3rd National Congress on Physical Sciences, 29 Sep. – 2 Oct. 2016, Sofia
Section: Radiophysics, Electronics and Quantum Electronics

Mode-Locking of Lasers with Broad Band Gain Spectrum Using Second Order Nonlinear Processes

V. Aleksandrov[1], **L. Petrov**[1], **I. Buchvarov**[1,2]

[1]Faculty of Physics, St. Kliment Ohridski University of Sofia,
5 James Bourchier Blvd., BG-1164 Sofia, Bulgaria
[2]ITMO University, 197101 St.-Petersburg, Russia

Abstract. Ultrashort (picosecond or femtosecond) laser pulses with high average power ($>$ 1 W) have attracted significant attention because of their applications in precise micromachining, time-resolved spectroscopy and nonlinear frequency conversion. However, the popular mode-locking (ML) techniques (SESAM and Kerr lens mode-locking) possess drawbacks, which limit obtaining high average power at minimum pulse duration or prevent mode-locking operation with picosecond pulse duration. An alternative ML technique is based on $\chi^{(2)}$-lens formation in a crystal for second harmonic generation (SHG). $\chi^{(2)}$-lens mode-locking allows generation of transform-limitted pulses at high average power. However, it was demonstrated manly for Nd-doped crystalline lasers.

In this work we report $\mathrm{ch}^{(2)}$-lens mode-locking of a broad amplification bandwidth Yb:YAG laser using a LBO SHG crystal. The laser generates 1.4 ps pulses with output power of 1 W.

The output power in self-starting mode-locking operation is 1 W at absorbed pump power of 45 W (Fig. 1a). The mode-locking operation is

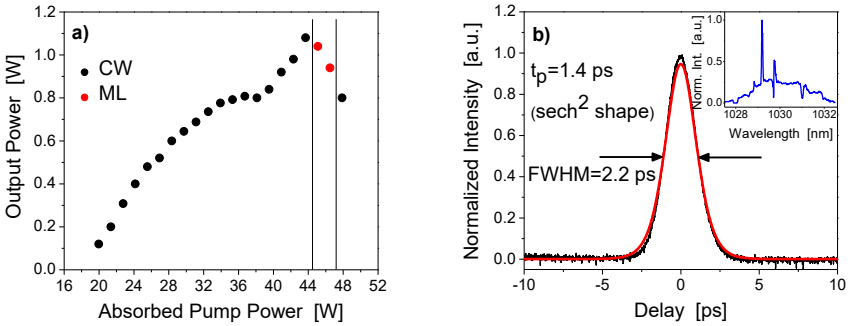

Figure 1: (a) Input-output characteristics of the laser in CW (black dots) and ML operation (red dots). (b) Autocorrelation curve (black line) and fit assuming sech2 pulse shape (red line); optical spectrum (inset).

observed at the region of input–output characteristics close to the maximum achievable output power in CW operation. The pulse duration is 1.4 ps (Fig. 1b). The pulse repetition rate is 120 MHz.

In conclusion, $\chi^{(2)}$-lens mode-locking of a Yb:YAG laser is demonstrated. Self-starting operation is achieved with output power of 1 W and pulse duration of 1.4 ps.