plotting figure 2, the gauge factor k_T was assumed constant. This was reasonable since within the small temperature range -5 to 40°C (the range found suitable for photothermoelastic studies, Khayyat 1975) the factor varied by only $^{+0.1}_{-0.2}\%$ of its nominal value. The nominal value of k_T was therefore used.

The α value in this particular sample in the range -5 to 40°C was found to be $50{\cdot}3\times10^{-6}\ \mathrm{K}^{-1}$ (cylinder 7, Khayyat and Stanley 1977). Because this value was relative to fused silica, it was increased by $\frac{1}{120}$ to finally give the corrected α value of $50{\cdot}7\times10^{-6}\ \mathrm{K}^{-1}$.

Whilst a constant gauge factor was used in evaluating α, there is no reason why a variation in the factor (particularly when using a larger temperature range) should not be allowed for.

To the author's knowledge this method of obtaining α has not been used before. It would seem to be more accurate and more convenient than the previous methods described (an accuracy of 1% is obtainable).

Acknowledgments

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X-ray absorption attachment for a powder diffraction camera

L Bretherton and C H L Kennard
Department of Chemistry, University of Queensland, Brisbane, Australia 4067

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Abstract Modifications have been made to a conventional powder diffraction camera so that x-ray absorption photographs may be taken in safety.

X-ray absorption photographs of small samples, such as human gallstones, were taken in safety in an x-ray diffraction laboratory by modifying a commercial Philips x-ray powder diffraction camera (figure 1). The modifications included

Figure 1 X-ray absorption attachments as made for a Philips x-ray diffraction camera

replacing the regular beam collimator by one with a large hole so as to give within the physical dimensions of the window the maximum x-ray flux from the tube. A gallstone was mounted using Plasticine on an insert at the centre of the camera. The other modification was to replace the regular beam stop by a chromium-plated brass film holder which acted as a beam stop and held either a 'film badge', dental or cut x-ray film. The relative position of the film to the sample could be adjusted by altering the position of the metal rod in the cap. The rod was held firmly in the screw cap by a neoprene washer. The resultant negatives were of the same quality as those produced using conventional medical radiography.

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A practical design of a nitrogen laser

A J Schmidt
Institut für Physikalische Elektronik, Technische Universität Vienna, A-1040 Vienna, Austria

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Abstract A practical design and the construction of a high-power nitrogen laser are described. It delivers pulses of up to 3·5 mJ at a rate of 10 per second. To optimize its performance as a pump source for a Hänsch-type dye laser, a comparatively long pulse width (about 10 ns) has been chosen.

Special care has been taken to make maintenance as convenient as possible. The fast transmission line is formed by sheet capacitors, which are held together by atmospheric pressure only and are therefore easily demountable in the case of dielectric breakdown.

1 Introduction

In recent years nitrogen lasers have been widely used as pump sources for dye lasers. The reasons are that peak powers of several kilowatts up to 1 MW are readily available from these lasers and that their output wavelength of 337·1 nm is located in the near UV, so that dyes covering the whole visible range can be pumped conveniently.

Since the discovery of UV laser action in the second positive band of nitrogen by Heard (1963), a large number of different designs for N_2 lasers have become known, their common feature being a fast transverse electrical discharge through a volume of N_2 gas. The design presented in this note is similar to those described by Basting *et al* (1972) and Godard (1974) but differs in some important features. We use a parallel-plate transmission line to excite the plasma, but we deliberately avoid a travelling-wave discharge. Thus our output pulse is considerably longer (approximately 10 ns) than in the design of Basting *et al* (1972) who obtain pulse widths of about 2 ns. The longer pulse width is desirable if one uses a dye laser arrangement according to Hänsch (1972), although this caused a somewhat lower peak power. This arrangement, now commonly used for N_2 laser pumped dye lasers, relies for optimum performance on a pump pulse width of at least the round-trip time of the dye laser cavity. Lasers of this type suffer electrical breakdowns fairly frequently. It is an important feature of our design that the dielectric of the transmission line can be replaced with comparative ease.

2 Design

Figure 1 shows the structure of the laser and its electrical connections. The two halves of the double transmission line are connected to a 106·7 cm long discharge channel which is only 6·35 mm high to make short electrical connections possible. Both sides of the inner plates of the transmission line are kept on the same high DC voltage via a small inductance, which consists of a few windings on a ferrite toroid; its value is not critical. The discharge of the transmission line which starts at the triggered spark gap leads to the development of a high voltage between the two knife-edge electrodes and thus to the creation of plasma in the discharge channel. As mentioned above, we deliberately avoid generating a travelling-wave discharge. Therefore we do not shape the spark gap side of the transmission line into any special form in the way Godard (1974) or Basting *et al* (1972) did, but leave it rectangular; the spark gap has been placed at the centre of the edge parallel to the discharge tube.

An overall view of the design is shown in figure 2. The main construction consists of two rigid, U-shaped, aluminium frames (101·6 cm × 121·9 cm) which hold between them two rectangular plates of Plexiglass 6·35 mm thick. In the gap between them two knife-edge stainless steel electrodes are located parallel to each other. They are about 106·7 cm long and are separated by about 1·27 cm. Except for a 5·08 cm wide strip next to the supporting frames, the Plexiglass plates are covered by foils of aluminium (0·0635 mm thick) which are in good electrical contact with the electrodes over their whole length. They serve as the high-voltage sides of the transmission lines. Four brass strips, roughly 7·62 cm in width, contacting the aluminium foils over their whole widths are soldered to two brass rods each 1·6 mm thick and embedded near the outer long edge of one Plexiglass plate. The ends of these rods sticking out of the plates connect to the high-voltage power supply and to one electrode of the spark gap (shown in figure 1).

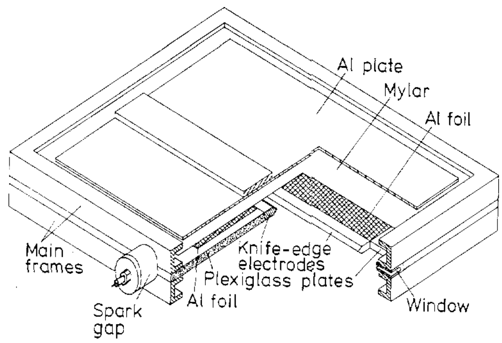

Figure 2 Overall view of the laser

This structure is covered on both sides by a 0·254 mm thick Mylar sheet, followed by a rectangular aluminium plate forming the grounded electrodes of the transmission lines. The plates are about 0·8 mm thick and have been strengthened by two strips of aluminium 6·35 mm thick which have been glued on to the plate in such a way that they lie on top of the discharge channel formed by the two electrodes. Similar brass strips to those mentioned above connect the plates to the main frames and thus to the case of the spark gap. The ends of the discharge channel are closed by quartz windows which are mounted on supporting blocks made out of UV-Plexiglass transparent to UV. These blocks are fastened on to the main frames and carry one tube connection each to pass nitrogen gas longitudinally through the laser.

The covering aluminium plates, the Mylar sheets, the Plexiglass plates and the window blocks are sealed to each other with silicone rubber (RTV 732) in such a way that the discharge channel together with the spaces between the various layers of the transmission lines form one single volume. Under normal working conditions this volume is always filled with nitrogen gas of a pressure well below one atmosphere.

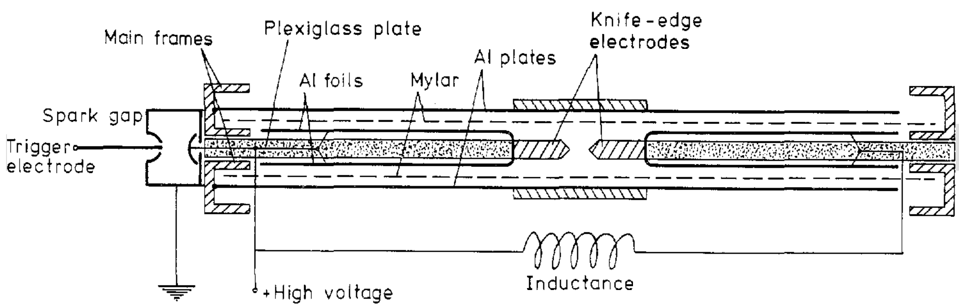

Figure 1 Structure of the laser and electrical connections

The various layers are therefore tightly pressed together and no further mechanical clamps or support are necessary to keep them in place. Consequently the replacement of a defective Mylar sheet in case of an electrical breakdown is comparatively easy and involves only resealing the edges of the various layers.

The spark gap is of cylindrical symmetry. Its case is made of aluminium and is directly fastened on to the main frames. The electrodes are made of machinable tungsten (Elkonite 30W3) and have the form of discs (1·9 cm diameter) with rounded edges. A normal automobile spark plug is used as a trigger electrode. The spark gap is sealed and can be filled with an inert gas. It can be cooled by water flowing through channels inserted in its case.

The high voltage was provided by a capacitor charging unit (Hartley Ltd, model 411 2220), which was capable of delivering up to 20 kV. At a working voltage of 10 kV the laser draws 1·8 mC per pulse. The nitrogen used in the laser is of technical quality. For repetition rates up to 10 Hz a gas flow of 5 l min^{-1} (at atmospheric pressure) was sufficient. A filter filled with type 13X molecular sieve was inserted between the vacuum pump and the laser to prevent pump oil from reaching the discharge channel.

3 Experimental results

The output of the nitrogen laser was monitored with a fast photodiode (Hamamatsu R617) connected to a Tektronix 7904 CRO and a pyroelectric joulemeter (Molectron J3-05). Using no mirror, the output was the same on either end of the laser, as expected. A 100% mirror increases the output by about a factor of 3. The pulse width was about 10 ns. The energy per pulse was 1·6 mJ for an operating voltage of 6 kV and 3·5 mJ for 14 kV. For optimum performance the nitrogen pressure had to be adjusted so that E/p (operating voltage over nitrogen pressure) was about constant (about $1{\cdot}33\times10^4$ Pa for 6 kV). The laser could be operated at a repetition rate of 10 Hz for extended periods without noticeable signs of deterioration.

Acknowledgments

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A rectangular-bore gas gun

I M Hutchings, M C Rochester† and J-J Camus‡
Cavendish Laboratory, Madingley Road,
Cambridge CB3 0HE, UK

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Abstract Design details and measured performance are presented for a laboratory gas gun with a novel rectangular bore. Projectiles weighing 0·5 g have been accelerated to 300 m s^{-1}. This design eliminates axial rotation of the projectile which is possible in a cylindrical-bore gun, and provides important advantages in some impact experiments.

1 Introduction

Conventional gas guns with cylindrical bores allow the projectile to rotate axially during its passage down the barrel. Such rotation is usually small, but it is not reproducible; for impact experiments in which precise projectile orientation at the point of impact is needed, this degree of freedom may be a serious disadvantage. The gun described here overcomes this problem by employing a barrel of rectangular cross section. We present the essential constructional details of a gun which has been in use for several years, discuss the performance and design criteria of the instrument and give brief details of two experiments in which this apparatus has been employed.

2 Description

Figure 1 shows the general layout of the breech end of the gun. The barrel, of rectangular cross section, is coupled via a solenoid-operated valve (Hale-Hamilton Ltd, Model MV16) to a gas reservoir of 0·1 dm^3 capacity. This reservoir is charged with gas to a predetermined pressure before firing. The barrel is made from two rectangular steel bars clamped together at intervals by machine screws. Figure 2(*a*) shows a section through the barrel at AA′ (figure 1). The projectile moves in a

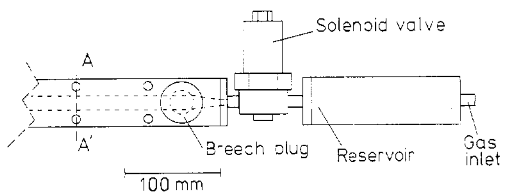

Figure 1 The breech end of the gun

slot of dimensions 16 mm × 1·5 mm, milled into one of the barrel members. At the breech end of the barrel the slot tapers smoothly over a distance of 30 mm into a round bore of 6·3 mm diameter, as shown in figure 1. The tapering bore was formed by hand filing and finished by polishing. The solenoid valve is coupled to the barrel by a screw thread. Projectiles are loaded into the barrel slot through a removable breech plug; a section through the breech is shown in figure 2(*b*). In our gun

† Work performed in University of Cambridge Engineering Laboratory, Trumpington Street, Cambridge.
Present address: School of Engineering Science, Plymouth Polytechnic, Drake Circus, Plymouth, Devon.
‡ Present address: University of Cambridge Engineering Department, Whittle Laboratory, Madingley Road, Cambridge.