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Letter to the Editor

A simple N_2 laser for dye laser pumping

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Introduction

Starting with Leonard and Gerry [1, 2] constructions of transtransversaly excited nitrogen lasers have been developed in various versions and improvements (for references see e.g. [3]). Most of the efforts have been done to construct a sufficient pump for dye laser excitation.

In this work we report a simple and nonexpensive construction which has been successfully employed for dye laser pumping, although some of its parameters, e.g. output power and efficiency are lower than "top" parameters achieved.

Description of the laser

Laser construction is based on the design by Schenck and Metcalf [4] and was described elsewhere [5]. The cross-section of the laser channel is shown in fig. 1.

Dumping capacitors (500 pF in number 20) are mounted in two rows to improve mechanical stability. The ends of the laser channel are sealed off by quartz windows.

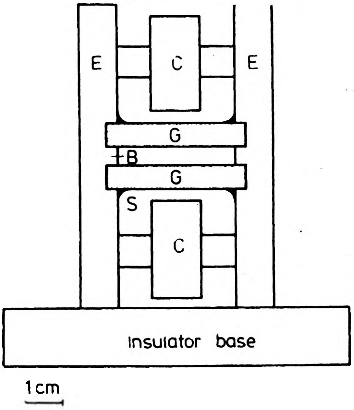

Fig. 1. Cross-section of the laser channel. E — aluminium electrodes, C — dumping capacitors, G — glass plates, B — saw-tooth blade, S — seal

High voltage triggering circuit consists of a low inductance storage capacitor (4×4800 pF in parallel) charged through the 120 kΩ resistor from a regulated H.V. power supply (30 kV/60 mA Philips), and a fast hydrogen filled thyratron (5C22 Philips) used as a switch for triggering. The thyratron being at our disposal reduces the applicable voltage up to 16 kV. Pulses for the thyratron grid come from the simple pulse generator whose repetition rate can be altered from 1 to 30 Hz.

Experimental performance

Measurements of the influence of the operating conditions on the output power of the laser were made by using a silicone photodiode (MD-1, Monsanto) calibrated against a pyroelectric joulmeter (Molectron) and an oscilloscope (454A Tektronix).

A typical oscillogram of the laser pulse is shown in fig. 2. The pulse has a 3 ns rise time, its half-width is of order of 10 ns. The pulse height was reproducible within ±10%.

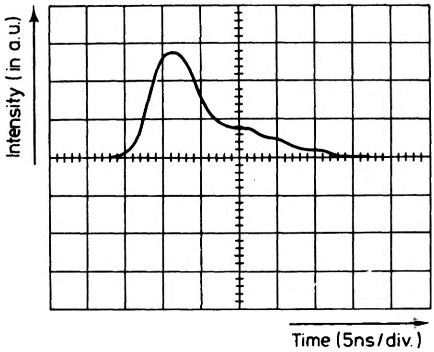

Fig. 2. Oscillogram of the laser pulse at 337.1 nm for 16 kV and nitrogen pressure 80 hPa

Peak power as a function of nitrogen pressure at various charging voltages is given in fig. 3. Each curve showns a maximum, the position of which depends on the voltage applied (fig. 4). The rapid decrease of the power beyond the optimal pressure is due to the onset of arcing at the ends of the laser channel.

The linear dependence of the laser power on the voltage implies that there is one optimal value of $E \cdot p^{-1}$ for the configuration used. This value calculated from the slope of the straight line in fig. 4 equal to 176 V cm^{-1} $(hPa)^{-1}$ with tolerance $^{+25}_{-12}\%$, is in good agreement with the theoretical estimate of 187.5 $V \cdot cm^{-1}$ $(hPa)^{-1}$ by Godard [6]. Other authors have reported the values of $E \cdot p^{-1}$ between 60 and 150 $V \cdot cm^{-1}$ $(hPa)^{-1}$ [6-8].

The laser beam divergence is 9 mrad in the horizontal plane and 15 mrad in the vertical direction.

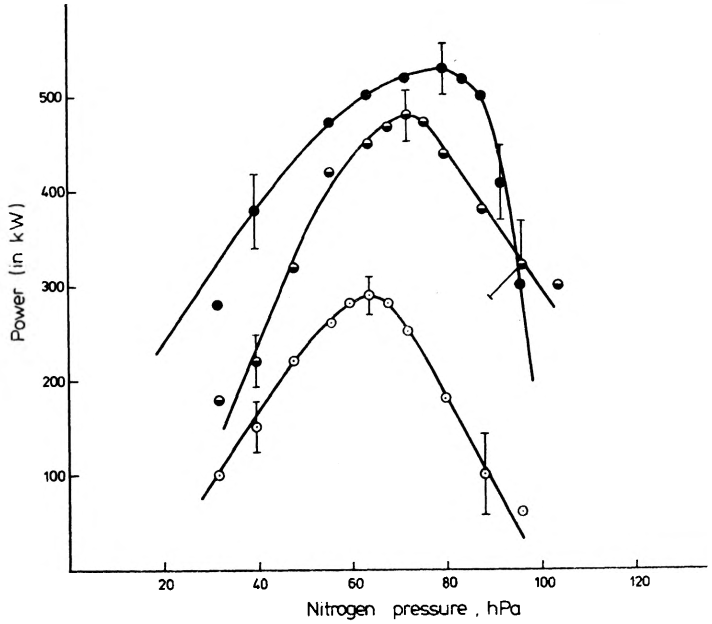

Fig. 3. Laser pulse power as a function of nitrogen pressure for different voltages

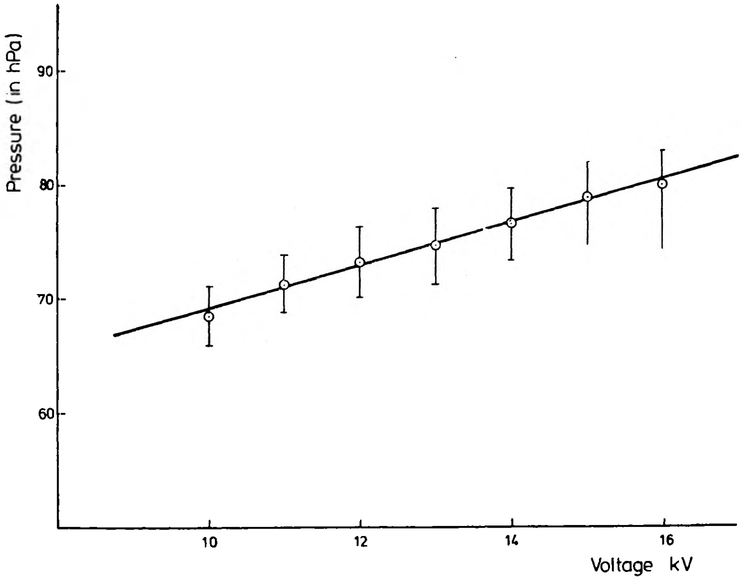

Fig. 4. Optimal nitrogen pressure as a function of the voltage

Dye laser pumping

The nitrogen laser described above has been successfully employed as a pump for a dye laser. A block diagram of the experimental setup is shown in fig. 5. The 337.1 nm radiation is focussed by two quartz lenses into a rectangular quartz cuvette containing a dye medium. The cuvette is tilted to avoid cavity effects between the walls. Dye laser cavity with an optical length of 35 cm is formed by a 1200 grooves mm diffraction grating (Oriel 7271, blazed at 500 nm) as a tuning element and a 50% reflecting mirror. Two adjustable slits are used for narrowing the output bandwidth.

Superradiance was observed for Rhodamine 6G and 7-diaethylamino-4-methyl coumarin (DAMC) solutions in ethanol. The concentrations and tuning ranges obtained are presented in table.

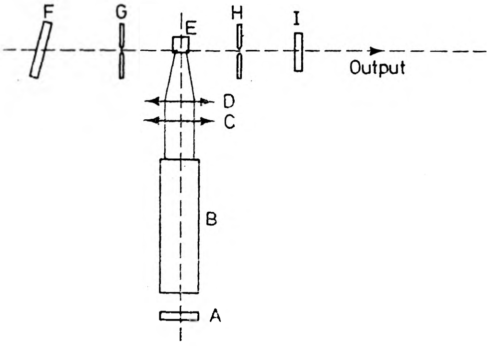

Fig. 5. Block diagram of the experimental setup for transverse dye pumping: A — 100% mirror, B — nitrogen laser 337.1 nm, C — cylindrical lens, D — D — convex lens, E — dye cell, F — grating, G, H — slits, I — 50% mirror

Table

Dye	Concentration (mol/dm^3)	Tuning range (nm)
Rhodamine 6G	$2\cdot10^{-3}$	575-600
DAMC	$1.2\cdot10^{-3}$	460-480

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