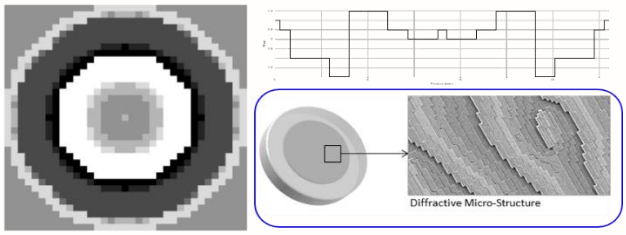

Figure 2. Diffractive beam shaper

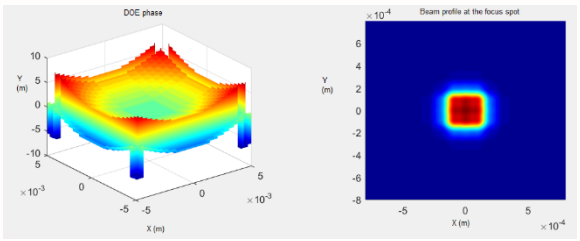

Figure 3. Design software output

(b) Refractive beam shaper for line laser @193nm

High aspect ratio beam line has been found to be useful in laser material processing. For example, in DUV lithography applications, the uniform beam line can effectively improve the processing speed. An aspect ratio of close to 400:1 has been achieved as shown in Figure 4. It was achieved by two pieces of specially designed lens.

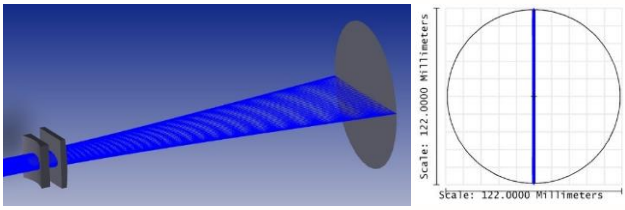

Figure 4. Design of high-aspect-ratio line beam at 193nm

Conclusion

As a global enterprise, leading photonics innovation since 2002, WOE has built up customization engineering capability for refractive and diffractive optics design.

(65) 6564 9624
www.wavelength-oe.com
info@wavelength-tech.com
Block 2 Bukit Batok St.24 #06-09
Skytech Building Singapore 659480