0.6W Single-Frequency Nd:YVO_4/BiB_3O_6 Laser at 671nm

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Abstract: Using a Nd:YVO_4 ring laser and a type-I critically phase-matched BiBO crystal, a record 620 mW single-frequency red laser at 671.2nm is demonstrated. The laser is tunable over $\Delta\lambda$~1.2nm around 671 nm.

OCIS codes: (140.3570) Lasers, single-mode; (190.2620) Frequency conversion

Single-frequency cw lasers in the visible region are very interesting for high precision spectroscopy as alternative to dye lasers. A laser source emitting at 671nm is necessary to laser cool Lithium atoms on the $^2S_{1/2}$–$^2P_{1/2}$ dipolar transition and it could be achieved using intracavity second-harmonic generation of the 1342nm emission line of the Nd:YVO_4. Watt-level power diode-pumped frequency-doubled cw lasers were previously demonstrated at 671nm [1] but without spectral purity (i.e. single-longitudinal mode or SLM) or tunable operation. The largest SLM red power (370mW) was reported by Agnesi *et al* by using a standing-wave cavity in which the type-II cut LBO harmonic generator served also as a birefringent etalon [2]. In this work, in order to avoid hole-burning modes we employ a single-end longitudinally pumped, unidirectional ring resonator containing a type-I cut (θ=8.6°,φ=0°) BiB_3O_6 (BiBO) nonlinear crystal [3] to synthesize as much as 620 mW of single longitudinal mode (SLM) red output at 671nm, which is – to the best of our knowledge – the largest cw SLM red power obtained from such a Nd:YVO_4 laser.

A low-doped (0,15at%) 10 mm long Nd:YVO_4 crystal is used in order to decrease the thermal lens generated inside the crystal, resulting in ~90% absorbed fiber-coupled diode pump power at 808nm. A fused silica thin etalon with facets reflectivity of 40% is placed near the larger beam focus inside the cavity to minimize insertion loss. The unidirectional operation is obtained using a Brewster-cut TGG Faraday rotator and a zero-order half wave plate.

All mirrors are broadband HR-coated dichroic mirrors (R>99.8% in the range 1300-1350nm, with T~90% in the 650-810nm range). The near-IR power leaking through M3 is used for diagnostic purposes (wavelength measurement and spectral analysis by a confocal Fabry-Perot resonator with a FSR=750 MHz free spectral range). The BiBO crystal is placed between two curved mirrors at the smaller cavity waist.

At gain center a maximum SLM red output with 620mW is achieved without etalon (Fig.2b), owing to the self-suppression of longitudinal modes in a homogeneously broadened laser (higher loss experienced by sum frequency processes between longitudinal modes). This corresponds to an optical-to-optical efficiency η=6% at P_{abs}=10W of absorbed pump power. However smooth, stable and extended ($\Delta\lambda_{red}$ ~1.25nm) SLM wavelength tuning requires the insertion of the etalon at the expense of higher losses (Fig.2a).

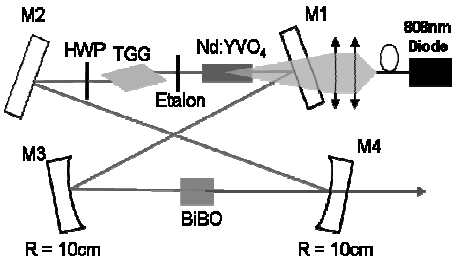

Fig. 1 : Diode end-pumped Nd:YVO_4/BiBO ring laser setup.

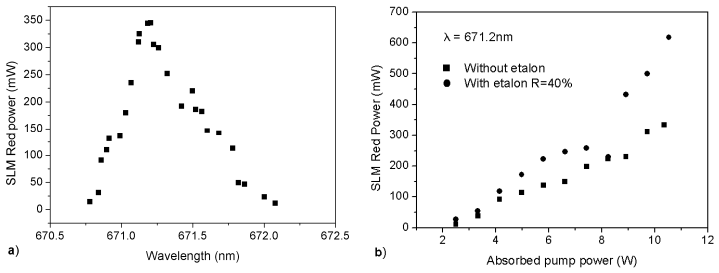

Fig. 2 : Single-frequency red output power versus wavelength (a), taken at P_{abs}=10W with the R=40% etalon, and versus absorbed pump power (b). Without etalon, SLM operation is characterized by frequent mode-hops.

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