CW and quasi-CW operation of a Nd:YLF/KGW Raman Laser at 1163 nm, 552 nm and 581 nm.

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In the past 7 years, a fast development of continuous wave (CW) crystalline Raman lasers could be observed, in part due to their ability to reach wavelengths in the range between 1.1 μm and 1.2 μm and in the yellow-orange spectral region [1].

As a very well known material, Nd:YLF has two interesting characteristics for lasers. It has a weak thermal lens due to the compensation of the negative dn/dT (negative lens) by the positive face bulging (positive lens) and two different polarized emissions at 1047 nm (π) and 1053 nm (σ) [2]. In this work, we are interested in exploring these benefits of the Nd:YLF crystal in order to enhance the performance of CW and quasi-CW Raman lasers. We report a Nd:YLF/KGW intracavity Raman laser where the Nd:YLF operates at the 1053 nm fundamental line and the KGW at the 901 cm^{-1} Raman scattering line.

For the experiments we used a 4×4×15 mm^3 plane-Brewster cut Nd:YLF (1 at%-Nd^{3+}) as the laser active medium, a 5×5×24 mm^3 KGW, cut for propagation along the N_p axis, as the Raman medium and a type-I non-critical phase matched 4×4×10 mm^3 LBO crystal for the visible nonlinear conversions (second harmonic and sum frequency generation). The pump mirrors have very high reflectivity at the fundamental-1053 nm and Stokes-1163 nm (R>99.9%) and high transmission at 880 nm, which is the pump wavelength. We used a fiber coupled diode laser emitting at 880 nm as the pump source, pumping directly at the upper level laser. The output coupler for the Stokes has a transmission of 0.2% and for the visible the mirrors have high transmission at the lime-green and yellow regions. We operated the laser in CW and quasi-CW regime (0.6 ms pulses).

We observed, weak thermal lensing which allowed us to build long cavities such as the one used for the 1st Stokes laser, which was 160 mm long. We have obtained an output power at 1163 nm of 0.95 W (CW) and 1.56 W (quasi-CW peak power), shown in Figure 1(a), with a reasonable good diode to Stokes efficiency of 7.3% and very good beam quality M^2 of 1.49. After second harmonic generation we obtained 1.10 W (CW) and 1.65 W (qCW) at 581 nm, Figure 1(b), with slightly worse beam quality, M^2 of 1.93 and diode to yellow efficiency of 7.8%. The best result in terms of power was observed for sum frequency mixing of 1053 nm and 1163 nm, Figure 1(c), resulting in 1.90 W (CW) and 3.12 W (qCW) at 552 nm, M^2 of 2 and a respectable diode to visible efficiency of 14.6%.

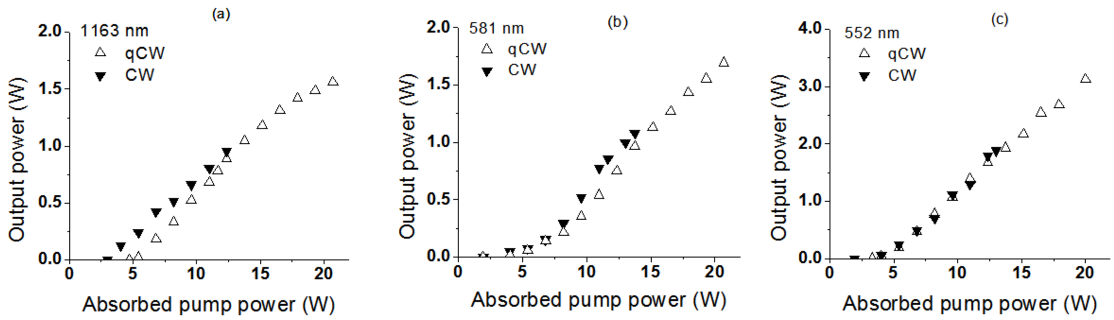

Fig. 1 Laser performance at (a) 1163 nm, (b) 581 nm and (c) 552 nm.

We believe this is the first time that a Raman laser has been investigated using the 1053 nm fundamental of Nd:YLF and as a consequence, it is the first time a crystalline Raman laser has been operated at this sequence of visible wavelengths. This demonstration of Nd:YLF in Raman laser has shown that this gain medium can be used to build efficient Raman lasers with high beam quality in the future.

References

[1] J. A. Piper, H. M. Pask, "Crystalline Raman lasers," IEEE J. Sel. Top. Quant. **13**, 692-704 (2007).

[2] P. J. Hardman, W. A. Clarkson, G. J. Friel, M. Pollnau, and D. C. Hanna, "Energy-transfer upconversion and thermal lensing in high-power end-pumped Nd:YLF laser crystals," IEEE J. Quantum Elect. **35**, 647-655 (1999)