Properties of Diffractive Optical Elements

The different types of DOEs (beam splitters, Fourier holograms, beam shapers, diffusers and various grating structures) act like optical processors, splitting or reshaping light to almost any desired distribution. Additionally, diffractive optics can realize almost the same optical functions as refractive optics such as lenses, prisms or aspheres, but they are much smaller and lighter. DOEs are not limited to laser applications; partially coherent light from LEDs or other light sources can also be modulated.

Problem Analysis & Feasibility Studies

The first step is the work towards a specification that contains all relevant parameters. In some cases, a feasibility study is required. HOLOEYE offers a range of off-the-shelf diffractive optical elements. Proof-of-concept experiments with these elements are often helpful for the derivation of the specification. In addition, as a supplier of spatial light modulator (SLM) technology, HOLOEYE also has the capability to demonstrate optical functions of DOEs experimentally using SLM devices as switchable optical elements.

Steps towards the solution:

- System analysis
- Feasibility studies
- Experimental investigation with HOLOEYE DOE standard products or SLMs
- Custom design of diffractive elements according to customer specifications
- Fabrication of prototypes
- Tooling for DOE replication
- Replication of diffractive elements
- Optical performance tests

Design & Simulation of Diffractive Optical Elements

HOLOEYE uses computational design methods like Iterative Fourier Transform Algorithms (IFTA), direct binary search (DBS) algorithms, gradient search algorithms and methods based on the determination of geometrical map transformations. We can design DOEs for patterns on inclined surfaces and with arbitrary angles of diffraction. This allows us to precisely place diffraction spots freely on a target surface. The obtained element design will be verified in scalar or rigorous wave-optical simulations prior to fabrication.

Fabrication of DOEs

The fabrication technology should be carefully chosen depending on the specification and the target production volume. Fabrication options include

(A) High-quality fabrication by lithography for single pieces or low element numbers
(B) High-precision low-volume to medium-volume replication
(C) High-volume low-cost replication

First the design data is optimized for minimum fabrication error dependency. The lithography technology will be chosen to meet specifications on the one hand and to minimize cost on the other hand.
We need to know the following parameters for the development of your customized DOE:

**Light Source:**
- Type (cw laser, pulsed laser, LED, other)
- Wavelength (center and bandwidth)
- Polarization
- Power/Energy (average and/or peak)
- Beam profile (diameter, divergence, M² quality)

**Optical Function:**
- Desired light field distribution (shape, uniformity)
- Working distance
- Field of view / Diffraction angles
- Target surface inclination and/or shape

**Application:**
- Eye Safety requirements
- Element form factor (size, shape)
- Element material
- Environmental conditions
- Packaging of elements
- Sensor and/or screen type for light field (CCD/CMOS/ human eye/…)

Last but not least, the target annual production and a price target are required to choose the best solution.

**Quality Assurance and Implementation Support**

After fabrication, HOLOEYE will validate the compliance of the DOEs with the specification experimentally. When replicating elements in larger numbers, optical key properties will be monitored using automated equipment.

Upon customers’ request, we are ready to visit the customer’s laboratories and provide assistance regarding the actual implementation of the DOE into the customer’s system.