In-band Pumped Nd:$LuVO_4$ Laser Mode Locked by $\chi^{(2)}$-Lens Formation in an LBO Nonlinear Crystal

V. Aleksandrov, H. Iliev, I. Buchvarov

Department of Physics, University of Sofia, 5 James Bourchier Boulevard, BG-1164 Sofia, Bulgaria
e-mail: vn.aleksandrov@abv.bg

Multi-Watt operation of picosecond diode-pumped Nd^{+3} doped laser oscillators has been demonstrated mainly by two passive mode-locking techniques, one based on semiconductor saturable absorber mirrors (SESAMs) and the other on intracavity frequency doubling. Although passive mode-locking by SESAMs is well established approach for ps-pulse generation around 1 μm, their residual absorption, leading to heating, is an intrinsic drawback that limits their power-scaling capabilities. Besides, their production requires complicate equipment. However, the potential of $\chi^{(2)}$-lens formation in nonlinear crystal for second harmonic generation (SHG) related to its transparency at the fundamental wave and shorter pulse generation seems not to have been exploited effectively, yet. Indeed, in diode-pumped mode-locked Nd-lasers using intracavity SHG for instance, mostly crystals with higher nonlinearly have been used up to now and the shortest pulses of 2.8 ps were obtained in the case of Nd:$GdVO_4$ lasers emitting at 1.06 μm while the output power is modest [1]. Although the Nd: $LuVO_4$ has broader bandwidth among vanadate family, the shortest pulses obtained so far at multi-watt operation are longer than 10 ps exploiting SESAM mode-locking technique only [2]. On the other hand, $\chi^{(2)}$-lens mode locking technique shows capability to keep relatively shorter pulse duration at muti-watt level of laser output power [3]. This indicates that this technique has strong potential for high-power mode-locking of broader bandwidth Nd-materials.

In this work we present the results on passive $\chi^{(2)}$-lens mode-locking of a Nd: $LuVO_4$ laser pumped by 808 nm laser diode as well as in-band pumped at 880 nm. An LBO nonlinear crystal has been used for intracavity SHG. With 808 nm pump source and 30 % output coupling, we achieve maximum output power of 2.7 W and 36 % slope efficiency while the measured pulse duration is 7.5 ps. By replacing the pump source with the one having central wavelength around 880 nm, (using the advantages of in-band pumping,) we were able to increase the output power with ~ 89 % up to 5.1 W while the pulse duration was 5.6 ps. The shortest pulse duration obtained for Nd:$LuVO_4$ is 1.6 ps while the output power is 0.7 W. The repetition rate in both cases was ~ 111 MHz, determined by the cavity roundtrip time.

Acknowledgements: We acknowledge financial support under bilateral scientific project between Romania and Bulgaria (grant number DNTS 02/24/2010) and grant number DDVU 02/105/2010 of the Bulgarian national science fund.

References

[1] S. Holmgren, V. Pasiskevicius, F. Laurell, Optics Express, vol. 13, pp. 5270 (2005).
[3] G. Xie, D. Tang, H. Luo, H. Yu, H. Zhang, L. Qian, Laser Physics Letters, vol. 5, pp. 647 (2008).
[3] H. Iliev, I. Buchvarov, S. Kurimura, V. Petrov, Optics Letters, vol. 35, pp. 1016 (2010).