CThA6 **9:15 am**

Visible light generation by self-frequency doubling in Nd:YCOB

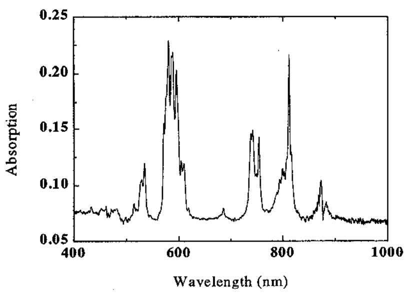
Bruce H.T. Chai, Jason M. Eichenholz, Qing Ye, Won K. Jang, Martin Richardson, *Center for Research and Education in Optics and Lasers, University of Central Florida, 4000 Central Florida Boulevard, Orlando, Florida 32816-2700; E-mail: jason@creol.ucf.edu*

The standard approach to generating high-power, visible laser light is by intracavity second-harmonic generation of near-infrared laser sources using crystals with a large nonlinear coefficient. Nonlinear crystals such as KDP, KTP, and β barium borate (BBO) have been used to frequency convert 1-μm laser sources into the green visible region.

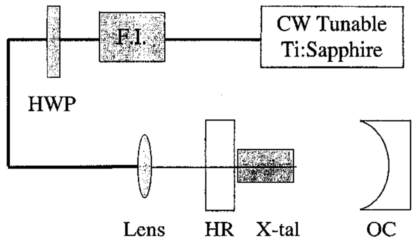
We report on an alternate approach to generate high-power, visible laser light by incorporating the harmonic conversion element into the gain medium. Previous studies of this approach have utilized Nd-doped hosts such as $MgO{:}LiNbO_3$ and $YAl_3(BO_3)_4$.[1,2] In this paper, we describe the first results of self-frequency doubling in one of a new class of laser hosts, the oxoborates. This new laser material, 2% $Nd{:}YCa_4O(BO_3)_3$ (Nd:YCOB) was grown by the Czochralski method. Single crystals can be grown exceeding 40 mm in diameter and 150 mm in length from a congruent melt. The crystals are nonhygroscopic with good optical and mechanical properties, permitting easy fabrication of laser samples. Linear and nonlinear optical properties of undoped GdCOB and YCOB have been reported.[3,4]

Preliminary absorption spectroscopy shown in Fig. 1 indicates several strong absorption peaks near 808 nm, making this material amenable to laser diode pumping. Undoped YCOB has been shown to have a nonlinear coefficient, d_{eff} of 1.1 pm/V, which is between that of KDP (0.37) and BBO (1.94 pm/V).[4,5]

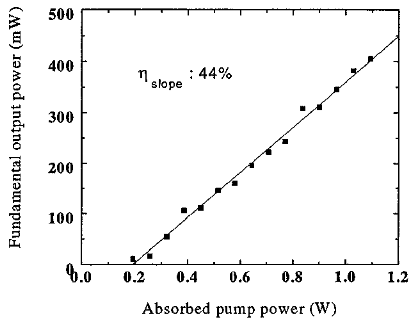
Initial experiments were performed to investigate the potential of this material as a laser medium. A simple hemispherical laser system pumped by a tunable cw Ti:sapphire laser was constructed. Figure 2 shows the linear cavity design consisting of a 5-m radius of curvature high reflector and a 10-cm radius of curvature output coupler. The uncoated 5 mm × 5 mm × 13 mm-long Nd:YCOB crystal was uncooled and was placed next to the high reflector. The pump laser polarization was rotated for maximum absorption in the crystal and focused into the crystal with a 10-cm plano/convex lens. The output power at both the fundamental and self-frequency doubled laser wavelengths were measured for 0, 1%, and 2% output coupling. Figure 3 shows the fundamental output power for 2% output coupling versus absorbed pump power. The minimum pump threshold for lasing at 530 nm was determined to be 97 mW for the lowest transmission output coupler. Slope efficiencies of 44% with fundamental output powers exceeding 400 mW for 1 W of absorbed pump power was observed for 2% output coupling. Green self-frequency doubled output powers of over 0.7 mW have so far been measured for 1 W of absorbed pump power in a laser system in which no measures were yet taken to optimize laser performance. We will report also on further studies that optimize the laser material, resonator, and pump parameters for maximum fundamental and second-harmonic generation.



CThA6 Fig. 1. Absorption spectrum for 2% Nd:YCOB.



CThA6 Fig. 2. Experimental cavity design. F.I., Faraday isolator; HWP, half-wave plate; lens, 10-cm PL/CX lens; HR, 5-m ROC mirror; X-tal, 2% Nd:YCOB; OC, 10-cm ROC output coupler.



CThA6 Fig. 3. Output power at fundamental wavelength versus absorbed pump power.

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CThA7 **9:30 am**

Second-harmonic generation in solar-pumped laser

Mordechai Lando, Yehoshua Shimony, Roth M.J. Benmair,* I. Vishnevetsky,* Amnon Yogev,* *Rotem Industries, P.O.B. 9046, Beer-Sheva 84190, Israel*

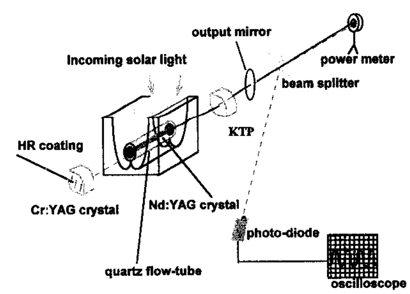
Solar-pumped lasers are candidates for wireless power transmission in space,[1] free space optical communication, and photochemistry. The broad variety of applications necessitates a spectral coverage between the UV and the IR. Here, we report on second-harmonic generation (SHG) of a solar-pumped laser[2] using a type II KTP crystal in an intracavity Q-switched resonator.

Q-switching was obtained either passively by a saturable absorber[3] or actively with an acousto-optic modulator. Concentration of the solar energy that was used to pump the laser was obtained by a 3-stage concentrator; 12 large heliostats, a three-dimensional compound parabolic concentrator (3-D CPC), and a 2-D CPC. A Nd:YAG rod was installed within the reflective 2-D CPC.

In the passively Q-switching mode of operation, shown in Fig. 1, a water-cooled Cr^{+4}:YAG wafer was introduced into the laser resonator for a dual purpose; the bulk material served as a passive Q-switch, while the high reflectivity coating was used as laser rear mirror. A repetition rate in the range of 10–50 kHz was obtained with the passive Q-switch. In the actively Q-switched laser, we used a normal incidence acousto-optic modulator, which was located between the flat rear mirror and the Nd:YAG laser rod.

In both cases, a dichroic output mirror with R = 100% at 1064 nm and T = 20% at 532 nm was used. An intracavity frequency doubling was achieved with the help of a type II KTP crystal (produced by RAICOL, Israel), and was located between the laser rod and the coupling mirror.

The measured output power at 532 nm was 4.1 W and 8.7 W for the passively and actively Q-switched lasers, respectively. Figures 2 and 3 present the dependence of output power on absorbed solar power. The passively Q-switched SHG laser had the advantage of simplicity, but had no repetition rate control. Thus, with increasing absorbed power the repetition rate increased while the peak power in the fundamental line did not. In contrast, with acousto-optic modulation the repetition rate could be kept constant at an optimal rate of 7.3



CThA7 Fig. 1. The 2-D CPC and the passively Q-switched laser with intracavity KTP crystal.