

Studies of Supersonic COILs at Ben-Gurion University: (1) Experiments on 10-cm Gain-length Device. (2) Computational Fluid Dynamics Modelling

Ilan Brami-Rosilio, Karol Waichman,
Boris D. Barmashenko and **Salman Rosenwaks**¹

Department of Physics, Ben-Gurion University of the Negev, Beer-Sheva 84105, Israel

Following the achievement of a 40% chemical efficiency in a supersonic 5-cm gain-length chemical oxygen-iodine laser (COIL), experimental studies on a 10-cm gain-length device are reported. It is envisaged that higher efficiency may be achieved in this device. Also reported are results of three-dimensional (3D) computational fluid dynamics (CFD) modeling of the gain in an ejector COIL.

Experimental and theoretical work in progress on supersonic COILs at Ben-Gurion University are reported. Following the achievement of a record value (40%) for the chemical efficiency of a supersonic 5-cm gain-length COIL in our lab [1], a 10-cm gain-length device was manufactured. The aim is to enable the use of lower reflectivity mirrors which are less sensitive to fine alignment and provide a larger extraction efficiency that ought to result in even higher chemical efficiencies. In the first experiments with the 10-cm device, the power and small signal gain dependence on the flow of iodine and secondary N₂ (serving as iodine carrier gas) was tested. To preclude basic hydrogen peroxide (BHP) carry-over from the chemical generator of singlet oxygen we started with small chlorine flow rate, ~ 20 mmole/s, which is about 1.5 times smaller than the estimated optimum flow rate, 30 mmole/s, and with large secondary N₂ flow (42 mmole/s). For these non-optimal flow conditions the maximum small signal gain was 0.4%/cm, resulting in 8% round trip gain, which is ~ 1.5 times larger than that obtained in the 5-cm COIL. The power was also studied as a function of the mirror transmission. Maximum output power exceeding 0.6 kW with chemical efficiency of 35% was obtained for 1% total mirror transmission. Further experiments at optimal flow conditions and mirror transmission are underway.

Recently a 3D CFD model of our slit nozzle supersonic COIL was developed and compared with experimental results [2]. Although the conclusions reached applying this model were based on studies of our specific system with low pressure in the optical resonator, it is expected that they are generally valid, including systems with high pressure in the optical resonator. To check our expectations we started carrying out 3D CFD modelling of the gain in an ejector COIL where the pressure in the optical resonator is more than 5 times larger than in our slit nozzle COIL. An ejector COIL with high stagnation (~ 200 Torr) and static (~ 15 Torr) pressures in the resonator was suggested and studied in detail in Ref. [3] in order to achieve good pressure recovery and effective exhaust of the laser gas into the atmosphere. The calculated gain and temperature in the resonator are in reasonable agreement with the experimental results obtained in Ref. [3].

- [1] V. Rybalkin, A. Katz, B. D. Barmashenko and S. Rosenwaks, *J. Appl. Phys.*, **80**, 023106 (2005)
- [2] K. Waichman, V. Rybalkin, A. Katz, Z. Dahan, B. D. Barmashenko and S. Rosenwaks, *J. Appl. Phys.* **102**, 013108 (2007)
- [3] V. D. Nikolaev, M. V. Zagidullin, M. I. Svistun, B. T. Anderson, R. F. Tate and G. D. Hager, *IEEE JQE*, **38**, 421(2002)

¹ E-mail: zamik@bgu.ac.il