L.2: Development of Krypton Chloride Excimer Laser ($\lambda = 222$ nm)

Krypton chloride (KrCl) excimer laser operating at 222 nm wave length was designed and developed indigenously at Excimer Laser Section, LMPD. The laser was driven by a compact, efficient and simple excitation technique using automatic UV pre-ionization with discharge pumped self-sustained C-C energy transfer circuit. Initial experiments resulted in generating reliable output laser energy of 25 mJ from an active discharge volume of 60 cm^3 using gas mixture consisting of HCl, Kr and Ne. in an optimized ratio at total pressure of 2.5 atm.

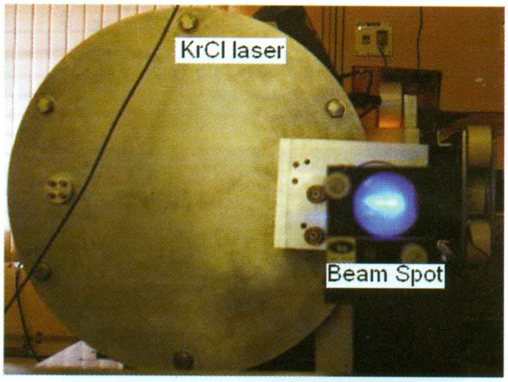

Fig L.2.1. KrCl laser system in operation

KrCl laser with its emission wavelength of 222 nm is the lowest wavelength excimer laser using chlorine-based gas mixtures. The absorption of UV radiation is strong in many materials of interest and increases towards shorter wave length. KrCl lasers find applications in material processing of engineering materials, precision micromachining of polymers, laser assisted chemical process in photochemistry and decontamination applications in nuclear industry. KrCl lasers are characterized by low gain and for achieving higher laser energy, it is necessary to dump one order higher electric power (~10 MW/cm^3) into gas medium as compared to XeCl and KrF (~1 MW/ cm^3) excimer lasers

The KrCl laser system developed mainly consisted of laser head with gas circulation/cooling system and a compact high voltage exciter. The photograph of the laser in operation is shown in fig. L.2.1. The laser head comprised of a pair of profiled electrodes made of nickel. A gap of 15 mm was maintained between these electrodes and this leads to a discharge of volume 50 cm x 1.5 cm x 0.8 cm. The pre-ionization of the active discharge volume relies on UV radiation created uniformly by the spark gaps along the discharge length. For repetitive operation, the gas mixture with a velocity ~ 4 m/s was circulated in the discharge zone using magnetically coupled tangential blower and a set of heat exchangers. The laser gas flows transversely in the discharge zone and sweeps out the discharge volume between two pulses. These sub systems were mounted and contained in a leak tight cylindrical chamber of volume 50 liter made of aluminum alloy. The total system was made leak proof both for pressure & vacuum conditions with leak rate of~ 5 x 10^{-6} mbar lit/sec.

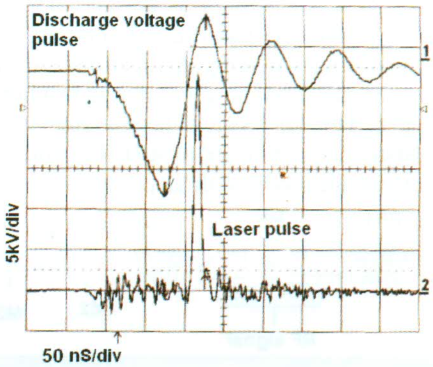

Fig.L.2.2: Discharge voltage and laser pulses

Due care was taken in the design of the compact discharge loop to achieve minimum loop inductance that is required for high peak power deposition. The high voltage discharge pulses with rise time of less than 90 ns across the laser head as shown in fig. L.2.2 were achieved for efficient laser operation. The optical resonator/cavity was formed by a dielectric-coated total reflector with a plane flat quartz window separated by 100 cms.

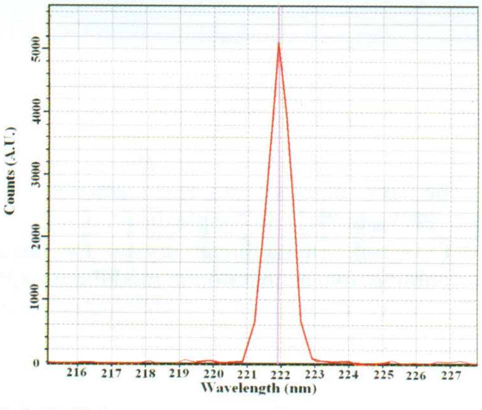

Fig.L.2.3:KrCl laser emission at λ=222nm

The optical pulse length of the laser was observed to be 14 ns (FWHM) is shown in fig.L.2.2. The emission spectrum of the laser was recorded at 222 nm with bandwidth of ~ 1.5 nm as depicted in figure3. The laser beam spot cross-section was found to be completely filled with near Hat-Top type intensity profile. Presently, further investigations are in progress to achieve higher output energy.

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