In addition to the excellent fabrication capabilities, DOC has custom design software which enables the generation of high efficiency, highly uniform diffusers which minimize unwanted stray light. Output patterns match predicted input patterns to within a fraction of a percent (see Figure 1).

Application Example: Gesture Recognition Diffuser and Collimator

Many gesture recognition systems utilize Near Infra-Red (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, simplifying the optical system significantly and reducing cost. Figure 2 is a photo of the output from a combined collimator/diffuser with an 830 nm laser diode as the source.

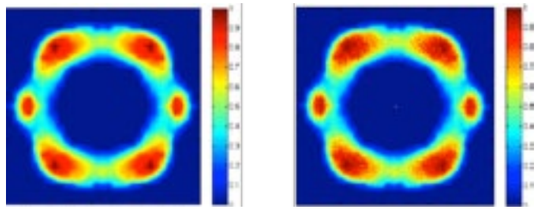

Figure 1: simulated pattern (on the left) matches measured pattern (on the right)

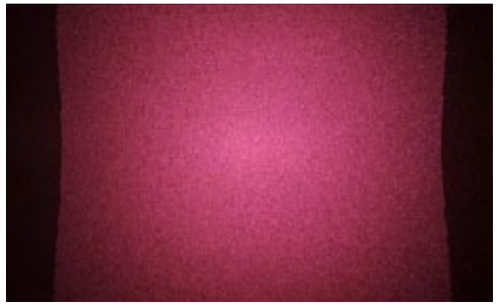

Figure 2: output pattern from a diffuser + collimator lens

Contact a DOC sales representative for more information.

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DS00??, 01-2012

Diffractive Optical Elements (DOEs)

Ideal Solutions for Narrow Band Systems

DigitalOptics Corporation

Diffractive optics generate output patterns by means of interfering light waves, providing precise, customized patterns for a broad spectrum of laser-based applications. DOEs are typically built using digital patterning process, where a discretized target is transferred into a substrate. DigitalOptics Corporation uses a binary lithographic approach to fabricate its 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.

Keyboard output pattern generated by DOC's DOE

Design Capability

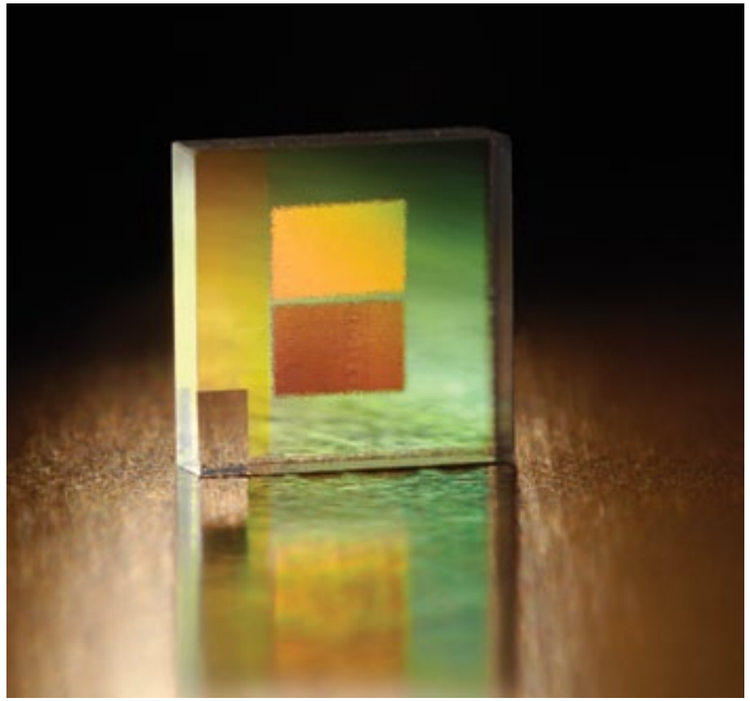
DOC designs pattern generating DOEs using custom in-house developed software. Starting with a target pattern, a phase function is determined which will reconstruct the desired pattern in the far-field, with high efficiency and low stray light. In addition, other diffractive functions such as lens functions, anti-reflection structures, wavelength filtering structures, and combinations of these can be designed and modeled using in-house and commercial software.

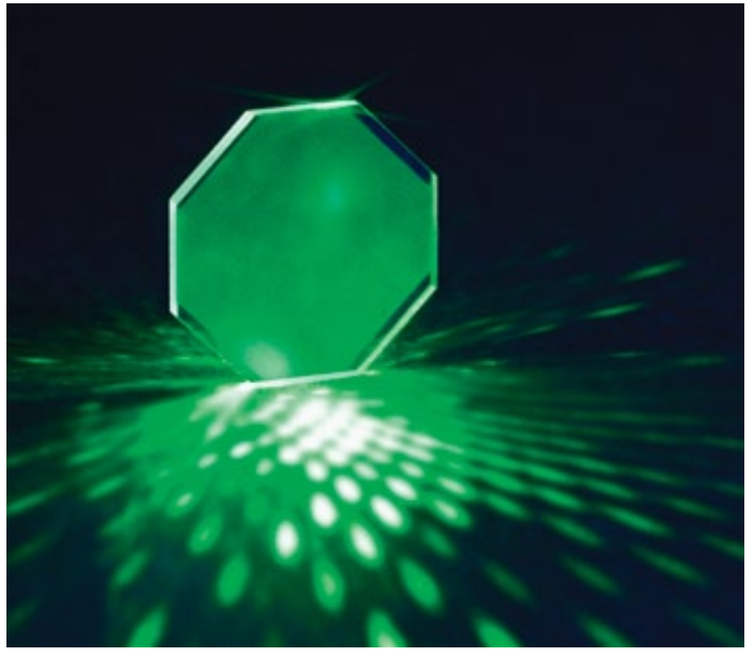
High Volume, High Quality Production Capabilities

DigitalOptics Corporation 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, DigitalOptics Corporation fabricates DOEs with sub-micron features to match

Capabilities

- **Generate nearly arbitrary angular distributions, generally resulting in higher system efficiencies for uniform illumination.**
- **Create customizable intensity profiles or distortion corrections not possible with lens arrays, all with the lowest roll-off regions possible of all competing technologies.**
- **Provide nearly arbitrary phase correction to laser inputs in very compact form factors not possible with refractive elements.**
- **Create anti-reflection and wavelength filtering functions using sub-wavelength structures.**





Optical Functions

- **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**
- **Ultra-compact imaging systems**
- **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**

each application's customized requirements. Comprehensive, automated, in-house test systems provide full process and quality controls.

DigitalOptics Corporation's state-of-the-art 100,000 ft2 ISO registered facility for wafer-level optic fabrication provides manufacturers high repeatability, offering consistent performance between first article and follow-on orders.

Enhanced Capabilities with Deep UV (DUV) lithography

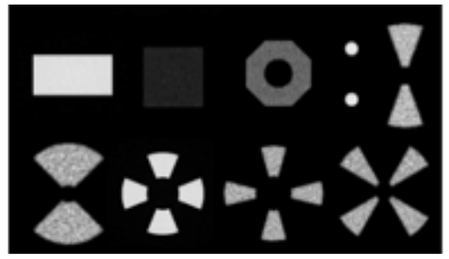
DOEs create patterns through diffraction. The larger the output pattern, the smaller the features which are required to create it. Feature sizes also scale with wavelength. Thus, in order to make diffractives for use with shorter wavelengths, smaller feature sizes must be patterned. In addition, for higher efficiency, low stray-light designs, with multiple phase levels need to be patterned. This necessitates both small features and extremely tight overlay of one level to the next. DOC's advanced manufacturing tools enable fabrication of highly precise small features, resulting in higher performance and significant reduction of stray-light. DOC 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, or product variability will be too large. Using the DUV lithography capability at DOC, diffractive elements made in rugged ArF grade fused silica or crystal quartz are able to satisfy the very demanding requirements of this industry.

DOC Diffractive Optics

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



Controlled Angle patterns