海纳光学
HIGHLIGHT OPTICS

S-waveplate

Converts linear polarization to radial or azimuthal polarization

Why choose an 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.

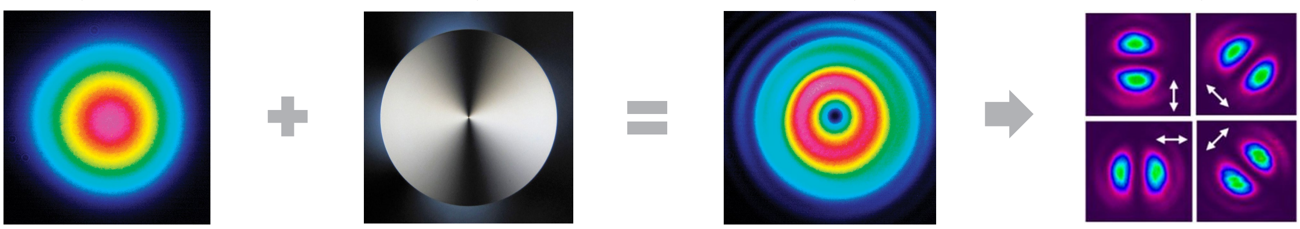
Description

S-waveplate

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

Beams with radial or azimuthal polarization attract significant interest due to having 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-waveplates can be beneficial for 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:

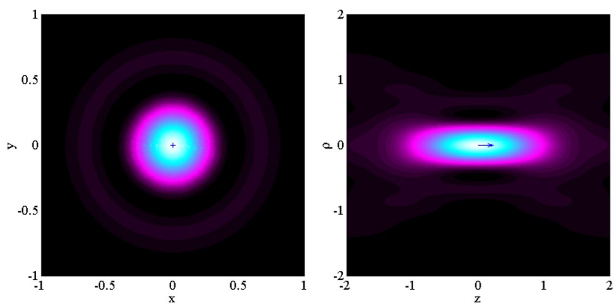


Figure 1. Normalized intensity of the longitudinal (z-) component of a high-NA (1.32) radially polarized beam at focus and through focus. Intensities of 0 and 1 correspond to black and white, respectively. The units of x, y, ρ, and z are in wavelengths.[2]

Higher-order S-waveplate

Higher-order S-waveplate converts linear polarization to higher-order polarization patterns.

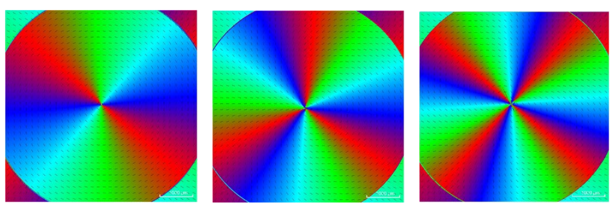


Figure 2. Examples of fast axis patterns for 2nd (left), 3rd (center) and 4th (right) order S-Waveplates (measured with Hinds Instruments Exicor MicroImager).

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[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

Combining HOS with an axicon enables vector Bessel beams (VBBs) to be obtained that can be used for the efficient drilling of transparent materials.

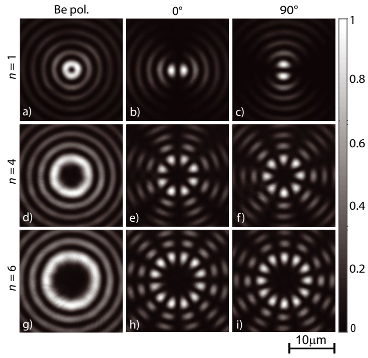

Figure 3. Beam spatial intensity profiles of the 1st, 4th and 6th order vector Bessel beams (a, d, g) and their single polarization component spatial intensity distribution when polarizer was rotated at two different angles. When the polarizer was parallel to incoming polarization (0°) beam intensity profiles are depicted in second column and when polarizer was perpendicular (90°) beams are depicted in third column.[3]

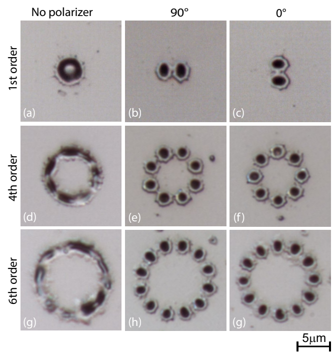

Figure 4. Transparent material modification on the D263t glass sample surface with higher order VBB's and their transverse polarization components. 1st, 4th and 6th order VBB damages are depicted in a, d, and g respectively. The single polarization component of the appropriate VBB are depicted in second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

Technical features:

- LIDT High damage threshold: 63.4 J/cm² @1064 nm, 10 ns 2.2 J/cm² @ 1030 nm, 212 fs
- High transmission (no AR coating): 94% @ 1030 nm, 92% @ 515 nm,
- 85% @ 343 nm of most SS lasers
- Large aperture possible - up to 15 mm

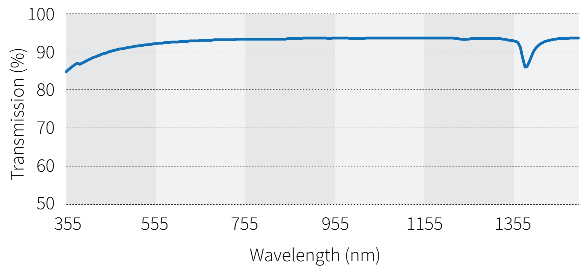

Figure 5. Transmission of uncoated S-waveplate.

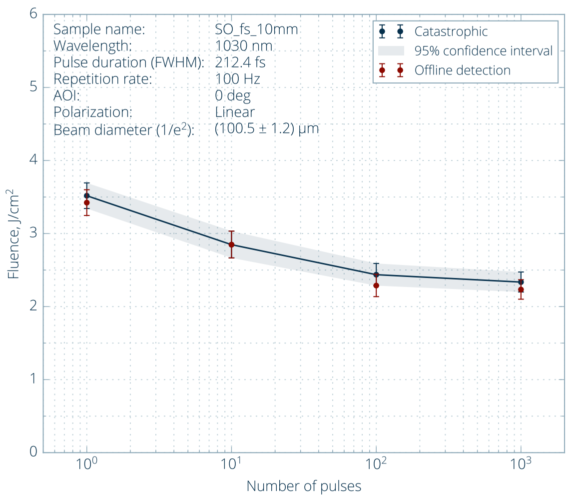

Figure 6. LIDT at femtosecond regime.

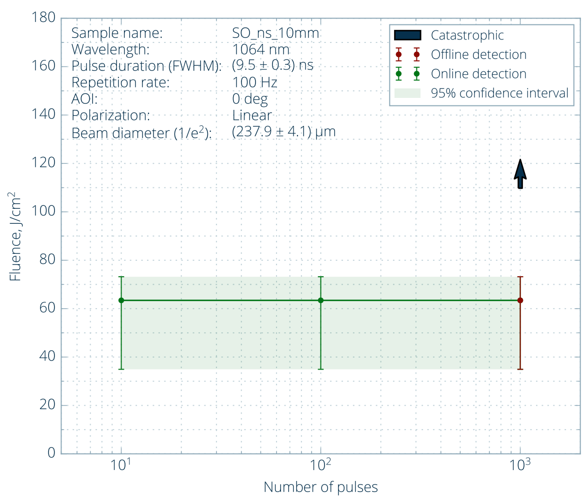

Figure 7. LIDT at nanosecond regime.

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

[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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Typical Items for S-waveplates (Radial/Azimuth Polarization Converters)

工作波长 (nm)	中心波长带宽 (nm)	透射率 (%，不镀膜)	透射率 (%，镀膜)	通光孔径 (mm)	产品型号
343/355	±15	>80	>87	2	RPC-0343-02
				4	RPC-0343-04
				6	RPC-0343-06
				8	RPC-0343-08
				10	RPC-0343-10
				15	RPC-0343-15
488	±15	>85	>92	2	RPC-0488-02
				4	RPC-0488-04
				6	RPC-0488-06
				8	RPC-0488-08
				10	RPC-0488-10
				15	RPC-0488-15
515/532	±20	>90	>97	2	RPC-0515-02
				4	RPC-0515-04
				6	RPC-0515-06
				8	RPC-0515-08
				10	RPC-0515-10
				15	RPC-0515-15
633	±20	>92	>99	2	RPC-0633-04
				4	RPC-0633-06
				6	RPC-0633-08
				8	RPC-0633-10
				10	RPC-0633-15
				15	RPC-0800-02
780/800	±25	>92	>99	2	RPC-0800-04
				4	RPC-0800-06
				6	RPC-0800-08
				8	RPC-0800-10
				10	RPC-0800-15
				15	RPC-1030-02
1030/1064	±35	>92	>99	2	RPC-1030-02
				4	RPC-1030-04
				6	RPC-1030-06
				8	RPC-1030-08
				10	RPC-1030-10
				15	RPC-1030-15
1550	±40	>92	>99	2	RPC-1550-02
				4	RPC-1550-04
				6	RPC-1550-06
				8	RPC-1550-08
				10	RPC-1550-10
				15	RPC-1550-15