L.1: Development of DPSS green laser for pumping of Ti: Sapphire laser

Diode pumped solid state (DPSS) green lasers have drawn much attention due to their high efficiency, good beam quality, compactness, and their use to pump tunable dye lasers and Ti:Sapphire laser crystals. However, in solid state laser crystals, during pump-lasing cycle, a portion of the absorbed pump power in laser crystal is lost in the form of heat due to non-radiative processes, which leads to strong thermal effects such as thermal lensing, thermal aberrations, etc. These thermal effects limit the laser output, cavity stability, and also degrade the output beam quality. We have developed a diode end-pumped intra-cavity frequency doubled Nd:YVO_4 green laser under direct pumping to $^4F_{3/2}$ level using a laser diode at 880 nm instead of conventionally used 808 nm pump source. Under this direct pumping scheme, laser performance improved significantly, which is attributed to reduced thermal loading in the crystal by elimination of the non-radiative $^4F_{5/2}$ –$^4F_{3/2}$ transition, which occurs during 808 nm pumping. In an L-cavity, laser delivers ~4.5 W of average green power with short pulse duration of ~10 ns at 30 kHz of pulse repetition rate. The M^2-parameter of the green beam was measured to be ~2.5.

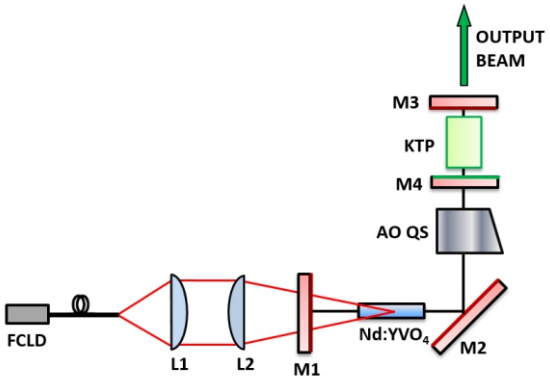

Fig. L.1.1: Schematic of diode end pumped Q-switched Nd:YVO_4/KTP green laser.

The schematic of the L-shaped laser resonator is shown in the Figure L.1.1. L-shaped cavity was formed by three plane mirrors M1, M2 and M3. These mirrors were coated for high reflection (R>99.5%) at 1064 nm, whereas mirror M1 was also coated for high transmission (T>95%) at 880 nm for efficient pumping. Gain medium was a 0.2 at% Nd^{3+}-doped 18 mm long Nd:YVO_4 laser crystal and pumped by a fiber coupled laser diode (FCLD). For Q-switching operation, an acousto-optic modulator was positioned in the cavity. To generate intra-cavity green pulses, a type-II phase matched KTP crystal with polished end surfaces was employed. The generated green beam was coupled out through output mirror M3, which was also coated for high transmission (T>95%) at 532 nm. A plane harmonic mirror M4 was kept in between Nd:YVO_4 and KTP crystal to retro-reflect the backward generated green beam. The overall cavity length was ~220 mm.

The performance of the laser system is shown in Figure L.1.2. Under pulsing operation, threshold pump power was measured to be ~3 W. Average green power increases with the incident pump power while the pulse width decays rapidly as a function of incident pump power as shown in Figure L.1.2(a). At 25 W of absorbed pump power, ~4.5 W of average green power with ~10 ns pulse duration was obtained at 30 kHz of pulse repetition rate. This pulse repetition rate was found to be optimum to generate high average green power by intra-cavity frequency doubling. A typical temporal pulse profile with pulse duration of ~10 ns (FWHM) is shown in Figure L.1.2(b). The pulse has a sharp rise time of 5.6 ns and 22 ns fall time. On further increasing the pump power, output power did not vary significantly due to Q-switch hold-off capability. Pulse jitter with respect to trigger signal given to acousto-optic (AO) Q-switch was measured to be less than ±3 ns for half an hour operation and corresponding histogram is shown in Figure L.1.2(c). The beam quality parameter (M^2) of green beam at the maximum output power was measured to be ~2.5 and a plot for the same is shown in Figure L.1.2(d). These results show that under 880 nm pumping, shorter green pulses with good beam quality, high pulse repetition rate and high efficiency can be generated from intra-cavity frequency doubled AO Q-switched Nd:YVO_4 laser, which is suitable for pumping of Ti:Sapphire laser crystal.

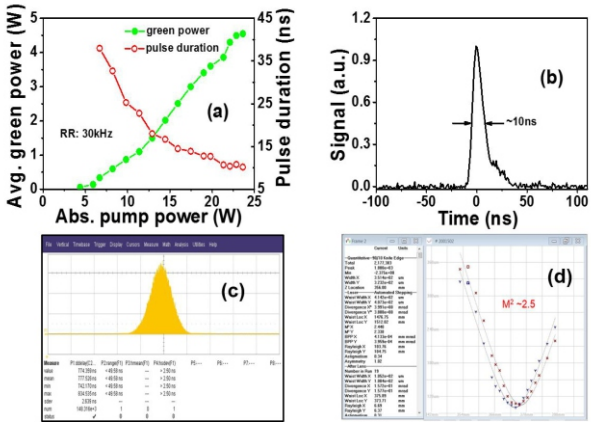

Fig. L.1.2: Lasing performance of DPSS green laser at 30 kHz pulse repetition rate.

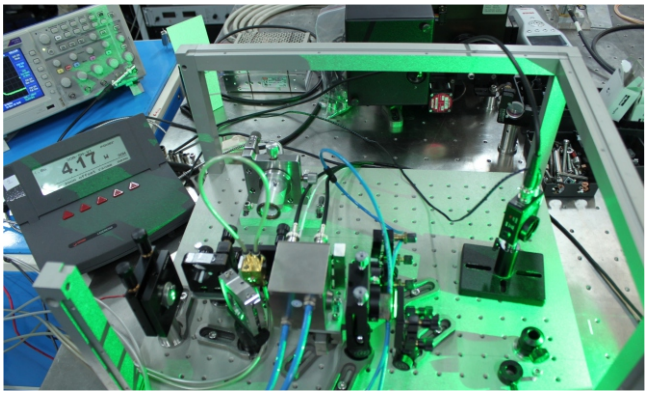

Fig. L.1.3: A photograph of green laser under operation.

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