L.2: Development of all solid state RF powered 2 kW fast axial flow CO_2 laser system

Radio frequency excited fast axial flow CO_2 lasers (RF-FAF) are widely used in various material processing applications, for generation of EUV source at 13.5 nm for high volume chip fabrication and also gas phase nano-particle synthesis. Traditionally, these lasers are excited by RF sources built using high power vacuum tube devices like triode, tetrode etc. The existing 2kW RF excited FAF CO_2 laser excited by triode based RF oscillator developed earlier at RRCAT has been upgraded with all solid state modular RF power (SS-RFPS) sources. Such a multi-kilowatt laser system with all solid state modular power supplies has been developed for the first time to the best of our knowledge. The CO_2 laser discharges excited with triode based 20 kW RF source is shown in Fig.L.2.1.

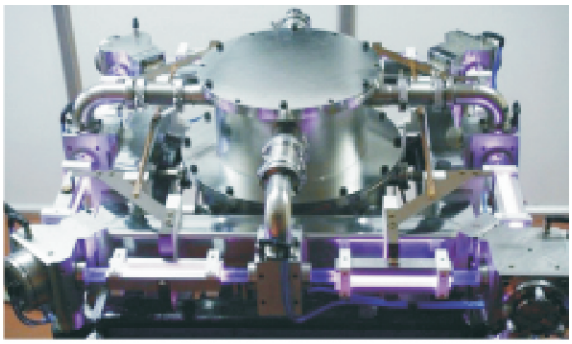

Fig. L.2.1:RF discharge in four sections of the laser

The indigenously built 20kW E2V triode based RF oscillator was replaced with four 5kW LD-MOSFET based COMET make SS-RFPS. The schematic layout and the 20 kW modular power supply with four SS-RFPS has been shown in Fig. L.2.2 and Fig. L.2.3.

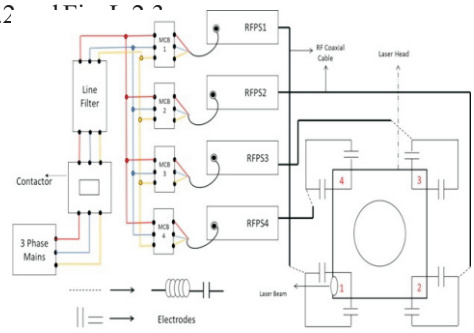

Fig. L.2.2:Layout of modular RF power sources

The significance of this work lies in the fact that such power sources are optimized for use in thin film fabrication industry and not for CO_2 lasers. CO_2 lasers operating at about 100 mbar gas pressure as active medium poses a challenge to the RF source in the form of dynamic impedance variation during discharge excitation and afterwards. The drasticvariation of

Fig. L.2.3: 20 kW modular SS-RFPS

the impedance during discharge ignition in the gas mixture and later its decrease with increasing RF power feed from the source demands robust impedance matching network. With these constraints, the 5 kW SS-RFPS, initially one unit, was integrated with the laser head to excite it through capacitively coupled RF discharge in two of the 20 mm internal diameter quartz glass tubes at 100 mbar with gas mixture flowing at 160m/s at 25° C. Upon successful integration of one unit, the other three 5 kW RF units were also deployed. However, due to four independent RF sources feeding power into four capacitive loads coupled with each other through capacitive coupling, RF leakage into other load or source becomes a serious problem. This problem was circumvented by connecting the RF sources in Daisy configuration through common exciter mode of operation with one of the sources acting as master. After integration of four sources, the matching networks were optimized for VSWR ~ 1.1-1.5 at 12kW total RF input power.

Fig. L.4.4: Upgraded 2 kW RF-FAF CO_2 laser

We operated the laser with a plano-concave stable resonator to obtain 1.1 kW at 10 kW RF input. The upgraded laser system with 20 kW all solid state RF source is shown in Fig. L.2.4.

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