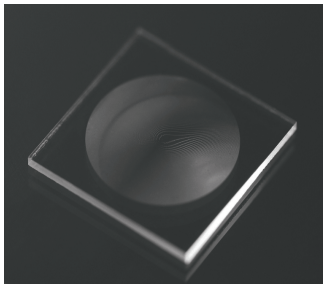
Compact Tunable Lens

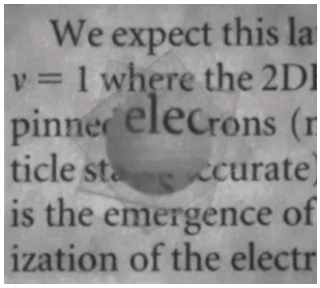
Diffractive Optical Elements (DOEs) with continuously adjustable optical power

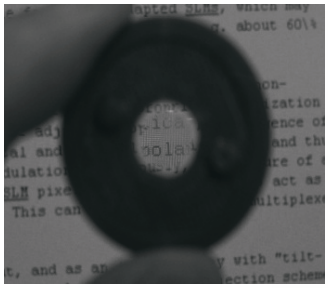
Two specifically structured DOEs
are cascaded to obtain various optical elements
like **lenses**, axicons or spiral phase plates.

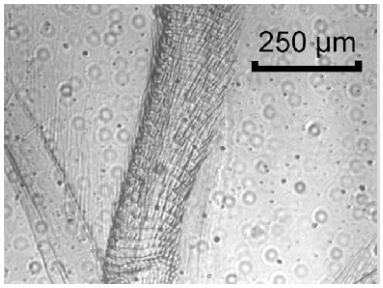
Their optical power is continuously adjustable,
simply by rotating the DOEs
with respect to each other.

+ Flexible lens material
  - → Low fabrication costs
  - → High power applications
+ Focal spot stays on optical axis
+ Compact design (thin and lightweight)
+ Scalable in size, wavelength and power
+ Diffraction limited resolution (monochromatic light)
+ Continuous, simple and exact variation of optical-properties within a wide range (e.g. D= ±25 dpt)



DOE


cascaded to build a lens


prototype with housing



resolution diffraction limited

Application: Tunable Lens

Protected under patent family WO 2009/012789 A1

USA:	*granted*
RUSSIA:	*granted*
JAPAN:	*granted*
EUROPE:	*pending*

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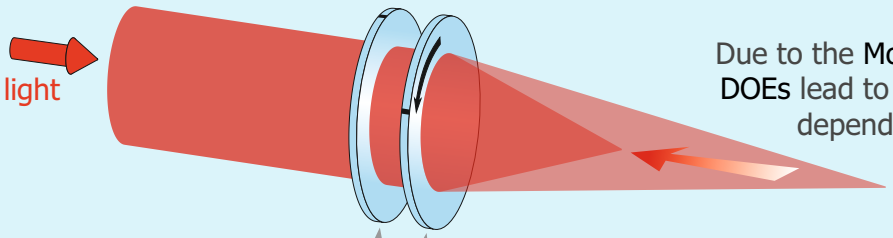
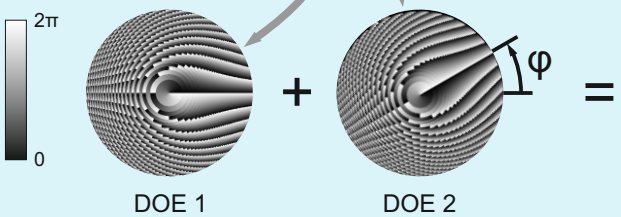
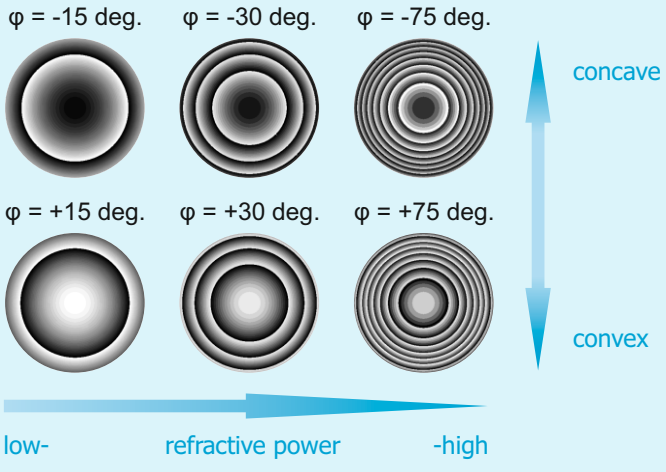


Due to the Moiré effect a mutual rotation of the DOEs lead to a lens of certain refractive power, depending on the rotation angle φ.

Principle:



The DOEs possess a surface structure that shifts the phase of monochromatic light in the range between 0 and 2π. The superposition of the complementary structured DOEs have the same effect as a corresponding Fresnel lens.



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Application fields & Markets

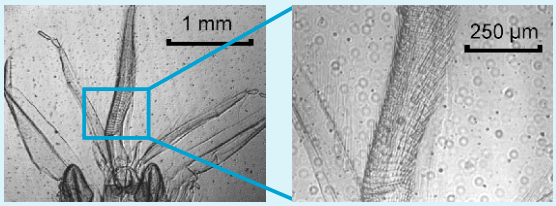
Imaging	lightweight & compact zoom optics for cameras, mobile phones or microscopes, adjustable eyeglasses, human eye like imaging systems
High Power	laser-engraving, -marking & -cutting, scanheads for highpower applications
Beam projection	adjustable illumination systems, lamps & headlights, varifocal 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

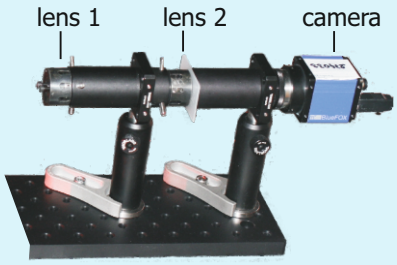
offset optical power can be implemented,
optical efficiency up to 90%, chromatic aberrations computationally reducible,
combination with "standard" optics (e.g. glass lenses) permits
compensation of dispersion effects

Realization of Zoom Optics without Lens Translation

Results:



Setup:



Test image at different magnification factors

M = 1,35 M = 2,71 M = 4,11 M = 6,92