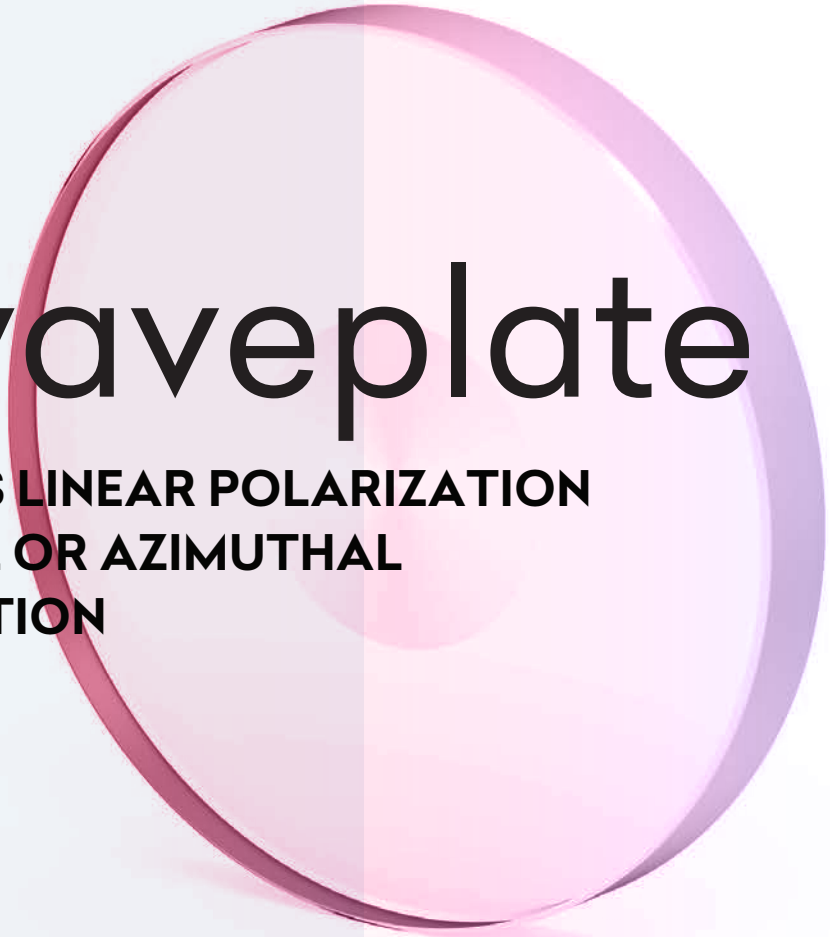
WORKSHOP OF PHOTONICS



s-waveplate

CONVERTS LINEAR POLARIZATION TO RADIAL OR AZIMUTHAL POLARIZATION

WHY CHOOSE S-WAVEPLATE?

- Best choice for converting:
  - linear polarization to radial or azimuthal polarization;
  - circular polarization to an optical vortex.
- 94% transmission @ 1030 nm (no AR coating).
- Stand-alone – no additional optical elements needed.
- Suitable for high LIDT applications and high-power lasers.
- Reliable and resistant surface – the structure is inside the bulk.

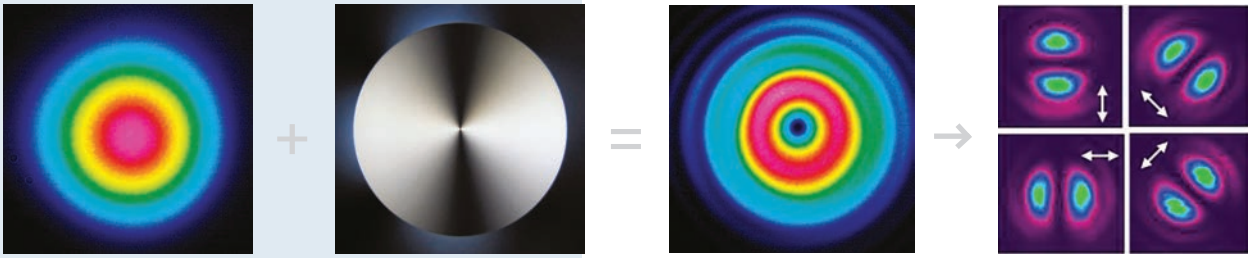
Get in touch
www.wophotonics.com

Mokslininku st. 6A,
08412 Vilnius, Lithuania

+370 5 215 7551
info@wophotonics.com

S-waveplate

It is a space-variant retarder that converts linear polarization to radial or azimuthal polarization and circular polarization to an optical vortex. Fabrication of S-waveplate is based on the inscription of self-organized nanograting's inside fused silica glass using a femtosecond laser.

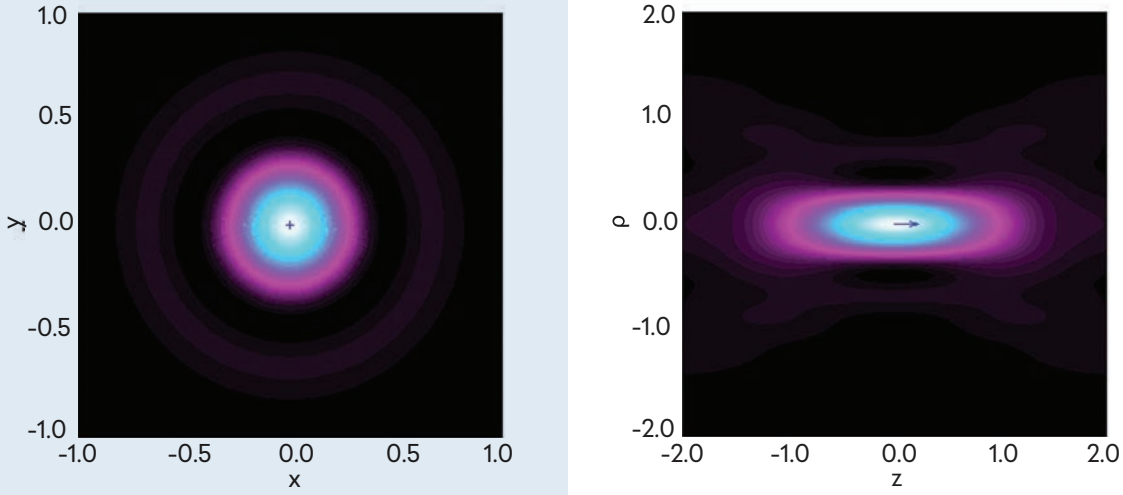


Linear polarization | S-waveplate | Radial/azimuthal polarization | After linear polarizer

Beams with radial or azimuthal polarization attract significant interest due to unique optical properties associated with their inherent symmetry. Such beams enable resolution below the diffraction limit and interact without the undesirable anisotropy produced by linearly polarized light.[1]

S-waveplate can be beneficial in polarization-sensitive applications. For example, a radially polarized beam is more efficient at drilling and cutting high-aspect-ratio features in metals. Vector beams are also applicable in optical tweezers, laser micromachining, STED microscopy, and two-photon-excitation fluorescence microscopy.

Application example:



Normalized intensity of the longitudinal (z-) component of a high-NA (1.32) radially polarized beam at focus and through focus. Intensities of 0 and 1 correspond to black and white, respectively. The units of x, y, ρ, and z are in wavelengths.[2]

[1] Radially polarized optical vortex converter created by femtosecond laser nanostructuring of glass Martynas Beresna, Mindaugas Gecevičius, Peter G. Kazansky, and Titas Gertus.
[2] Focusing of high numerical aperture cylindrical-vector beams KS Youngworth, TG Brown - Optics Express, 2000

Higher order S-waveplate

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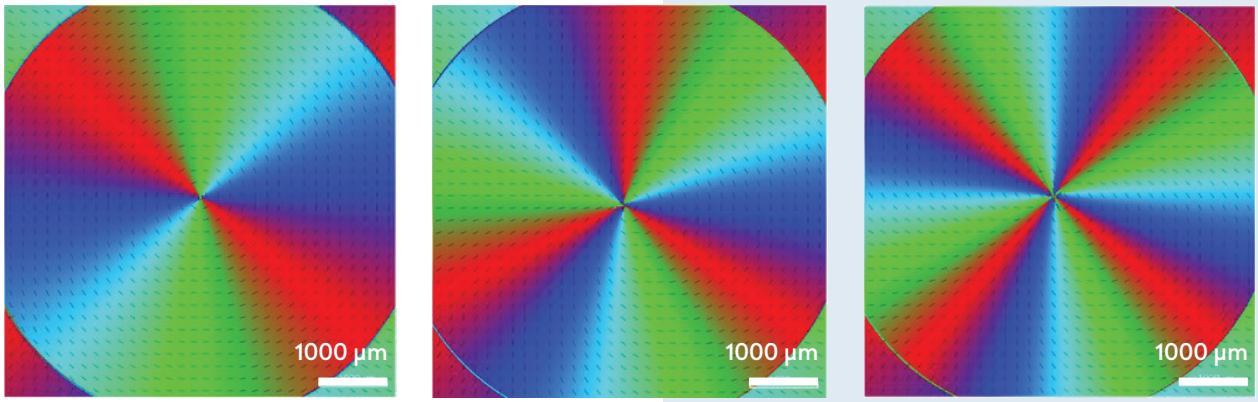
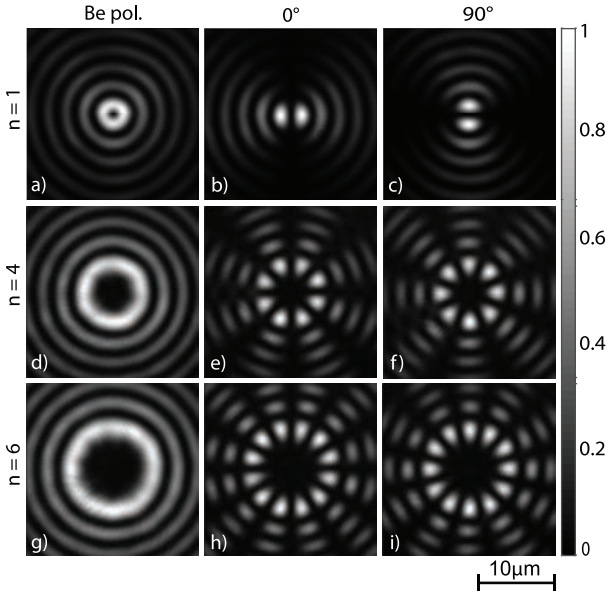
It is similar to ordinary - converts linear polarization to radial or azimuthal polarization. However, this product can generate higher topological charge optical vortices.

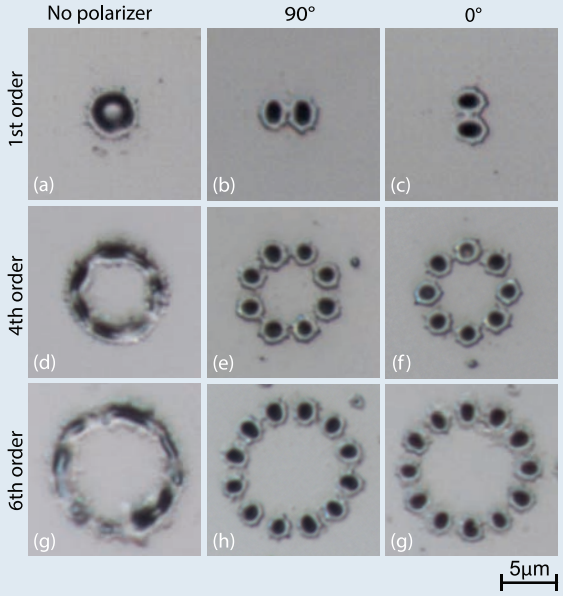


Examples of fast axis patterns for 2nd (left), 3rd (center) and 4th (right) order S-Waveplates (measured with Hinds Instruments Exicor MicroImager).

Combining HOS with an axicon enables obtaining vector Bessel beams (VBB) that can be used for efficient drilling of transparent materials.



Transparent material modification on the D263t glass sample surface with higher order VBB's and their transverse polarization components. 1'st, 4'th and 6'th order VBB damages are depicted in a, d, and g respectively. The single polarization component of the appropriate VBB are depicted in second and third column. [3]



Beam spatial intensity profiles of the1'st, 4'th and 6'th order vector Bessel beams (a, d, g) and their single polarization component spatial intensity distribution when polarizer was rotated at two different angles. When the polarizer was parallel to incoming polarization (0 deg) beam intensity profiles are depicted in second column and when polarizer was perpendicular (90deg) beams are depicted in third column. [3]

[3] Justas Baltrukonis, Orestas Ulcinas, Pavel Gotovski, Sergej Orlov, Vytautas Jukna, "Realization of higher order vector Bessel beams for transparent material processing applications," Proc. SPIE 11268, Laser-based Micro- and Nanoprocessing XIV, 112681D (2 March 2020); doi: 10.1117/12.2545093

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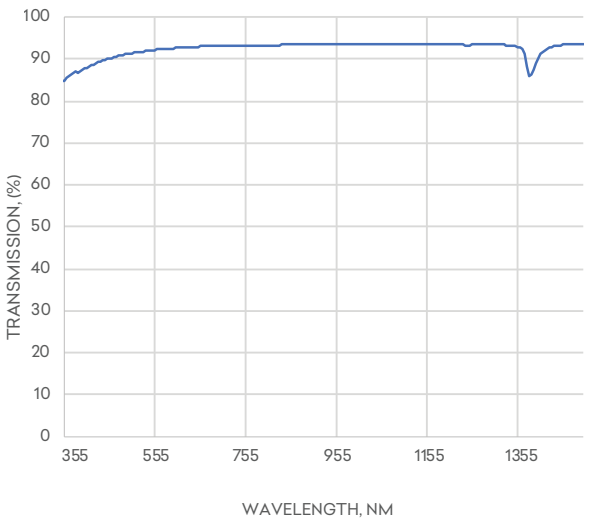
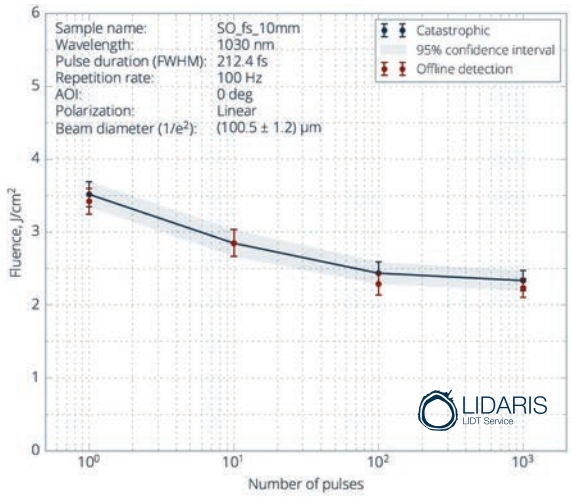
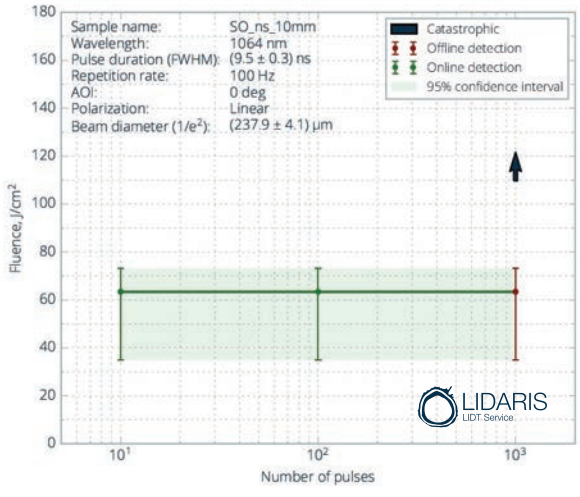


Transmission of uncoated s-waveplate



LIDT at femtosecond regime



LIDT at nanosecond regime

Technical features

- LIDT | High damage threshold:

  63,4 J/cm² @1064 nm, 10ns
  2,2 J/cm² @1030 nm, 212fs

- High transmission (no AR coating):

  94% @ 1030 nm, 92% @ 515 nm,
  85% @ 343 nm of most SS lasers

- Large aperture possible - up to 15mm

Application examples

- STED microscopy
- Micromachining
- Micro drilling high-aspect-ratio channels
- Generate any cylindrical vector vortex
- Multiple particle trapping
- Micro-mill is driven by optical tweezers
- Use as an intracavity polarization-controlling element in cladding-pumped ytterbium-doped fiber laser for radially polarized output beam generation

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