DEVELOPMENT OF SIMPLE AND ROBUST FEMTOSECOND OPTICAL PARAMETRIC OSCILLATOR FOR MULTIPHOTON IMAGING

Ignas Stasevičius,[1,2] Mikas Vengris,[1]
[1]Vilnius University, Laser Research Centre, Vilnius, Lithuania
[2]Light Conversion Ltd, Vilnius, Lithuania
Author e-mail address: ignas.stasevicius@lightcon.com

Keywords: femtosecond optical parametric oscillator, second harmonic of Ytterbium pump, numerical modelling, multiphoton imaging.

1. Abstract:

Femtosecond optical parametric oscillators (OPO's) are attractive sources for tunable femtosecond light pulses in near-infrared range, especially suitable for multiphoton microscopy [1]. Current state of art OPO systems for multiphoton microscopy are invaluable tools, but their setups are complicated, hence sometimes being unreliable or unavailable for a big part of multiphoton imaging community. We present simple cavity length tunable and chirped mirror based optical parametric oscillator with LBO nonlinear crystal and tunable in the wavelength range of 780-970 nm. The OPO is pumped by second harmonic of femtosecond Yb:KGW Kerr lens mode locked oscillator emitting 3W of output power in the fundamental wavelength and 1.7W of second harmonic, resulting in ~60% conversion efficiency. Repetition rate of the pump oscillator is 75 MHz. In our experimental setup, we tuned the output wavelength only by adjusting cavity length while using broad amplification bandwidth nonlinear crystal without the need of crystal rotation. The OPO emits maximum output power of 400 mW at 860 nm, with lowest power of 150 mW at 970 nm. The bandwidth is limited by the reflection range of resonator mirrors as well as crystal amplification bandwidth. The resonator dispersion is controlled by chirped mirrors with negative group delay dispersion. Compensation of negative group delay dispersion is required to compensate positive group delay dispersion of LBO nonlinear crystal as well as positive group delay dispersion induced by self and cross phase modulation of the resonating signal [2,3]. The pulse duration varies between 50 and 320 fs through the tuning range. The simultaneous modelling in time and spatial domain allows to model intensity dependent phase modulation effects and allows understanding interplay of negative group delay dispersion and self / cross phase modulation. The experimental results are compared with numerical modelling while solving coupled electric field equations in spatial and time domain to include the effects of self and cross phase modulation. The given results pave a way for simple and robust optical parametric oscillator as a tool for multiphoton imaging.

2 . References

1. W. Tian, Z. Wang, "High-power, widely tunable, green-pumped femtosecond BiB3O6 optical parametric oscillator", *Optics Letters*, Vol. 41, No. 21, 4851-4854 (2016).

2. G. M. Gale, M. Cavallari, F. Hache, "Femtosecond visible parametric oscillator", *J. Opt. Soc. Am. B.* **15**, 702-715 (1998).

3. J. Hebling, E.J. Mayer, J. Kuhl, "Chirped-mirror dispersion compensated femtosecond optical parametric oscillator", *Optics Letters*, Vol. 20, No. 8, 919-922 (1995).