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SUBJECT: Authorization for Release of Technical Information, Control Number: **AFRL-PR-ED-TP-2002-092**
Angelo Alfano (ERC) *et al.*, "A Gas-Solid Singlet Delta Oxygen Generator for the Chemical Iodine Laser"

AFRL Technology Horizons **(Statement A)**
(Deadline: N/A)

A GAS-SOLID SINGLET DELTA OXYGEN GENERATOR FOR THE CHEMICAL IODINE LASER

The discovery of the chemical oxygen-iodine laser (COIL) was made in 1978 by McDermott and co-workers [1] at the predecessor unit of today's Air Force Research Laboratory's Directed Energy Directorate. The technique involved the production of electronically excited singlet delta oxygen at 1.27 microns by passing chlorine gas through aqueous, basic hydrogen peroxide (H_2O_2/OH^-). The direct relaxation of singlet delta oxygen to the ground state by the emission of radiation is formally forbidden but it is observable. Therefore, the energy that is available from the chlorine-basic hydrogen peroxide chemical reaction must be transferred from the excited oxygen to an efficient light emitter. This transfer partner should have an energy level close to the excited oxygen state at 1.27 microns to facilitate the energy transfer [2]. The iodine atom, which has a 1.3 micron excited state, is well suited for this purpose. There is a serious competing pathway for the deactivation of the excited oxygen by collisions within the liquid reaction medium. The main collision partners are water, hydrogen peroxide, and oxygen itself. This nonradiative relaxation results in the creation of undesired heat and not the desired light emission. Several patented developments [3] have addressed this need to rapidly extract the excited oxygen from its quenching, aqueous environment and to efficiently mix it with iodine for subsequent lasing at 1.3 microns. These enhancements add further complexity and weight to a reaction chemistry that also involves the preparation and handling of unstable basic hydrogen peroxide.

To circumvent the problems associated with the aqueous COIL chemistry AFRL's Directed Energy Directorate has developed the all gas-phase iodine laser (AGIL) [4]. The AGIL laser produces excited nitrogen chloride (NCl) from chlorine atoms and gaseous hydrogen azide. The excited NCl transfers energy to iodine atoms and the 1.3 micron laser wavelength, which is well propagated through the atmosphere, is available as in COIL. However, the advantage of eliminating the aqueous basic hydrogen peroxide chemistry with the AGIL is compromised by the explosion hazards of its HN_3 chemistry.

In an effort to improve the safety and reduce the complexity of the COIL and AGIL concepts, chemists in AFRL's Propulsion Directorate at Edwards AFB investigated alternative means of preparing singlet delta oxygen from safe starting materials while avoiding liquid-phase quenching problems. Solid-solid, solid pyrolysis, and gas-solid reactions were investigated. Their breakthrough emerged when singlet delta oxygen was produced with solid alkali metal/alkaline earth peroxides and gaseous hydrogen/deuterium halides. The production of singlet delta oxygen was verified by observing its emission at 1.27 microns and comparing the emission wavelength and band contour with well known singlet delta oxygen sources such as an O_2-He microwave discharge and a basic H_2O_2/Cl_2 sparger. The gas-solid reactions were carried out in a static system by admitting hydrogen/deuterium halide gas (up to 700 torr) to an evacuated cell containing the solid peroxide at room temperature. The nonhazardous, commercially available reagents react nonviolently and the products are oxygen, water and benign alkali metal or alkaline earth -halide salts. Further development of this concept could provide an improved singlet delta oxygen generator that utilizes the already available COIL technology for iodine atom production, oxygen-iodine atom mixing, and 1.3 micron laser light extraction. An improved singlet delta oxygen generator based upon the newly discovered gas-solid chemistry would offer significant operational improvements in COIL technology while preserving COIL's inherent advantage of single line emission at 1.3 microns. These gas-solid reactions are also well suited for reduced gravity environments since the need for gas-liquid separation is precluded. Researchers believe that the Airborne and Space-Based Laser programs would both benefit from the combined advantages of this innovative, excited state oxygen generator and existing technology.

Drs. Angelo Alfano and *Karl Christe, onsite contractors,* and Dr. Robert Corley, IPA, *of the Air Force Research Laboratory's* **Propulsion Directorate** *wrote this article.*

References

1 McDermott,W.C., Pchelkin,N.R., Benard,D.J., and Bousek, R.R. Appl. Phys. Lett., 32, pp. 469, 1978.
2 Calvert, J.G. and Pitts, J.N. *Photochemistry*. New York: John Wiley & Sons, 1966.
3 (a) Wagner,R.I. U.S. Patent 4,310,502 (1982)
(b) MacKnight, A.K. and Stancliffe, A.C. U.S Patent 4,342,116 (1982)
(c) Rockenfeller, J.D. U.S. Patent 4,461,756 (1984)
(d) McDermott, W.E. U.S. Patent 5,516,502 (1995)
(e) Dickerson, R.A. U.S. Patent 5,516,502 (1996)
4 (a) Manke II, G.C. " A New All Gas-Phase Chemical Iodine Laser." AFRL Technology Horizons, vol 3, no 1 (March 02), 21.
(b) Henshaw, T.L., Manke II, G.C., Madden, T.J., Berman, M.R., and Hager, G.D. Chem. Phys. Lett., 325, pp. 537, 2000.