National University of Science and Technology

Faculty of Applied Sciences

Department of Applied physics

Development of novel discharge excitation schemes and switching technology for small TEA CO_2 laser and excimer lamps and their possible applications

Submitted by

Peter Baricholo

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Supervisor: Prof H. M. von Bergmann

Co-supervisor: Dr. D. J. Hlatywayo

Associate supervisor: Prof M. Collier

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ABSTRACT

Dielectric barrier discharges (DBDs) are self-extinguishing discharges due to charge accumulation on dielectric surfaces. An experimental investigation of plasma dynamics using this novel technique of laser excitation was carried out. A discharge cavity with electrode separation of 5 mm and electrode length of 40 cm has been developed. We believe this is the first time that laser action has been observed in a small TEA CO_2 laser operating in a true pulsed mode regime and excited through glass dielectrics. This technology solves the arcing problem that is prevalent in mini TEA CO_2 lasers using exposed metal electrodes.

Experimental and theoretical investigations have been carried out on factors affecting power output of a dielectric barrier discharge excited CO_2 TEA laser. The laser system is excited by a thyratron driven power supply which produces pulses with maximum voltage of 40 kV at varying repetition rates with rise time of 100 ns. CO_2 laser gas mixtures of ratios 1:1:3 and 1:1:8 CO_2:N_2:He were used. The effect of gas pressure, resonator length and excitation pulse repetition rate on the optical output of the laser system was investigated. Optimum operating parameters of this laser are discussed. The voltage across and the current through the discharge were measured using a commercial high voltage probe and a locally made double shielded current probe respectively. Optical pulse energy was obtained by integrating over the pulse optical power and was found to be about 10 μJ. The laser was operated at pressures up to 500 mbar with excitation pulse frequency of up to 400 Hz.

Provision of clean water and sterilization of food as well as hospital equipment are some of the challenges faced by many poor nations the world over. It is against this background that through this project we developed VUV excimer lamps for use in bacteria sterilization.

A bipolar pulsed high voltage and high frequency power supply has been developed for the excitation of dielectric barrier discharge excimer lamps. Voltage and current signals across the 5 mm electrode gap have been measured. Energy transferred into the gas per pulse has been obtained by integrating over the applied power and was found to be about 300 μJ.

A coaxial Ar excimer lamp excited by a dielectric barrier discharge has been developed and characterized. The effect of discharge gas pressure, excitation pulse frequency, pulse width and gas flow rate on the intensity of the Ar^*_2 126 nm VUV excimer emission has been investigated. Intensity of the emission increases with pressure according to a second order polynomial. Intensity of IR emission from the Ar excimer lamp was also observed to be pressure and pulse repetition rate dependent. The VUV emission from the Ar excimer lamp was effectively used to inactivate *E. coli* bacteria. Fifteen minutes was found to be the optimum time required to kill *E. coli* when the developed lamp is operated at a pressure of 1 bar and an excitation repetition rate of 3 kHz.