

WHITE LIGHT LASERS FOR CONFOCAL MICROSCOPY

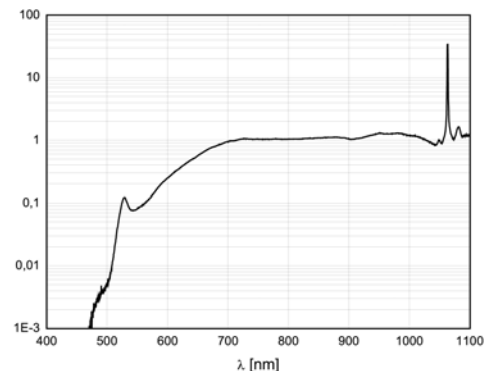
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Scanning optical microscopy owes its origins and rapid adoption to availability of bright spatially coherent light sources – lasers. The ability to focus such light source into a diffraction-limited spot, via the use of high numerical aperture objective lenses, proved to be the key to the development of a wide range of applications, stretching from biology to material science and electronics. As the number of such applications grew so did the realisation of the drawbacks of these sources: limited range of fixed wavelengths available and relative expensiveness, to name but two.

Recent advances in non-linear fibre optics and, in particular, photonic crystal fibres (PCF) offers an alternative light source for confocal microscopy: spectral continuum generated in a single mode PCF excited by a pulsed laser. This source, which combines seemingly irreconcilable properties of very broad emission spectrum and perfect spatial coherence, can be justifiably called white light laser. A number of recent papers used PCFs pumped by Ti:Sapphire lasers in fluorescence microscopy [1] and optical coherence tomography [2]. In our work we chose to use a microchip Nd:LSB laser as a pump source. Not only this greatly simplified the optical setup, but also produced a light source comparable in size, power consumption and price tag to arc lamps used in traditional fluorescence microscopy.

We employed a 10STA-01 laser (Standa, Vilnius, Lithuania), which produced 150 mW at 1062 nm in 600 ps pulses at 25 kHz repetition rate, together with a 20 m long section of PCF (Blaze Photonics, Bath, UK) with zero dispersion at 1040 nm [3] to produce supercontinuum radiation spanning from 500 to 2000 nm. Part of this spectrum in visible and near IR is shown on the right. This light was then used in a variety of confocal setups. Thus we produced fluorescence images using both common immunofluorescence and quantum dots for staining. We also used white light laser in conjunction with a Yokogawa lenslet-array Nipkow disk system. The use of broadband sources with this setup proved to be unsuccessful in the past, because high spatial coherence of the source is required.



Because of the uniformity of the spectrum they produce, white light lasers are also very useful tools for quantitative spectral characterisation of optical elements. We took advantage of this property to measure the chromatic aberration of high NA objective lenses. We also revisited the old idea of using a lens with deliberately exaggerated axial chromatic aberration to achieve high-speed confocal profilometry. We will be discussing these results as well as some challenges that remain, in particular coping with the low pulse repetition rate of such sources and extending their spectrum to blue wavelengths.

- [1] G. McConnell, Optics Express, v.12, 2844 (2004)
- [2] I.Hartl et al, Optics Letters, v.26, 609 (2001)
- [3] W.J.Wadsworth et al, Optics Express, v.12, 299 (2004)