Extreme Linewidth Broadening in a Nd:YLiF$_4$-KGW Intracavity Raman Laser

D. Geskus[1, 4], J. Jakutis-Neto[2], D. J. Spence[3], H. M. Pask[3], N. U. Wetter [4]

1. Department of Materials and Nano Physics, KTH - Royal Institute of Technology, Kista, 16440, Sweden

2. Instituto de Estudos Avançados, IEAv-DCTA, Trevo Cel. Av. José A. A. do Amarante, 1, Putim 12228-001 São José dos Campos, SP, Brazil

3. MQ Photonics, Department of Physics and Astronomy, Macquarie University, Sydney, NSW 2109, Australia

4. Centro de Lasers e Aplicações, IPEN/SP, Av. Prof. Lineu Prestes, 2242 São Paulo, SP, Brazil

Raman lasers are recognized for their wavelength flexibility, providing emission ranging from infrared pulsed lasers to continuous wave (cw) intracavity frequency converted Raman lasers operating in the visible wavelength range [1-4]. Broadening of the fundamental laser line in intracavity Raman lasers has been observed and it influence on the efficiency has been studied [5].

Here we study nine intracavity Nd:YLF-KGW lasers by variation of crystal lengths, while keeping the mode sizes constant in each of the crystals. The strength of the fundamental field, Stokes output power at 990 nm and spectral behavior is recorded, see Fig. 1. An extremely large broadening of the fundamental emission line of up to 4 nm is observed, making the laser operate in the wings of the ${}^4F_{3/2} \rightarrow {}^4I_{9/2}$ three-level, σ-transition at 908 nm, which has a fluorescence linewidth of less than 3 nm (FWHM).

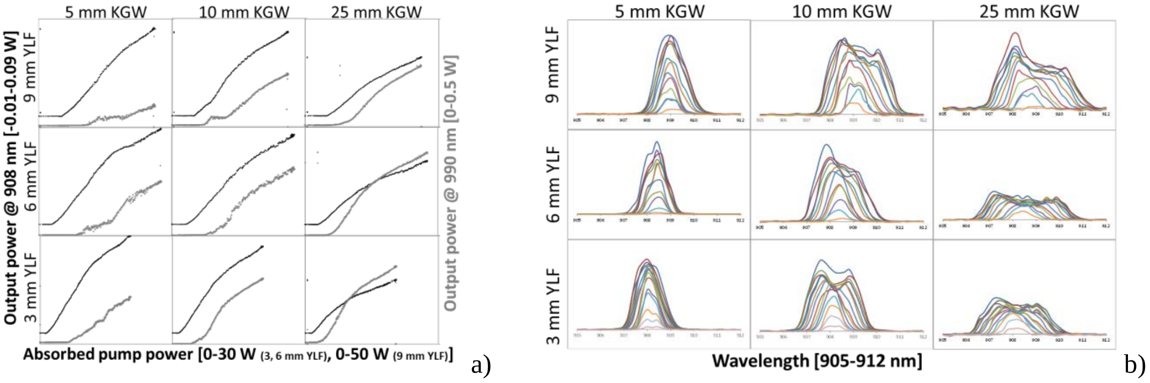

Fig. 11a. Measured fundamental (black) and Stokes (gray) output powers, and b emission spectra of the fundamental field at various powers.

Although a stronger Stokes coupling provides more Stokes output power in all our experiments, it also causes more losses to the fundamental emission line, broadening the spectrum of the fundamental field. A mathematical model has been developed and a first version has shown good agreement with experimental data, predicting significant improvements in laser efficiency when restricting the fundamental spectrum using etalons [6, 7]. The combination between the available mathematical laser models and the experimental data enables us to unravel the laser processes into great detail.

References

[1] T. T. Basiev, R. C. Powell, "Special issue on solid state Raman lasers - Introduction," Opt. Mater. **11**, 301-306 (1999)

[2] J. Jakutis-Neto, J. Lin, N. U. Wetter, H. M. Pask, "Continuous-wave Watt-level Nd:YLiF/KGW Raman laser operating at near-IR, yellow and lime-green wavelengths," Opt. Express **20**, 9841-9850 (2012)

[3] D. Geskus, J. Jakutis-Neto, H. M. Pask, N. U. Wetter, "Intracavity frequency converted Raman laser producing 10 deep blue to cyan emission lines with up to 0.94 W output power," Opt. Lett. **39**, 6799-6802 (2014)

[4] D. C. Parrotta, A. J. Kemp, M. D. Dawson, J. E. Hastie, "Multiwatt, continuous-wave, tunable diamond Raman laser with intracavity frequency-doubling to the visible region," IEEE. J. Sel. Top. Quant. **19**, 1400108 (2013)

[5] D. J. Spence, "Spatial and spectral effects in continuous-wave intracavity Raman lasers", IEEE. J. Sel. Top. Quant. **21**, 1400108 (2015)

[6] D. Geskus, J. Jakutis-Neto, H.M. Pask, N.U. Wetter, "Ten deep blue to cyan emission lines from an intracavity frequency converted Raman laser," in Proceedings of: SPIE LASE Photonics West, 9347-6 (2015)

[7] G. Bonner, J. Lin, A. Kemp, J. Wang, H. Zhang, D. J. Spence, H. M. Pask, "Spectral broadening in continuous-wave intracavity Raman lasers," Opt. Express **22**, 7492-7502 (2014)

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