Centrifugal Spray Generator of Singlet Oxygen for a COIL

Otomar Špalek[a1], Vít Jirásek[a], Miroslav Čenský[a], Jarmila Kodymová[a], Irena Picková[a] and Jan Hrubý[b]

[a] Dept. of Chemical Lasers, Institute of Physics, Academy of Sciences CR, Na Slovance 2, 182 21 Prague, Czech Republic

[b] Institute of Thermomechanics, Academy of Sciences, Dolejskova 5, 182 21 Prague, Czech Republic

Results of an experimental study of a new type of singlet oxygen generator for the Chemical Oxygen-Iodine Laser are presented. This spray generator with a centrifugal separation of liquid can be used at extremely high generator pressures from 40 kPa to 80 kPa.

A new spray-type generator of singlet oxygen, $O_2(^1\Delta)$, with a following centrifugal separation of depleted liquid was studied. This generator (CSSOG) was developed to fulfill following requirements suitable for an advanced Chemical Oxygen-Iodine Laser (COIL): (i) a high-pressure operation, (ii) a single pass of reaction liquid, (iii) an efficient disengagement of gas/liquid mixture, and (iv) scalability for airborne and mobile application. The generator design takes advantage of very high g/l interfacial surface area of the fine spray produced by a special two-phase nozzle and a very fast liquid separation by applying a high centrifugal force.

The generator consists of a small cylindrical reaction space (69 cm^3) inside a rotor of the centrifuge and two narrow slit channels in the rotor shell, where liquid separation takes place. Preliminary studies of $O_2(^1\Delta)$ production in a two-phase mixture without a liquid separation has shown that the product of chlorine utilization, U_{Cl} (= reacted Cl_2/input Cl_2), and $O_2(^1\Delta)$ yield, Y_Δ (= $O_2(^1\Delta)$/total O_2), was rather high (0.5 – 0.8) when a contact time of both phases was very short (3 – 5 ms) [1]. A total generator pressure was 25 – 40 kPa (190 – 300 torr) at Cl_2 dilution with He of 4 - 9. The U_{Cl} Y_Δ product decreased to 0.35 – 0.5 at high generator pressures of 70 - 80 kPa (520 – 600 torr).

This contribution presents experimental results on the $O_2(^1\Delta)$ production with the centrifugal spray generator, i.e. including the liquid separation from the exiting gas. Experimental study confirmed our former calculations showing that effective liquid separation required very high rotation speed of the separator rotor (6000 – 10000 r.p.m.). A detailed investigation of $O_2(^1\Delta)$ production was performed with several two-phase nozzles, different gas flow rates (up to 30 mmol/s Cl_2 and 160 mmol/s He), different flow rates of liquid (basic hydrogen peroxide, BHP) of 8 - 20 ml/s, and generator pressure of 40 – 90 kPa (300 – 675 torr). The U_{Cl} Y_Δ product measured in the gas outlet of the generator was between 0.35 and 0.55. For a typical chlorine utilization of 80 - 85 % the $O_2(^1\Delta)$ yield varied between 45 % and 65 %. The BHP utilization was between 0.3 and 0.9. Both the generator pressure and the BHP utilization were much higher than in other types of $O_2(^1\Delta)$ generators used so far in the COIL technology.

[1] Špalek O., Hrubý J., Jirásek V., Čenský M., Kodymová J. and Picková I., Proc. SPIE **6346**, 63460C1-C9 (2007)

[1] E-mail: spaleko@fzu.cz