Tailored femtosecond laser beam focused by using microscope objective lenses

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Femtosecond laser-material processing using microscope objective lenses leads to high processing resolutions, thanks to the combined effect of ultra-short pulse lengths and small focal spot size. This has been developed in many applications, for example the Bessel beam generation for Nano-channel fabrication [1] and subsurface waveguides writing [2]. The state of polarization has a strong influence on the focusing properties of the beam, especially under high numerical aperture (NA) conditions. Laser beams with uniform polarization states (i.e. linear or circular polarizations) are widely used in many applications, since their focussing properties are well known. However, inhomogeneous states of polarizations (such as radial and azimuthal) have attracted significant interest in recent years, since they induce distinct focal field characteristics compared with uniform polarizations. The objective lenses have the ability of focusing laser beams into a near diffraction limited size, which makes micro-scale processing possible.

This research introduces the analyse of femtosecond laser beam focused under microscope objective lens with different NAs. By using a double liquid crystal spatial light modulator (LC-SLMs) system, the laser beam polarization, wavefront, as well as the intensity distribution have been modified. The footprints on polished single crystal silicon reveal the intensity distribution of the laser beam in Fourier plane. By designing tailored input laser beams, specific structured focus can be obtained, leading to high-quality and high-efficiency micro-scale processing.

[1] F. Courvoisier, M. K. Bhuyan, M. Jacquot, P. A. Lacourt, R. Salut, L. Furfaro (2011) High aspect ratio taper-free micro and nano-channel fabrication in glass with ultrafast nondiffracting Bessel beams, SPIE LASE, Vol. 7921, pp. 79210K

[2] V. Diez-Blanco, J. Siegel, A. Ferrer, A. Ruiz de la Cruz, J. Solis (2007) Deep subsurface waveguides with circular cross section produced by femtosecond laser writing, Applied Physics Letters, vol. 91, pp. 051104