STEADY STATE MODE-LOCKING OF Nd:YVO_4 LASERS OPERATING ON THE 1.34 μm TRANSITION

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Passive mode-locking of Nd-lasers operating on the $^4F_{3/2} \rightarrow {}^4I_{13/2}$ transition around 1.34 μm has been demonstrated using either saturable absorbers [1,2] or intracavity frequency doubling [3]. Currently saturable absorbers at 1.34 μm are mostly based on semiconductor saturable absorber mirrors (SESAMs) [1] or single-walled carbon nanotubes (SWCNT) [2]. The SWCNT technique is a promising approach but it is under development and still not appropriate for multi-Watt operation. Although SESAMs are widely used for passive mode-locking around 1 μm, their fabrication for longer wavelengths is much more difficult and shows relatively high residual absorption and nonsaturable losses which limits the laser output power. Average output powers ~1 W were demonstrated only recently [1] using AlGaInAs based SESAM, but the obtained pulse duration from this Nd:YVO_4 laser is relatively long, 26.4 ps. The intracavity frequency-doubling technique based on type-I SHG provides two different types of passive mode-locking mechanisms: The first one is amplitude modulation based on the intensity dependent reflectivity of the frequency-doubling nonlinear mirror (FDNLM) and the second one is phase modulation based on $\chi^{(2)}$-nonlinear phase shift of the fundamental wave, i.e. $\chi^{(2)}$-lens mode-locking. The same technique has been previously demonstrated on Nd-lasers emitting at 1.06 μm [3]. It is not only practically free of spectral limitation but also enables easier power scaling to the multi-Watt level and in contrast to the Kerr-lens mode-locking and in addition is easily applicable to narrow bandwidth laser materials such as Nd-doped crystals.

In this work we present our experimental results on passive mode-locking of Nd:YVO_4 lasers operating at 1.34 μm using birefringent or periodically poled SHG nonlinear crystals. Bismuth triborate BiB_3O_6 (BIBO) has been proposed as a promising SHG material for this application. Using 7-mm-long BiB_3O_6 nonlinear crystal an average output power of 0.9 W was achieved. The measured FWHM of the autocorrelation trace (5.7 ps) corresponds to pulse duration of 3.7 ps assuming $sech^2$ pulse shape. Similar performance has been observed when 20-mm-long and 1-mm-thick periodically-poled Mg-doped stoichiometric lithium tantalate (PPMgSLT) was used for intracavity SHG. The maximum average output power reached 0.8 W and the pulse durations were ~3.6 ps. In both cases the pulse repetition rate was ~120 MHz. In comparison to previously reported results [1], for the first time high average power and short pulse durations are simultaneously available from a passively mode-locked 1.34-μm diode pumped laser source.

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References:

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