Homopolar Generator as the Energy Store for a Large Laser

THE homopolar generator[1,2] at the Australian National University in Canberra can be connected to deliver $1{\cdot}5 \times 10^6$ A at more than 800 V for 0·1 s. When light sources capable of handling such power and energy are developed, it will be possible to use the energy to pump a large laser. We have used the generator with its four disks in series to power a co-axial discharge tube filled with xenon at a pressure of 30 cm of mercury. During a pulse lasting for 7·5 ms we injected 6,000 J/inch into the flash tube which enclosed a Nd glass laser rod 0·5 inches in diameter and 6 inches long. The fluorescent lifetime of the glass is quoted as 360 μs. A record of the radiation intensity is shown in Fig. 1. The decrease in intensity with time was caused by the current being reduced by a variable resistor in series with the lamp, increasing in preparation for the termination of the pulse. If the laser assembly could stand it, a pulse of this power could be supplied for 50 s from the generator.

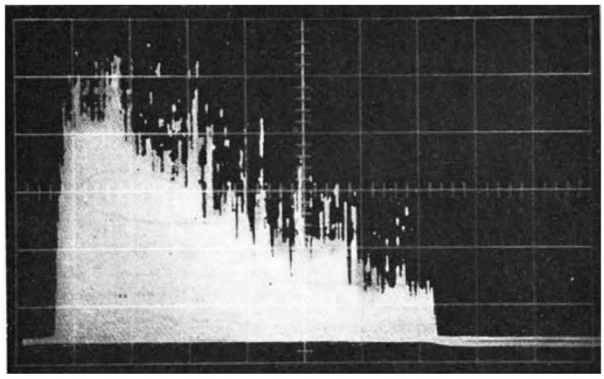

Fig. 1. Intensity of laser light produced by a Nd glass rod 0·5 inches in diameter and 6 inches long, pumped with 1,000 J/inch ms^{-1}. Time-base, 1 ms per division.

During these high current pulses several thermal and mechanical problems arise, together with others caused by the electromagnetic forces on the plasma in the flash tubes, which are not encountered in smaller lasers. These will make it necessary to arrange the current paths in the large arrays of flash tubes which are envisaged, in a pattern designed to prevent the mutual forces deflecting the plasma.

The enormous energy available from the homopolar generator will make it possible to proceed with the development of lasers with powers and energies considerably greater than any used to date. Present work is concentrated on the development of methods of switching currents at these power levels with adequate precision of timing. On the laser side, attention is being given to methods of minimizing the electrical, thermal, optical and mechanical stresses in the laser material and cavity, with the aim of building a laser system to match the energy storage potential of the homopolar generator. 10^8 J could be supplied in 0·1 s.

We thank the staff of the generator section of the Department of Engineering Physics, for their help with the construction and operation of the generator, the control equipment and the laser assembly, in particular, Professor G. Newstead for his support and Mr R. A. Marshall who designed and had built the brushes in the generator[3,4]; these include the new adjustable inner brushes which will be described elsewhere.

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Oxidation of Graphite catalysed by Palladium

PALLADIUM significantly increases the reaction rate of graphite with oxygen in the 600°–700° C temperature range[1]. The activation energy for the catalysed reaction in this range is 124·5 kcalories/mole, however, compared with 48·8 kcalories/mole for the uncatalysed reaction, so the pre-exponential term A in the Arrhenius equation $k = Ae^{-E/RT}$ is correspondingly large. (In the equation k is the rate of reaction, E the activation energy and R and T have their usual identity.) This implies that the catalysed reaction takes place on surface sites which differ in both quantity and nature from those of the uncatalysed reaction.

To investigate this reaction, a 100 Å layer of palladium was evaporated on to both British Nuclear grade and spectroscopically pure graphites, which were mounted on silica support films on electron microscope mounts. The specimens were fitted into the heating stage of a Siemens Elmiskop 1 electron microscope and the temperature slowly raised to 500° C in a vacuum of 10^{-5} torr. Dry air was then passed over the specimen by means of a special attachment[2], and its behaviour was watched and recorded on photographic plates and on videotape by means of closed circuit television.

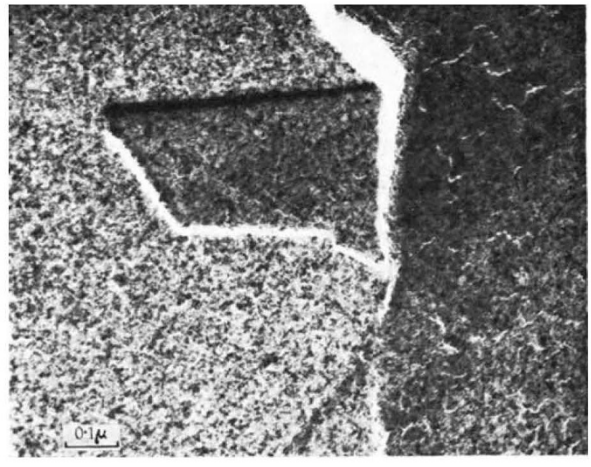

Fig. 1. Evaporated palladium film on graphite.

Fig. 1 shows the appearance of the palladium film on the graphite before heating, and Fig. 2 its appearance at 400° C after the total heating time, from room temperature, of 86 min. Some nucleation and decoration[3] occurred exposing areas of graphite and considerable grain growth took place in the remaining film. The temperature was then raised to 500° C causing the remaining film to nucleate, the nucleated particles often being situated at surface steps and discontinuities in a similar manner to "decoration" although the particles were much bigger (100–5000 Å).

The admission of air at this temperature caused a small amount of oxidation at the edges of graphite flakes and