Experimental Modeling the Active Medium of a Pulsed DOIL with Volume Generation of Iodine Atoms

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The active medium of a pulsed DOIL with volume generation of iodine atoms was experimentally simulated using the chemical generator of singlet oxygen and MW discharge to understand the feasibility of a pulsed oxygen-iodine laser with electrical generator of singlet oxygen.

The successes obtained to now in development of electrically driven singlet oxygen generators make it possible to produce singlet oxygen with a yield $Y = [O_2(^1\Delta_g)] / [O_2(^1\Delta_g)] + [O_2(^3\Sigma_g)]$, where $[O_2(^1\Delta_g)]$ and $[O_2(^3\Sigma_g)]$ are the concentration of oxygen in excited and ground states, respectively, over the threshold level (Y = 15%) for the room temperature.

But active medium small signal gain obtained to now are too small. Thus, applications of low losses and highly reflecting 99,9949% [1] mirrors are necessary to get cw lasing. In particular, the low iodine atoms concentration is a reason of a small gain.

The method of volume generation of iodine atoms used earlier with a success in a chemical oxygen-iodine laser can be used to increase the iodine atoms concentration. Application of this method, as well, could realize the laser pulsed mode, which provides the high pulse power at low average power. Such a feature could be useful to extend the field of laser application.

In the case of electrical singlet oxygen generator the application of this method has a property govern by the presence of oxygen atoms in the flow from the electrical generator. Oxygen atoms react with iodide molecules and form RO_2 species which are the strong quenchers of oxygen and iodine excitation. This effect protects the forming of a large dimension active medium.

The modeling of such an active medium was performed by using the flow of chemically produced singlet oxygen with admixture of products formed in oxygen passing throw the MW discharge. The active medium was cooled by using “dry ice” to reduce the singlet oxygen threshold yield. Evaluation of an active medium temperature from photodissociation iodine laser parameters showed the cooling efficiency was high enough. The temperature down to 200K was obtained. It was observed the application of chemical singlet oxygen generator in the case of a deep cooling of active medium resulted in a decrease of initiation due to deposition of water vapour on the internal surface of a laser chamber.

Taking into account this effect one can state the laser effect can be obtained at our experimental conditions at the singlet oxygen yield of about Y = 11%. The influence of discharge products on the laser performance was investigated. It was shown the methods used to remove the oxygen atoms from the flow from discharge were not effective. The ways for future investigations are discussed.

[1] King D.M., Carroll D.L., Verdeyen J.T., Laystrom J.K. *et al.* “Power Enhancement of the Hybrid ElectricOIL Laser”, 37th AIAA Plasmadynamics and Lasers Conference, AIAA 2006-3756 (2006)

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