NEODYMIUM LASER WITH REGULATED PULSE DURATION

V. A. Aleshkevich, V. V. Arsen'ev, V. S. Dneprovskii, D. N. Klyshko, and L. A. Sysoev
Physics Department, Moscow State University
Submitted 27 December 1968
ZhETF Pis. Red. 9, No. 4, 209-211 (20 February 1969)

The presently available pulsed lasers have generation pulse durations on the order of either a millisecond, or a nanosecond, or a picosecond. For certain applications, however, it is desirable to have intermediate pulse durations.

In the present communication we present preliminary results of the development of a neodymium laser with a generation pulse duration adjustable in the range from 30 to 700 nsec and with a homogeneous spatial radiation structure, both effected by two-photon absorption.

To this end, a plate of cadmium selenide, which possesses appreciable two-photon absorption, was placed inside the cavity of a Q-switched neodymium laser. The two-photon absorption of CdSe at the neodymium laser frequency is ~0.4 cm/MW [1], and the width of the forbidden band is $E_g = 1.7$ eV ($\hbar\omega < E_g < 2\hbar\omega$, where $\hbar\omega$ is the laser quantum energy).

Similar experiments with a ruby laser were performed by Schwartz and Naiman [2], and also in [3].

The generator circuit is shown in Fig. 1. The Q-switching was with the aid of a rotating prism. Semiconducting CdSe plates 2 mm thick were mounted at the Brewster angle. The reflection coefficient of the output mirror was 70%. Pumping was with the aid of two IFP-2000 flash lamps. The generation pulse duration was varied by changing the pump energy. The dependence of the neodymium-laser pulse duration on the pump energy is shown in Fig. 2.

A typical oscillogram of the laser pulse is shown in Fig. 3. With increasing pump energy, the generation

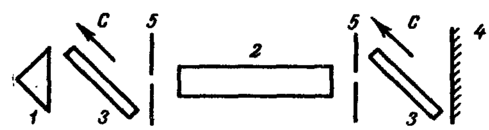

Fig. 1. Diagram of laser: 1 - rotating prism, 2 - neodymium glass (diameter 10 mm, length 120 mm), 3 - CdSe crystal, 4 - mirror, 5 - diaphragm.

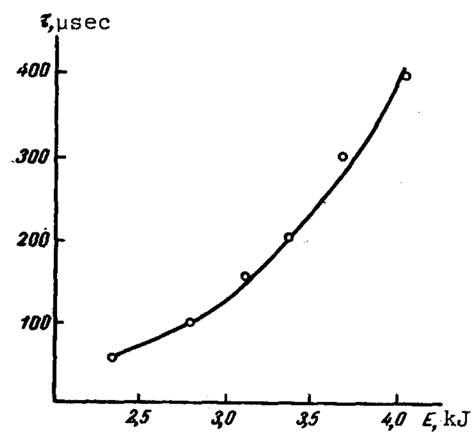

Fig. 2. Neodymium-laser pulse duration vs. pump energy.

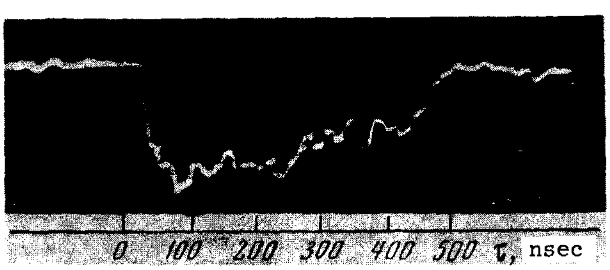

Fig. 3. Oscillogram of the neodymium-laser generation pulse.

pulse duration τ decreases monotonically; the radiation power then changes insignificantly and amounts to approximately 100 kW at τ = 200 nsec and 50 kW at τ = 500 nsec (without the semiconducting plates the generation power is 3 MW at τ = 30 nsec). It is possible to obtain stable emission pulses with duration up to 0.7 msec, and the spatial structure of the radiation is improved thereby.

Inside the resonator are placed two plates of a two-photon absorbing semiconductor (Fig. 1), for if one plate is placed between the output mirror and the active crystal, the lasing pulse has an appreciable overshoot at the beginning, connected with lasing due to reflection from the end face of the active element. On the other hand, if the semiconducting crystal is placed between the prism and the active element, then the main single pulse is accompanied by free-running radiation generated in the resonator made up of the end face of the active element and the output mirror. In this case, a decrease of the monopulse duration is observed. It is apparently possible to use one two-photon absorbing crystal, provided the end faces of the active element are cut at the Brewster angle.

The use of amplifiers makes it possible to obtain radiation of large power and of adjustable duration. We obtained a power gain by a factor of 4 using a neodymium-glass amplifier (crystal length 120 mm).

It is apparently possible to choose semiconducting materials capable of regulating the generation-pulse durations of all generators. In particular, the experimental results of Zubov et al. [4] show that germanium can be used as this material for a dysprosium laser.

It should be noted that the method used in the present investigation can be employed to vary the pulse duration of lasers operating in the mode-synchronization regime (picosecond range).

In conclusion, the authors thank G. A. Boiko and D. R. Kondorskii for help with the experiment and R. V. Khokhlov for a discussion of the results.

[1] A. Z. Grasyuk, I. G. Zubarev, and A. N. Mentser, Fiz. Tverd. Tela 10, 543 (1968) [Sov.-Phys.-Solid State 10, 427 (1968)].
[2] J. Schwartz, C. S. Naiman, and R. K. Chang, Appl. Phys. Lett. 11, 242 (1967).
[3] V. V. Arsen'ev, V. S. Dneprovskii, and D. N. Klyshko, Abstracts of papers delivered at Fourth All-union Symposium on Nonlinear Optics, Moscow State Univ. Press, 1968.
[4] B. V. Zubov, A. A. Kulevskii, T. M. Murina, and A. M. Prokhorov, ibid.

EMISSION PRODUCED BY EXCITED HELIUM MOLECULES WHEN SOLID TARGETS ARE BOMBARDED BY MEANS OF FAST HELIUM IONS

V. V. Gritsyna, T. S. Kiyan, A. G. Koval', and Ya. M. Fogel'
Khar'kov State University
Submitted 16 December 1968
ZhETF Pis. Red. 9, No. 4, 212-215 (20 February 1969)

It was established in our earlier paper [1] that bombardment of a metallic target with fast hydrogen ions produces a glowing halo extending 1 - 1.5 cm from the surface of the target. It was shown that this glow is due to the emission by the fast hydrogen atoms when the ions of the primary beam are scattered by the surface of the target. In the present communication we present the results of an investigation of the glow produced when a number of