Таким образом, методом жидкофазной эпитаксии получен образец слоя $KGd_{0,0284}Yb_{0,0469}Y_{0,9247}(WO_4)_2$ с содержанием ионов Ho^{3+} 4.97 ат.% толщиной 140 мкм, который характеризуется высоким оптическим и структурным качеством и может быть использован в качестве активной среды планарных волноводных лазеров, излучающих в спектральной диапазоне около 2 мкм.

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Yb:YAB BASED CHIRPED PULSE REGENERATIVE AMPLIFIER

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1. Introduction

Diode-pumped femtosecond laser sources with pulse repetition rates of hundreds kHz and pulse energies of tens microjoules are of practical importance for high-precision micromachining in industry and biomedicine [1].

These pulse trains can be generated conveniently with RA systems based on bulk regenerative amplifiers. One of the highest output power reported so far for bulk RAs is 28 W in an Yb:CALGO operating at 500 kHz, with 217 fs pulses [2]. The output power of about 21 W at 200 kHz PRF with 200 fs pulse duration is obtained on Yb:KGW dual crystal system [3]. Generalizing the above data, we can conclude that the search for new laser media with appropriate spectroscopic properties for regenerative amplification of ultrashort laser pulse is still of high interest.

Yb:YAB crystal demonstrate promising spectroscopic properties that confirmed by excellent experimental results in mode-locked lasers provided near-transform limited pulses with wide spectra [4].

In our paper we present the experimental results of Yb:YAB-based chirped pulse regenerative amplifier for the first time to the best of our knowledge.

2. Experimental layout

The conceptual scheme of the system layout is shown in Fig. 1. As a seed laser diode-pumped Yb:KYW oscillator was used which provided 100 fs pulse train with 70 MHz PRF and 10 nJ single pulse energy. The seed pulse spectrum was 12 nm wide (FWHM) and centered at 1037.7 nm. A BaB2O4 (BBO)-based pulse-picker was used to reduce pulse repetition frequency to the levels of 1-100 kHz. For stretching the pulse Martinez-scheme stretcher based on the reflection Au-coated grating was used with period of 1800 mm^{-1}.

The stretched seed pulse duration was about 150 ps. After passing through a Faraday isolator, the seed pulse was injected into the RA. The isolator was employed to protect the seeder from high-intensity back reflections and, at the same time, for separating the amplified output pulse from the seed oscillator.

A grating compressor is employed at the RA output in order to compress the chirped femtosecond pulse. Compressor consists of two reflection Au-coated grating with period of 1700 mm^{-1}. Transmission of the compressor was about 76 %.

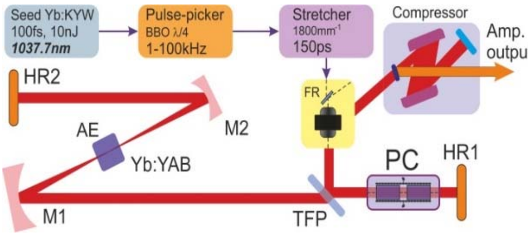

Fig. 1. Schematic of the Yb:YAB chirped pulse regenerative amplifier

As a pump source a multiple single emitter InGaAs fiber coupled laser diode (Ø105 μm, NA=0.15) with maximum output power of about 25 W was used. The pump light was formed by set of lenses into the spot with diameter of about 180 μm (1/e^2). The losses on transmission of the hole from such "pump" mirror did not exceed 3 % of pump power. Besides that such pumping scheme enable us to tune the wavelength of the laser diode exactly in the absorption band of the material without losses in the short-wave pass filter (input mirror). One of the important things most notably for regenerative amplifiers with longitudinal pumping schemes is that the part of the intracavity pulse energy passes through the input mirror and damages pumping diode. Our pumping scheme is free of these negative issues.

In Fig. 2 the pump beam profiles during the propagation through the gain crystal are depicted. As can be seen the pump beam profile was a circular and homogeneous inside the crystal. The drop in the middle of the pump beam profile appears at the distances >3mm from pump beam waist and therefore do not introduce any negative influence due to the pumping inhomogeneity on the mode-matching and output laser performance.

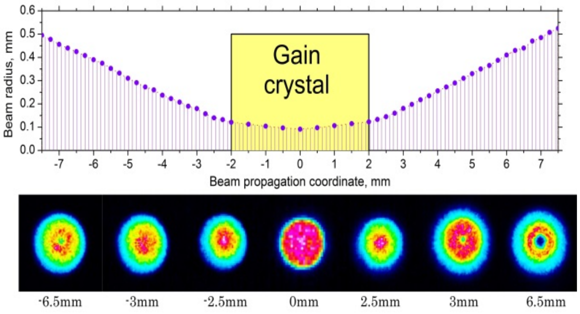

Fig. 2. Beam radius and pump beam profiles during the propagation through the cavity and gain crystal

3. Chirped pulse regenerative amplifier performance

During the RA experiment we measured the output pulse train parameters for σ-polarized light in the gain medium at 100 kHz PRF. The dependencies of average output power and pulse duration on cavity round trip number for Yb:YAB regenerative amplifier system (compressor transmission was about 76 %) are presented in Fig. 3.

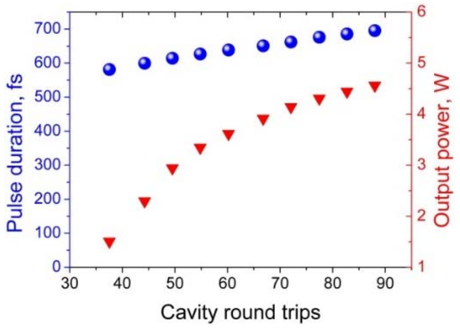

Fig. 3. Dependencies of average output power and pulse duration on cavity round trip number

The maximum average output power of 4.6 W was obtained. On increasing the cavity round trips number from 37 to 88 pulse duration increases slightly from 581 fs to 695 fs. The dependency of amplified pulse peak power on cavity round trips number are shown Fig. 4.

Maximum pulse peak power was about 66 MW at 100 kHz repetition frequency. Spectrum of the amplified pulses at the highest output power are shown in Fig. 5.

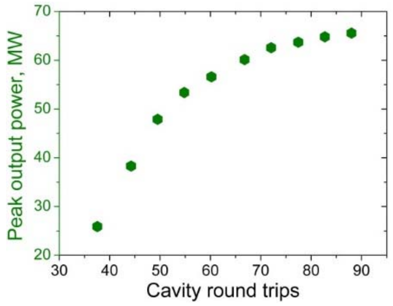

Fig. 4. The dependency of amplified pulse peak power on cavity round trips number

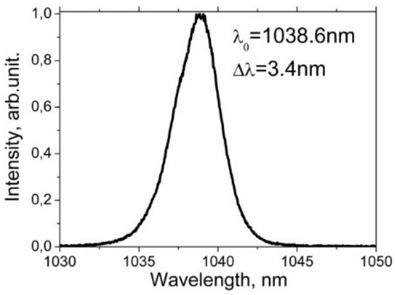

Fig. 5. Spectrum of amplified pulses at highest output power

Autocorrelation trace of the amplified pulses at the highest output power is shown in Fig. 6. Measured pulse duration was about 695 fs assuming Gaussian pulse shape.

In conclusion, the results of experimental investigation of Yb:YAB-based chirped pulse RA are reported for the first time to our knowledge. It generates as high as 4.6 W of average output power with 695 fs compressed pulses and 66 MW peak power at 100 kHz repetition rate.

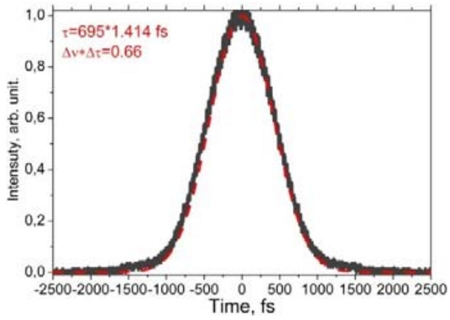

Fig. 6. Autocorrelation trace of the amplified pulses at the highest output power.

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МЕТОД ЗЕРКАЛЬНОЙ РАЗВЕРТКИ ДЛЯ ГАБАРИТНОГО МОДЕЛИРОВАНИЯ ОБЪЕКТИВОВ

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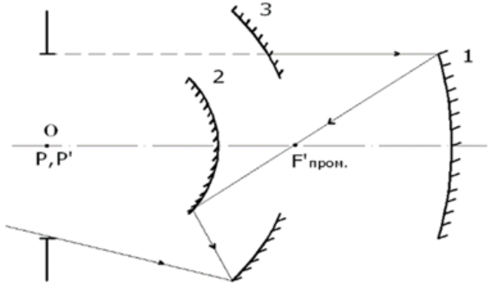
Зеркальные системы широко используются в оптическом приборостроении. Они не имеют хроматических аберраций для любых апертур и фокусных расстояний. Достоинства зеркальных систем: высокое разрешение в широком оптическом спектральном диапазоне; отсутствие селективной непрозрачности и ограничений по апертуре, связанных с размерами заготовок; небольшие габариты, меньшая длина, чем в линзовых и зеркально-линзовых ОС, выигрыш по весу (особенно для объективов диаметрами больше 200 мм); а также экономичность материалов, подтверждают актуальность проблемы моделирования и разработки зеркальных систем.

В связи с расширением диапазона длин волн спектра в ИК и УФ областях оптико-электронных приборов широкое распространение получила группа чисто зеркальных оптических систем (ОС). Такие системы достаточно компактны; при сравнительно несложной конструкции можно получить достаточно совершенную коррекцию сферической аберрации и меридиональной комы.

Одно из направлений в вычислительной оптике – постоянный поиск новых схем с улучшенными характеристиками. Это определяется интенсивным развитием оптической отрасли, развитием новых технологий и исследований.

В данной работе рассматривается новый метод, основанный на зеркальной развертке оптической системы. С помощью этого метода можно решить большинство проблем, возникающих при габаритном моделировании и параметрическом расчете зеркальных объективов.

Метод основан на теоретических положениях, приведенных в работе [1]. С использованием метода было получено ранее новое схемное решение зеркального концентрического объектива [2]. На рисунке 1, *а* приведена конструкция объектива, состоящая из трех концентрических зеркал (базовая схема).



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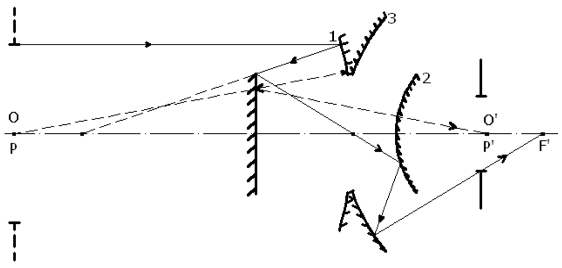

б

а – схематический чертеж; *б* – схема с плоским зеркалом
Рисунок 1 – Зеркальный концентрический объектив