L.6: 20 kHz, efficient operation of a large-bore copper vapor laser (KE-CVL)

Laser System Engineering Division (LSED) has been working on the development of wide bore CVL lasers for the last few years. (Ref: "100 W kinetically enhanced copper vapor laser at 10 kHz rep-rate, high (1.5 %) efficiency, low (1.6kW/l) specific input power and performance of new resonator configurations"; Bijendra Singh, et.al.; Optics Communications Vol 281, p.4415 2008). Wide aperture elemental copper vapor lasers are optimized at moderate operating frequency (rep-rate) of ~ 4-5 kHz, due to limitations of radial discharge penetration (skin effect) and longer meta-stable deactivation time of lower laser level by wall collisions. Increase in frequency results in drastic reduction in CVL output power/efficiency to unacceptable levels. The operating frequency of a CVL can be boosted several times (3-4 times) without degrading its output power/efficiency using kinetically enhanced (KE) techniques, in which specialized buffer gas mixture consisting of hydrogen ~ 1-2 %. HCl ~ 0.5 % and balance as neon is used in highly optimized proportion. The dissociative attachment (DA) properties of hydrogen and HCl favorably controls the pre-pulse electron density and also the inter-pulse plasma is relaxed efficiently. Higher operating frequencies are desirable in CVLs for their various applications and experiments such as femto-second pulse amplifications. Single high rep-rate CVL system also avoids complicated multiplexing techniques and beam combiners etc.

We recently demonstrated the operation of a standard CVL in KE mode to operate at ~ 20 kHz efficiently. The KE-CVL was based on 50 mm bore x 1500 mm length discharge tube and was capable of delivering about ~ 30 Watt power as a standard CVL in non-KE mode of operation at ~ 5 kHz rep-rate. On operating the laser in KE mode the highest operating frequency achieved was about ~ 20 kHz with output power of ~ 35-40 Watt. Thus a record enhancement of 4 times in operating frequency was achieved without loss of power with respect to its standard operation (non -KE) in this indigenously developed KE-CVL.

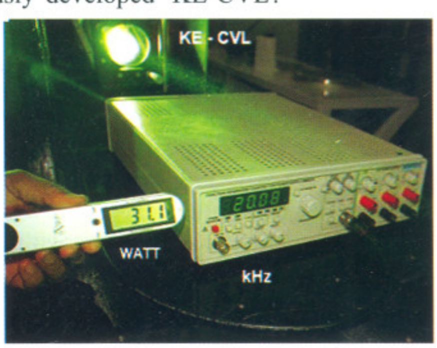

Fig L.6.1 CVL operating at 20 kHz

Fig L.6.1 shows laser operating at 20 kHz rep-rate. Table 1 lists laser power at other operating frequencies at constant input power of ~ 5 kW.

Table. L.6.1 : Performance of laser at various rep-rate

Rep-rate	Laser power	Mode of operation	Buffer gas Composition
5 kHz	30 W	Standard non-KE	Pure Neon
10 kHz	74 W	KE	H_2+ HCl + Neon
15 kHz	50 W	KE	H_2+ HCl + Neon
17 kHz	44 W	KE	H_2+ HCl + Neon
20 kHz	35 W	KE	H_2+ HCl + Neon

This is the first efficient demonstration of a large-bore elemental CVL at 20 kHz and to the best of our knowledge, has not been reported so far in the published literature.

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L.7: Dynamics of cold Rb atom cloud in a magneto-optical trap

Magneto-optical trap (MOT) has become a robust tool to cool and trap neutral atoms to explore both fundamental aspects of atomic physics and possible applications in the frontiers of quantum computation and information processing. Laser Physics Applications Division at RRCAT has developed a MOT which typically consists of a combination of three pairs of appropriately polarized counter-propagating laser beams intersecting at the zero of an externally applied quadrupole magnetic field. The cold atom cloud is obtained at the centre of the trap with temperature of nearly few hundreds of micro-Kelvin. Recently, the dynamics of cold rubidium (^{85}Rb) atom cloud in the MOT was investigated using a pulsed forcing laser beam. The impulse imparted to the atom cloud was measured in terms of its initial drift velocity.

Fig.L.7.1 shows the schematic diagram of the experimental setup. The time-of-flight (TOF) method was used to estimate the drift velocity and velocity width of the forced atom cloud. A continuous weak laser beam of nearly constant intensity and height of 200 μm was derived from the