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CHEMICAL OXYGEN IODINE LASER (COIL) PROSPECTS OF INDUSTRIAL USE

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The Chemical Oxygen Iodine Laser (COIL) is a recently developed high power cw laser. It is the first electronic transition chemical laser and its wavelength 1315 nm, in the near infrared, is the shortest achieved so far by chemical means. The pumping mechanism of the upper laser level $I^2P_{1/2}$ is based on a nearly resonant transfer from singlet delta oxygen to atomic iodine:

$$O_2^1\Delta + I^2P_{3/2} \leftrightarrow O_2^3\Sigma + I^2P_{1/2}$$

The singlet delta oxygen is produced by the chemical reaction:

$$Cl_2 + H_2O_2 + 2 Na OH \rightarrow O_2^1\Delta + 2 H_2O + 2 Cl Na$$

at the gas-liquid interface. Iodine is mixed in the oxygen flow. The typical operating pressure is of the order of 1 Torr.

Soon after the first laser effect at low power [1], the high power capability of COIL is demonstrated with a cw laser power of 100 W [2]. The highest reported power is 2 kW [3].

In view of industrial use, COIL shares with the solid state laser the advantage of a favorable wavelength as compared with CO$_2$ lasers: the interaction with most materials is enhanced and the possibility of beam transport and delivery by optical fibers makes applications much more convenient and flexible. In contrast with solid-state lasers, the high power capability of COIL is unlimited in comparison with industrial needs and very high optical quality can be maintained at high power because the laser medium is a low pressure gas. The efficiency of COIL is good. About 10 molecules of chlorine and hydrogen dioxyde are required for each laser photon, 0.1 mole/s for 1 kw of laser power or 25 kg/h of chlorine and 12 kg/h hydrogen dioxyde.

However, several difficulties must be considered. The low operating pressure implies a high pumping speed: 6000 m$^3$/h for 1 kw of laser power at 1 Torr. A cold trap is also needed for water vapor removal. There are hopes to increase the working pressure to 10 or 20 torr and schemes have been proposed to make a cold trap unnecessary but this has not been demonstrated yet. Chlorine and concentrated hydrogen dioxyde are hazardous chemicals but they are currently used in chemical industries and the end products are safe. Furthermore and thanks to optical fiber transmission, an industrial COIL could be located at some safe distance from the workstations. Bubble column generators are generally used for the production of singlet delta oxygen. They are unsuitable for continuous operation. Wetted wall or spray generators would be required. They are presently being developed.

REFERENCES