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CAVITY DUMPING BY THE SECOND HARMONIC GENERATION IN Nd:YAG LASER

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This paper presents a method of cavity dumping by the second harmonic generation. A theoretical model of the process is proposed; the influence of the pump power and cavity losses on the output pulse shape is analyzed. The possibility of laser operation in this mode is demonstrated experimentally. The calculations were made on the basis of rate equations for Nd:YAG laser..

The proposed method of cavity dumping by the second harmonic generation enables one to produce highly coherent pulse-periodic radiation of the enhanced power.

The setup used (Fig. 1) has two sequential working modes. In the first mode the second harmonic is not generated and all radiation is confined within the cavity as reflectivity of the mirrors for the fundamental-mode radiation is 1. The second mode starts when the intensity of radiation in the cavity reaches its steady-state value: the voltage applied to the electro-optic crystal changes the light polarization to circular. As a result, some part of the energy is transformed into the second harmonic. One of the cavity mirrors is made almost transparent for the second harmonic radiation to form a collimated laser beam outside. The remaining fundamental-mode radiation cuts off by the polarizer as its polarization becomes perpendicular to the original one. This is made to prevent the ongoing transformation of radiation into the second harmonic and to shorten the output pulse length.

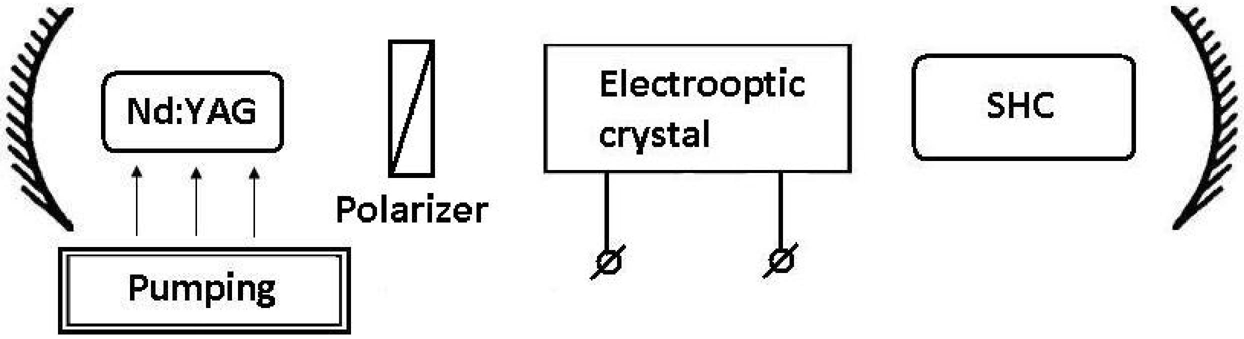

Fig. 1. Setup scheme.

It is assumed that operation of the setup with a Nd:YAG laser crystal is realized according to the standard 4-level scheme, the fundamental frequency corresponding to the wavelength 1.064μm. Simulation has been accomplished using the point model of an active medium[1], the setup parameters corresponding to those of a real DPSS laser[2]. The calculations are performed in two steps in line with two sequential modes: the first step is to obtain the parameters after the continuous generation mode is attained, assuming the mirror reflectivity $\rho=1$; and the second step involves the second harmonic generation. It is assumed that the second harmonic intensity $I2$ has a quadratic dependence on the intensity $I1$ of the fundamental-mode radiation, the polarizer transmission is 20%.

Using this model, we can determine the output photon flux density$S2$ as a function of time (Fig. 2). Under approximation of the immediate action of the setup elements, the pulse length is independent of the pump power and equals ~1ns (time required for double-passing the cavity).The described method has been tested experimentally when the second harmonic generation (532 nm) was obtained using a side-pumped Nd:YAG laser and a KTP second harmonic crystal.

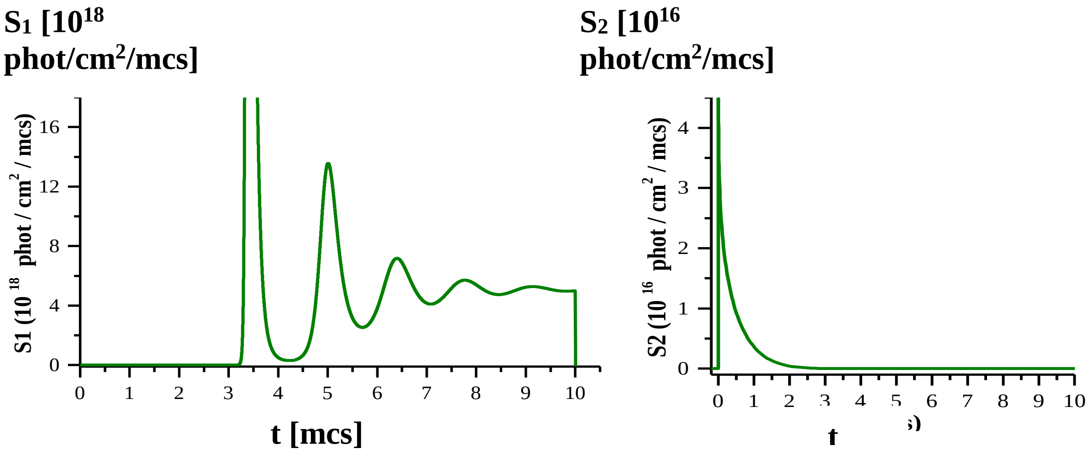

Fig. 2. Time dependence of the photon flux density of the second harmonic radiation S2 (right) and the fundamental-mode radiation inside the cavity S1 (left). The second harmonic pulse starts at t=10 mcs, pump photon flux density is5.76·1015phot/mcs/cm2.

The method of cavity dumping by the second harmonic generation enables one to obtain short pulses of collimated radiation outside the cavity. The pulse duration depends mostly on the timing parameters of the operating elements and is about 1 ns under the best conditions. The described set-up may be operated in the mode-locking and pulse-periodic modes.

List of literature

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