L.10: Wide aperture XeCl laser with high misalignment tolerance and pointing stability

We report development of a wide aperture XeCl excimer at λ = 308 nm wavelength with high misalignment tolerance and pointing stability at Excimer Laser Section of LMPD. Increase in laser energy capability combined with its improved beam characteristics such as focus-ability, misalignment tolerance and pointing stability enhances the application potential of excimer lasers in material processing particularly the micro-machining of metal targets. For achieving such objectives, a new and dedicated wide aperture XeCl laser system equipped with prism cavity has been designed and developed. The laser-profiled nickel electrodes and an in-built automatic UV pre-ionizer are incorporated in the laser system. The laser system has electrode separation of ~30 mm (wide aperture) and discharge volume of dimensions 50 cm x 1cm x 3 cm. The pre-ionizer assembly of the laser consists of inductively ballasted spark pins placed through HV electrode with proper insulation. The excitation circuit is a C–C transfer circuit using high capacity thyratron as the switching element. The main storage capacitors (60 nF) are charged up to required voltage of 30 kV using home-built resonant charging power supply and switched by a thyratron (E2V CX 3608). Magnetically coupled tangential blower was incorporated for this large gas volume replacement between the electrodes along with gas cooling unit for high repetition rate operation of the laser.

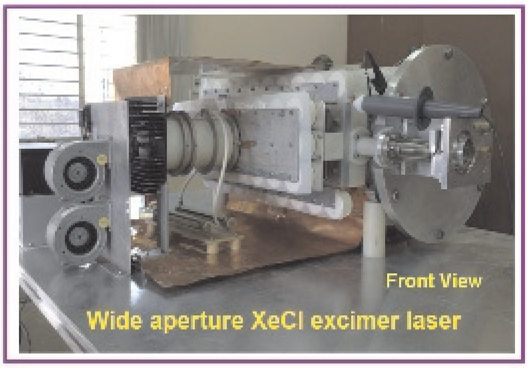
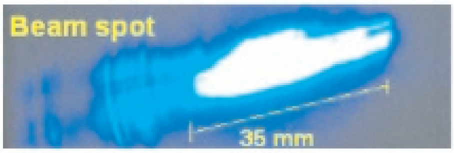
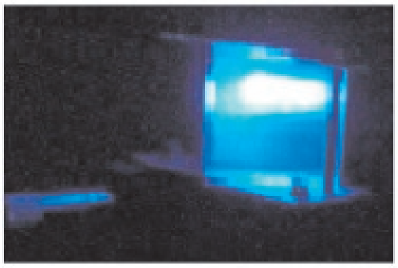


Fig. L.10.1: Wide aperture XeCl excimer laser system

To achieve a uniform glow discharge over entire active volume of this wide aperture excimer laser an efficient and enhanced pre-ionization (PI) was established. A low inductance discharge loop has been incorporated for achieving fast generating voltage pulses. The pre-ionization current is proportional to the rise time of the voltage pulse. Faster voltage pulses resulted in higher PI current there by creating efficient and effective PI over entire discharge volume. The photograph of the wide aperture excimer laser system is shown in Fig.L.10.1.



(a)



(b)

Fig. L.10.2: (a) XeCl excimer laser output beam spot, (b) Beam spot on porro-prism end reflector as part of prism cavity during laser operation.

For achieving high misalignment tolerance and pointing stability, retro-reflecting cavities are used. Prism resonator cavity consisting of porro-prism as end reflecting mirror was incorporated for the first time in the excimer laser to achieve high misalignment tolerance and pointing stability. The resonator cavity was formed by porro-prism as end retro-reflector and plane blank or plano-convex lens as output coupler. The laser generated coherent optical pulses with pulse energy of more than 150 mJ with high misalignment tolerance (β ~50 mrad). Fig.L.10.2 show, (a) XeCl excimer laser beam spot (35 mm) on semi transparent screen near output coupler and (b) on porro-prism (rear end reflector) as part of laser cavity. The laser beam was focused on copper sheet using a plano-convex lens of focal length 50 cm for generating micro holes. The optical microscope/SEM images of focused spot show clean and sharp edges of the micro holes (< 50 micron) indicating high shot to shot pointing stability at repetitive operation. The high misalignment tolerance and pointing stability of the output excimer laser beam are resultant of the retro-reflective properties of the prism resonator cavity. For more details, please refer to *N. S. Benerji and B. Singh, Opt. Commun. 331, 69 (2014)* and *N. S. Benerji et al., Rev. Sci. Ins. 86, 073112 (2015)*.

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