CLEO 97 ~~Optics Letters~~

1318

230 mW of Blue Light from Thulium:ZBLAN Upconversion Fibre Laser

R. Paschotta, N. Moore, W.A. Clarkson, A. C. Tropper, D. C. Hanna

Optoelectronics Research Centre, Southampton SO17 1BJ, England

Tel.: ++44 (1703) 59-3141, fax: -3142, e-mail: rp@orc.soton.ac.uk

G. Mazé

Le Verre Fluoré, Campus Ker Lann, 35170 Bruz, France

Abstract

230 mW at 481 nm have been obtained from a Tm:ZBLAN upconversion fibre laser, pumped by a Nd:YAG laser with 1.6 W at 1123 nm. The fibre developed a strong loss which however appeared to be fully reversible.

230 mW of Blue Light from Thulium:ZBLAN Upconversion Fibre Laser

R. Paschotta, N. Moore, W.A. Clarkson, A. C. Tropper, D. C. Hanna

Optoelectronics Research Centre, Southampton SO17 1BJ, England

Tel.: ++44 (1703) 59-3141, fax: -3142, e-mail: rp@orc.soton.ac.uk

G. Mazé

Le Verre Fluoré, Campus Ker Lann, 35170 Bruz, France

Blue laser sources are required for a number of applications such as colour displays, printing and data recording. One of several approaches which has been pursued in recent years is the infrared-pumped upconversion fibre laser, based on thulium-doped ZBLAN fibre [1]. The maximum power reported so far via this approach is 106 mW [2]. In this paper we report a blue output of up to 230 mW achieved by using a more powerful pump laser and a ZBLAN fibre with modified composition. At high power levels, we again see a rapid degradation in performance, as seen by others, but we have also observed that the fibre can be entirely restored during a period of lasing at low output power.

The pump laser was a diode-pumped Nd^{3+}:YAG laser which produced a TEM_{00} output of 1.6 W at 1123 nm for 7 W of pump power. This was coupled into the single-mode core of the ZBLAN fibre with a launch efficiency of ≈50 %.

The Tm^{3+}:ZBLAN fibre we used, produced by Le Verre Fluoré, had a thulium concentration of 1000 ppm (by weight), an NA of 0.2, and a cut-off wavelength of 800 nm. Both ends of a 2…3 m long fibre were butted against dielectric mirrors. The 1123 nm pump light was launched with an aspheric lens through the input mirror which was highly reflective for the blue light. Initial experiments were carried out with an optimized output coupler with 50 % reflectivity for the blue light and 98 %

reflection for the residual pump light; this led to a very good performance with a low threshold, around 100 mW, and a high slope efficiency of 25 % with respect to incident power. However, the fibre's output end was repeatedly destroyed at output powers of a few tens of milliwatts. This problem, whose physical origin is not clear, was solved by using another output coupler which does not reflect residual pump light and has 63 % reflectivity for the blue light. The achieved slope efficiency was reduced to 19 %, but the end was then much more robust and allowed a maximum output power of 230 mW for 1.6 W of incident pump light (see Fig. 1).

At higher power levels (above 100 mW output power) we observed a degradation of the fibre laser performance within a few seconds, and it was then found that the threshold and slope efficiency (also at lower powers) had deteriorated. By comparing the fibre's transmission of white light (measured with a halogen lamp and an optical spectrum analyzer) with that of an unused piece we found that the fibre had developed a broad-band loss which rises sharply towards shorter wavelengths and was typically a few dB/m at 480 nm. However, this loss appears to be entirely reversible: when the degraded fibre laser was operated at a lower power level (with e.g. 40 mW output power) this would eventually lead to a full restoration of the previous performance within up to one hour. We attribute the observed effects to the formation of colour centres as reported earlier [3]; further work aims at eliminating the colour centres by another modification of the ZBLAN glass composition, enabling operation at possibly even higher output powers with more stability.

FIGURES

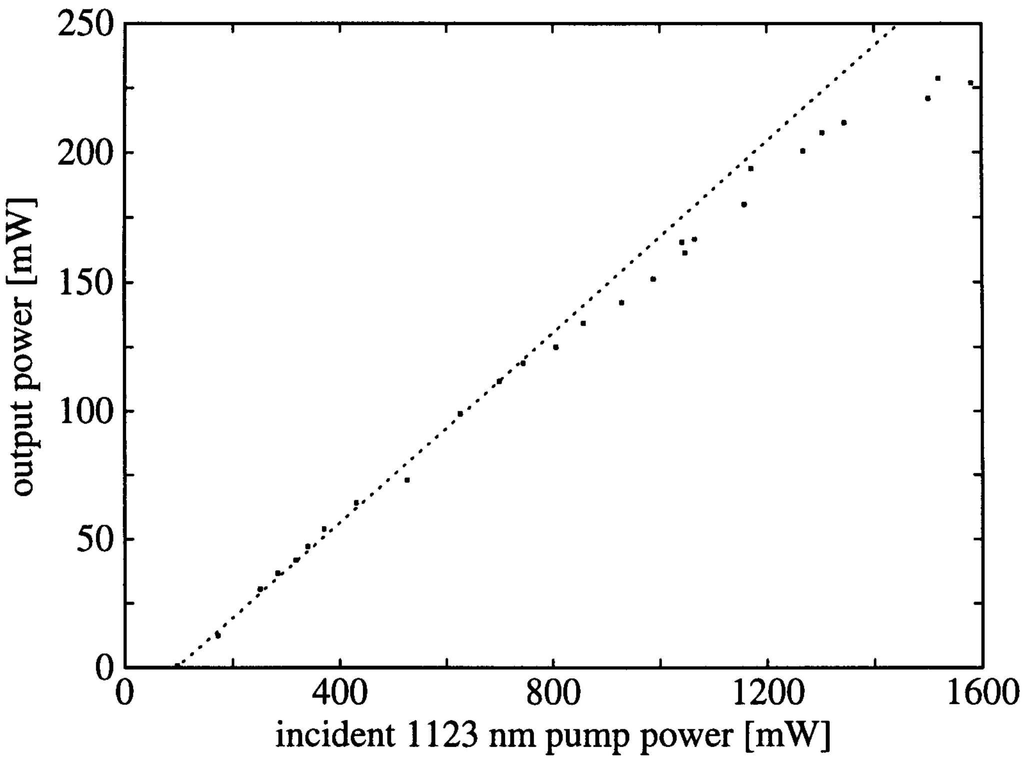

FIG. 1. Output versus incident input power for 2.2 m long laser, recorded within 30 s after lasing at low powers for 10 minutes.

REFERENCES

[1] S. G. Grubb, K. W. Bennett, R. S. Cannon, and W. F. Humer, Electron. Lett. **28**, 1243-1244 (1992).

[2] S. Sanders, R.G. Waarts, D.G. Mehuys, and D.F. Welch, Appl. Phys. Lett. **67**, 1815-1817 (1995).

[3] P. R. Barber, R. Paschotta, A. C. Tropper, and D. C. Hanna, Opt. Lett. **20**, 2195-2197 (1995).