L.2: Development of Narrow Line-Width Tunable UV Radiation Source based on Second Harmonic of CVL Pumped Dye Laser

A tunable UV radiation source based on second harmonic of copper vapour laser (CVL) pumped dye laser is developed in Laser System Engineering Section (LSES). Experimental set-up of the second harmonic generation of dye laser beam is shown in Fig.L.2.1. In this set up, a CVL pumped narrow line-width dye laser master oscillator power amplifier (MOPA) consisting of an oscillator, pre-amplifier and main amplifier is used. Total average CVL pump power was 18 W (at 5.5 kHz). Dye laser oscillator set-up was based on HMPGIG cavity. It consisted of double prism pre-expander (magnification ≈ 20), grazing-incidence grating (2400 lines/mm) and tuning mirror (reflectivity ≈ 100%). The dye laser output power was taken through a 20 % reflecting output coupler. For single axial mode operation of dye laser oscillator, an intra-cavity etalon of FSR 10 GHz and finesse 12 was inserted between the prism beam expander and grating. The single mode dye laser line-width was less than 500 MHz. The ASE of dye laser oscillator beam was removed by a lens and aperture combination. A cube polarizer was used between dye oscillator and the amplifier to polarize the dye laser oscillator beam. The output of dye laser MOPA beam was focused in the β-BBO crystal (8 x 6 x 7 mm^3, type-I phase matched at 40° for λ = 585nm) by spherical lens of focal length 10 cm. For Dye laser second harmonic generation (SHG), the crystal was rotated ± 2° around phase matching angle of 40° to obtain tunable UV phase matched radiation.

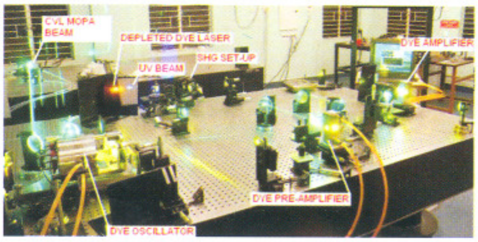
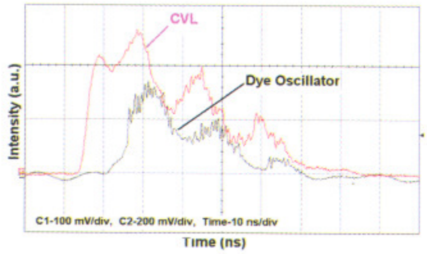


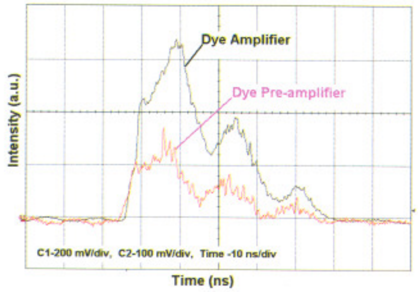
Fig.L.2.1 Experimental set-up of single mode dye laser MOPA and tunable UV generation.

Pulse shapes of CVL (upper trace) and dye laser oscillator (lower trace) are shown in Fig. L.2.2a and pulse shapes of the dye laser pre-amplifier (lower trace) and dye laser amplifier beam (upper trace) are shown in Fig L.2.2b. The dye laser pulse was delayed about 5 ns with respect to CVL pulse. The dye laser pulse width was about 25 ns (at FWHM). The peak structure of dye laser pulse shape follows the pattern of peaks of CVL pulse.

The output power of single mode dye laser oscillator was 12 mW. The dye laser oscillator beam was amplified in pre-amplifier. Non-ASE average dye laser output power after pre-amplifier was 300 mW. The dye laser beam was further amplified in dye laser amplifier to an average power of 1.2 W



(a)



(b)

Fig.L.2.2 Pulse shapes of (a) CVL and dye laser oscillator (b) Dye laser amplifier and pre-amplifier

Pulse shapes of depleted dye laser and UV beam are shown in Fig. L.2.3. The dye laser power just before the crystal was 1.05 W. Single mode UV power of about 106 mW was obtained with the conversion efficiency of about 10 %. By simultaneously tuning the dye laser wavelength and the phase matching angle of crystal, UV radiation was tunable from 290 nm to 298 nm.

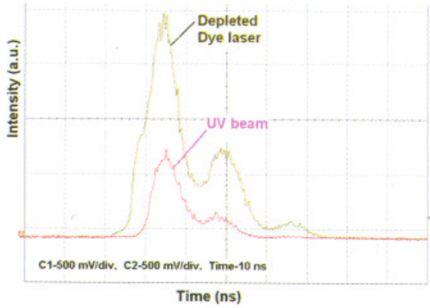


Fig. L.2.3 Pulse shapes of depleted dye laser & UV beam

The second harmonic generation was also performed for the dye laser oscillator without intra-cavity etalon. In this set-up, one oscillator and one amplifier were used. About 1.3 W average power dye laser MOPA beam (pulse duration ~36 ns at FWHM and average line-width ~ 2.5 GHz) was focused on BBO crystal. Average UV power of 125 mW was obtained with the conversion efficiency of 9.6 %. The generated tunable UV laser radiation will be very useful for optimizing the fiber Bragg grating writing in the photosensitive optical glass fiber and in spectroscopy studies.

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