Patterned birefringent polarization converters fabricated by femtosecond laser direct writing

T. Gertus[1], P. G. Kazansky[2]

1- Workshop of Photonics, Altechna R&D, Mokslininkų 6A, Vilnius, Lithuania

2- Optoelectronics Research Centre, University of Southampton, SO17 1BJ, UK

titas@altechna.com

Under certain exposure conditions, focused femtosecond light pulses can induce self-assembled nanogratings inside bulk of fused silica glass. Orientation of nanogratings is always perpendicular to incident light polarization. Induced nanograting period varies from 140 nm to 320 nm [1]. By changing incident light power and polarization orientation we can control induced retardance and slow axis of fabricated birefringent patterns. Induced nanogratings exhibit birefringence that provide retardance as large as 260 nm, which is sufficient for performing the required polarization conversion at visible and near-infrared wavelengths. Recently radially polarized optical vortex converter [2], Fresnel zone plates, polarization diffractive gratings, radial or azimuthal polarization converters were fabricated by inducing nanogratings in fused silica bulk [3].

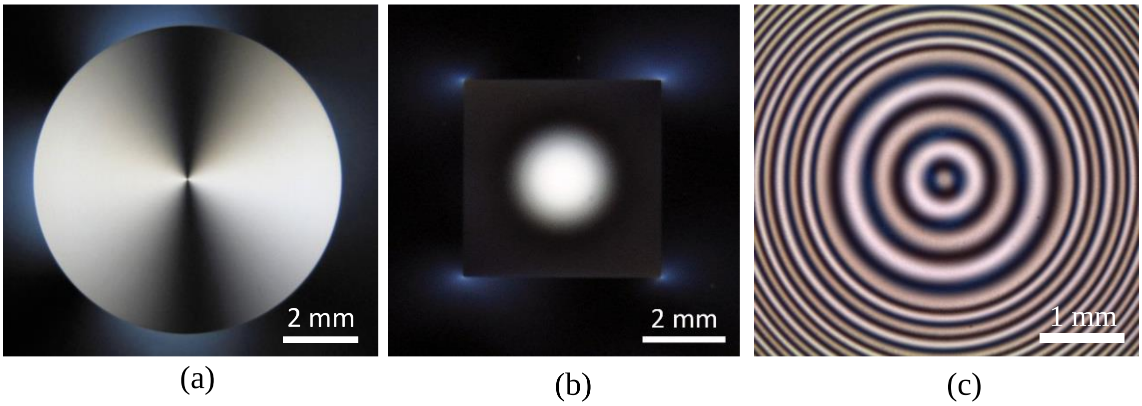

Figure 1 cross-polarized light photos of custom birefringent structures (a) radial or azimuth polarization converter, (b) Gaussian function shaped aperture and (c) sinusoidal zone plate fabricated by femtosecond laser direct writing.

Here we present fabrication of various spatially variant birefringent optical elements, such as linear to radial or azimuthal polarization converter (Figure 1, a), Gaussian function aperture (Figure 1, b), sinusoidal zone plate (Figure 1, c). Custom birefringent patterns (half-wave or quarter-wave) are used for tailored polarization conversion in advanced applications, such as stimulated emission depletion (STED) microscopy [4], tip-enhanced near-field coherent anti-Stokes Raman scattering microscopy [5], optical trapping and manipulation [6], surface plasmon excitation [7], laser beam shaping [8], micromachining [9] and particle acceleration [10].

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