

Product Brief

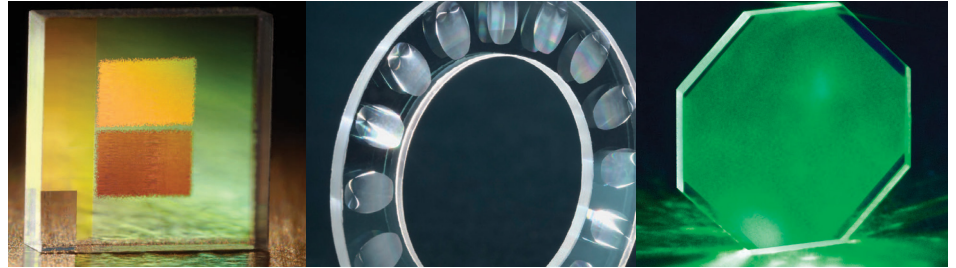
Diffraction Optical Elements

Key Features

- Diffusers
- Beam shapers
- Beam steering
- Pattern generators
- Wavelength filtering
- Beam combining
- Polarization controller
- Gratings
- Homogenizers
- Beam splitters
- Spot array generators
- Chromatic correctors
- Collimating lenses
- Null lens

Applications

- Free-form designs for Source Mask Optimization
- Head-mounted displays
- 3D Gesture
- Off-axis illumination for optical/DUV scanners
- Reticle and wafer inspection equipment
- Medical applications
- Optical sensors
- Machine vision systems
- Missile guidance systems
- Near-field wavefront correction and beam shaping
- Bar code



Ideal Solutions for Narrow Band Systems

Diffractive optics generate output patterns by means of interfering light waves, providing precise, customized patterns for a broad spectrum of laser-based applications. Diffractive Optical Elements (DOEs) are typically built using a digital patterning process, where a discretized target is transferred into a substrate. Broadcom uses a binary lithographic approach to fabricate DOEs, employing state-of-the-art Deep UV (DUV) tools. DOEs provide ideal solutions for narrow-spectrum optical systems in applications such as optical targeting, optical positioning, semiconductor lithography, beam shaping, and light source homogenization.

Design Capability

Broadcom designs pattern-generating DOEs using a sophisticated proprietary software tool set. Starting with a target pattern, a phase function is determined which reconstructs the desired pattern in the far-field, with maximum efficiency and low stray light. In addition, other diffractive functions such as lens functions, anti-reflection structures, wavelength filtering structures, and combinations of these can be designed and modeled using in-house and commercial software.

High Volume, High Quality Production Capabilities

Broadcom employs high-resolution lithographic techniques in combination with precision glass-etching capabilities to provide customers with customized, high-efficiency DOEs. Employing multiple tool sets and materials, Broadcom fabricates DOEs with submicron features to match each application's customized requirements.

Comprehensive, automated, in-house test systems provide full process and quality controls. The Broadcom state-of-the-art 100,000 sq/ft ISO-registered facility for wafer level optic fabrication provides high repeatability, and consistent performance from the first prototype through to volume production.

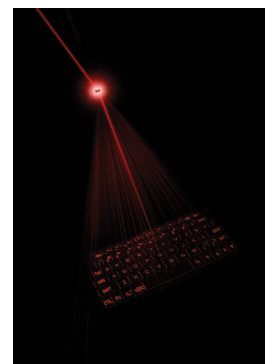


Figure 1: Keyboard Output Pattern Generated by Broadcom DOE

Enhanced Capabilities with Deep UV (DUV) Lithography

DOEs create patterns through diffraction. The larger the output pattern, the smaller the features required to create it. Feature sizes also scale with wavelength. Thus, to make diffractives for use with shorter wavelengths, smaller feature sizes must be patterned. In addition, for higher efficiency, low stray-light designs, multiple phase levels must be patterned. This necessitates both small features and extremely tight overlay of one level to the next. Broadcom advanced manufacturing tools enable fabrication of highly precise small features, resulting in higher performance and significant reduction of stray-light. Broadcom utilizes lithography tools operating in the DUV to attain feature sizes down to 100 nm with overlay of less than 15 nm.

Application Example: Deep UV Diffuser

Modern DUV lithography tools enhance their performance by shaping the laser light used to illuminate wafers. This is done by using diffractive pattern generators. Because of the very short wavelengths of 193 nm and 248 nm, feature sizes required to achieve the desired angles of diffractions must be very small. In addition, because of the importance of efficiency in the illumination path to wafer throughput, multi-level diffractives are often made. This means that overlay requirements are very tight. Using the DUV lithography capability at Broadcom, diffractive elements made in rugged ArF-grade fused silica or crystal quartz are able to satisfy the very demanding requirements of this industry.

In addition to excellent fabrication capabilities, Broadcom custom software enables the generation of high efficiency, highly uniform diffusers that minimize unwanted stray light. Output patterns match predicted input patterns to within a fraction of a percent.

Application Example: Gesture Recognition Diffuser and Collimator

Many gesture recognition systems utilize Near Infrared (NIR) lasers to illuminate the scene. Diffractives are ideal components for these systems, due to their ability to efficiently create a tailored, shaped light distribution at the scene, such as a rectangular and uniform illumination profile, to match the aspect ratio of the imaging system. In addition, multiple functions can be combined into a single element. For example, a collimating lens and a diffuser can be combined into a single surface, significantly simplifying the optical system and reducing cost. Figure 4 shows a photo of the output from a combined collimator/diffuser with an 830 nm laser diode as the source.

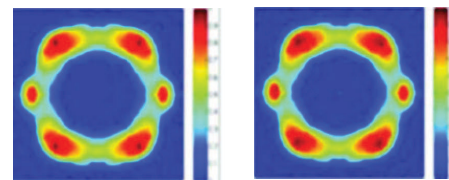


Figure 2: Simulated Pattern (left) Matches Measured Pattern (right)

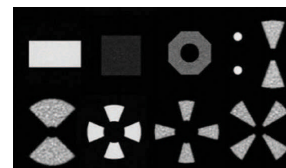


Figure 3: Controlled Angle Patterns



Figure 4: Output Pattern From a Diffuser and Collimator Lens

Specifications	
Diffractive Optic	Key Performance Characteristic
Wavelength	193 nm to 14 μ m
Materials	Quartz, fused-silica, silicon, germanium; other materials upon request
Pattern	Sub-micron patterning and alignment capabilities, single and double-sided
Dimensions	0.5 mm to 125.0 mm
Projection Angles	Wide: up to 120° (full angle)
Coatings	Anti-reflective coating and metallization capabilities
Zero Order	Typically < 1.5%
Efficiency	Varies by design