Compact Tunable Lens

Diffractive Optical Elements (DOEs) with continuously adjustable optical power

Two specifically structured DOEs are cascaded to obtain various optical elements like lenses, axicons or spiral phase plates. Their optical power is continuously adjustable, simply by rotating the DOEs with respect to each other.

Application: Tunable Lens

Due to the Moiré effect a mutual rotation of the DOEs lead to a lens of certain refractive power, depending on the rotation angle $\varphi$.

Principle:

The DOEs possess a surface structure that shifts the phase of monochromatic light in the range between 0 and 2$\pi$. The superposition of the complementary structured DOEs have the same effect as a corresponding Fresnel lens.
Application fields & Markets

**Imaging**
- Lightweight & compact zoom optics for cameras, mobile phones or microscopes, adjustable eyeglasses, human eye like imaging systems

**High Power**
- Laser-engraving, -marking & -cutting, scanheads for highpower applications

**Beam projection**
- Adjustable illumination systems, lamps & headlights, varifocal automotive lighting, scanners, projectors, printers, etc.

**Laboratory equipment**
- Adjustable multipurpose devices for optical prototyping, etc.

**Scientific and front-end**
- Laser beam shaping & modulation, production of doughnut beams in optical tweezers & interferometers, etc.

**Further applications**
- Thermography, infrared imaging, applications for terahertz radiation, varifocal ultra-sound lenses

Summary: Special high-end applications as well as numerous low-end mass products

Offset optical power can be implemented, optical efficiency up to 90%, chromatic aberrations computationally reducible, combination with “standard” optics (e.g. glass lenses) permits compensation of dispersion effects

Realization of Zoom Optics without Lens Translation

**Results:**

**Setup:**

Test image at different magnification factors

<table>
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<th>M</th>
<th>1.35</th>
<th>2.71</th>
<th>4.11</th>
<th>6.92</th>
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<td><img src="image2.png" alt="Image" /></td>
<td><img src="image3.png" alt="Image" /></td>
<td><img src="image4.png" alt="Image" /></td>
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</tbody>
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1 mm

250 μm