577 nm yellow laser source using external pumping

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Solid-state laser has found applications in retinal photocoagulation treatment for a long time now. However, it has been proven that a laser source at 577 nm serves better than the currently used 532 nm laser sources [1]. It's due to higher absorption in oxyhemoglobin and lower macular xanthophyll absorption at 577 nm than 532 nm hence lower energy is required to treat the eye, which in turn leads to a reduced recovery period after surgery. But due to the unavailability of a 577 nm laser source, a 532 nm laser source has been adopted despite not being optimum. In our previous work, we demonstrated how to achieve a yellow laser source at 577 nm with a proper combination of gain, Raman, and frequency doubling media using intracavity pumping [2]. As an alternative approach, here in this work, we employed external pumping to generate 577 nm.

The 577 nm laser cavity was a simple hemispherical cavity with a set of optics and also it contains a Raman medium and frequency doubling medium inside the cavity. This Raman resonator was pumped using an in-house developed external pump source, which is an electro-optically Q- Switched cryogenic Yb: YAG laser emitting around 1029 nm and generates pulse energy up to 1.4 mJ with a rep-rate of 1 KHz and Pulse width of 30 ns [3]. To collimate and focus the pump beam to the Raman resonator several other optical elements were used that includes optical isolator to avoid feedback light. The focal spot on the Raman medium was estimated to be around 130 µm in radius using 150mm focal length lens. The laser mode radius on the Raman cavity was estimated to be around 140 µm. As Raman medium, Barium Nitrate ($Ba(NO_3)_2$) crystal of length 20 mm with 5*5 mm^2 aperture was used to convert the fundamental wavelength to Raman wavelength (1154 nm). As a frequency doubling medium, three different Lithium triborate (hereafter LBO) crystals of lengths 10, 20, and 30 mm with 3*3 mm^2 aperture were used to convert to 577 nm. As output couplers, Toc=90 and 95% with Roc =100 mm coated for yellow wavelength were used.

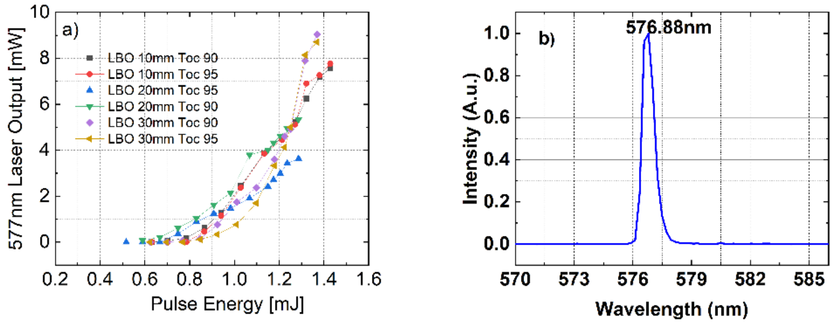

Fig. 1 (a) 577nm yellow laser output characteristics using $Ba(NO_3)_2$, different LBO's and Toc = 90 and 95%; (b) Measured yellow laser spectrum.

577 nm yellow laser was generated for all the combinations used. Figure 1 (a) presents the 577 nm laser output vs input pulse energy corresponding to the combinations of different LBO's, Toc's = 90 and 95% and 20 mm $Ba(NO_3)_2$. From the results, one can infer that the output power does not vary much with the change in transmission of output coupling. In addition, one can observe the output power increases non-linearly with the increase in incident energy. To be noted, better phase matching and good beam quality were obtained only with 10 mm LBO crystal, although maximum output power of 9 mW was obtained with 30 mm LBO. We believe, that with longer LBO's (20 mm and 30 mm) the mode matching becomes non-uniform near the LBO's, which results in poor beam quality. Figure 1 (b) shows the measured yellow nm laser spectrum output of around 577 nm. Present work is focused on using output coupling mirrors with longer Roc (150 mm and 200 mm) for better mode matching and trails with longer Raman medium (50mm) to enhance the output power.

References

[1] G. Staurenghi, "Why consider the yellow 577 nm wavelength", Retina Today (July/August), 31-33 (2016).
[2] V Jambunathan et al, "Development of a Yellow Laser Source at 577 nm for Ophthalmology Applications ", 2021 Conference on Lasers and Electro-Optics Europe & European Quantum Electronics Conference (CLEO/Europe-EQEC), 2021, pp. 1-1,
[3] V Jambunathan et al, "Efficient laser performance of a cryogenic Yb: YAG laser pumped by fiber-coupled 940 and 969 nm laser diodes", Laser Phys. Lett. 12 015002 (2015)