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Research of compound Nd:YAG phase-conjugate resonator with stimulated Brillouin scattering (SBS) cell

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How to improve the quality of output beam of phase conjugation cavity is a problem. In this paper, the output characteristic of compound phase-conjugate resonator with stimulated Brillouin scattering (SBS) cell was reported. The experimental results indicated it has high output energy and excellent stability. The output energy of the single pulse can reach 90 mJ, and the width of it is about 25 ns. The results of pulse widths, output energies and beam profiles were given.

Keywords: nonlinear optical, stimulated Brillouin scattering (SBS), phase-conjugation, compound resonator.

1. Introduction

Optics phase conjugation based on stimulated Brillouin scattering (SBS) is frequently applied in pulsed solid-stated lasers to improve the beam quality through compensation of pump-induced phase distortions in the active material [1–4]. Such phase -conjugating SBS mirrors has been realized in gases, liquids, and solids. In general, the threshold of phase conjugation resonator (PCR) is high with the output energy of it is lower. How to decrease the threshold and how to increase the output energy of PCR are the tasks that people cared for. The way of decreasing the threshold of PCR is using optical feedback [5], using a multipass Herriott cell [6], or ring resonator [7, 8]. Also, an internally tapered optical fiber can decrease the threshold to 15 μJ [9]. In this paper, we have designed and experimented a novel compound SBS phase conjugation resonator with SBS cell on Nd:YAG laser which has not been reported before. The experimental results show that the cavity of this type can output stability self Q-switched single pulse, while the quality and stability of the output beam is superior to those provided by linearity cavity.

2. Experiment setup and theory

The experimental arrangement of the cavity is shown in Fig. 1. The center wavelength of coating of high reflecting mirror M_1, M_3, M_4 is 1.064 μm, the bandwidth of which being 100 nm. The reflectivity of mirror M_2 is 20%, the F_1 and F_2 are thin lenses, the

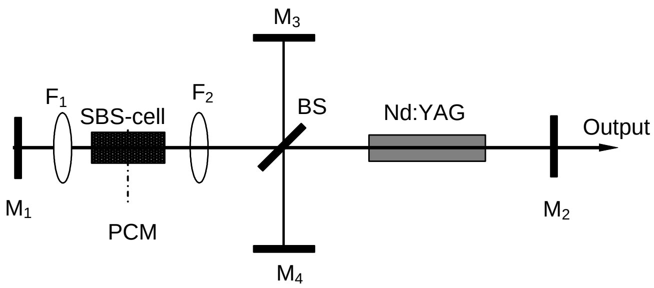

Fig. 1. Experimental setup (PCM – phase conjugation mirror).

focal length of them is 55 mm. The SBS cell of the length 100 mm is filled with acetone. The beam splitter BS has the splitting ratio 1:1 at the angle of π/4. The length of Nd:YAG rod is 70 mm, and its diameter is 6 mm. Xenon lamp pump were employed. The light path of the compound cavity is very complex, the assistant cavities of two side couplings with each other.

3. Experimental results

At first, the beam was focused into 100 mm length SBS cell containing acetone by means of two 55 mm focal length lenses. The results of single pulse whose width is about 25 ns appeared steady when the pump voltage is 800 V, and the length of phase

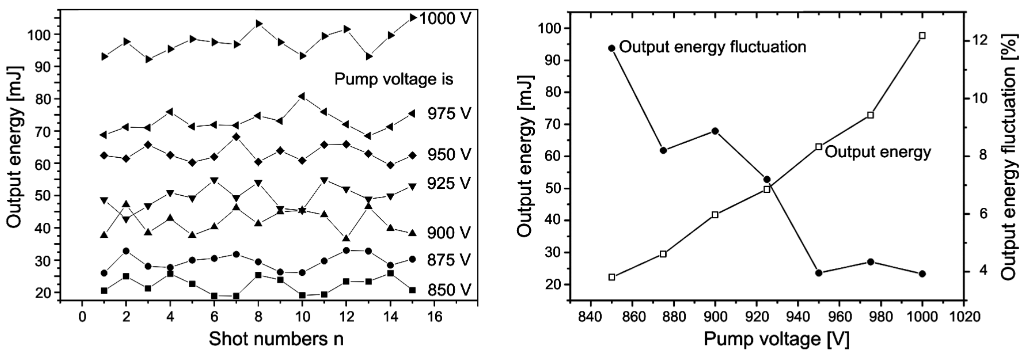

Fig. 2. Output energy of the compound cavity and its fluctuation.

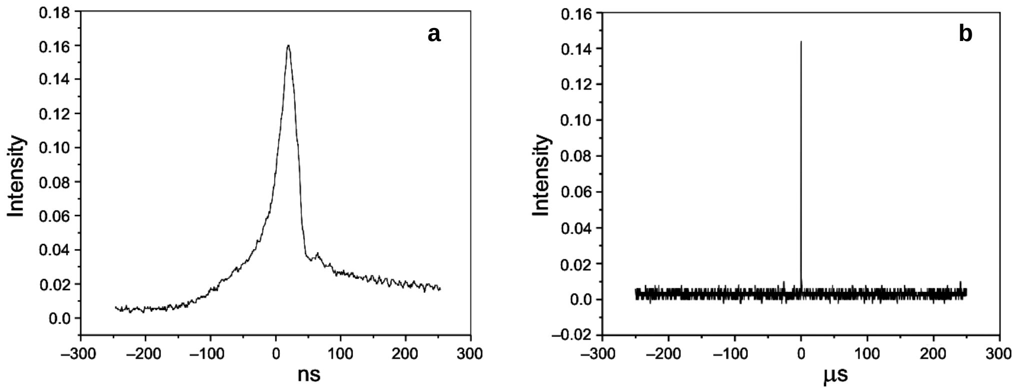

Fig. 3. Pulse of compound cavity as the pump voltage is 1000: expandedness of single pulse (**a**) and the pulse (**b**).

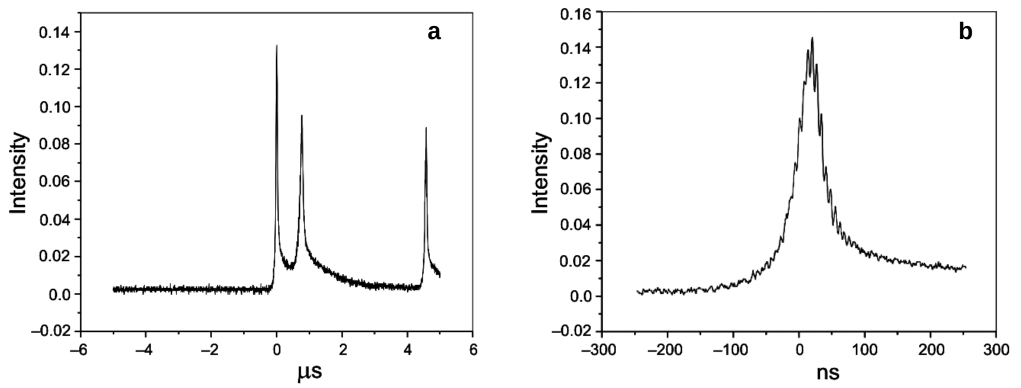

Fig. 4. Pulse of line cavity as the pump voltage is 1000: the pulse (**a**); expandedness of single pulse (**b**).

conjugation resonator L_{PCR} is nearly 700 mm at this time. The output energy is about 20 mJ, and it increases with the pump voltage. The output energy and its fluctuation are shown in Fig. 2, and the single pulse output stability with the higher pump voltage in Fig. 3, respectively.

The characteristic of the linear cavity was studied at the absence of the BS in the setup shown in Fig. 1. The experimental results indicated that the single pulse appeared as the pump voltage is 750 V, and the output energy increases with the pump voltage, but the stability of it was bad comparing to that for the compound cavity, and some burr was found in the single pulse at the high pump voltage, and also a few pulses alternation by few microseconds appeared (Fig. 4). Higher and lower pump voltage could cause the fluctuation of the output energy(Fig. 5). We have additionally captured the far field (3 m) spots of the cavity as the pump voltage was 900 V, and we can see

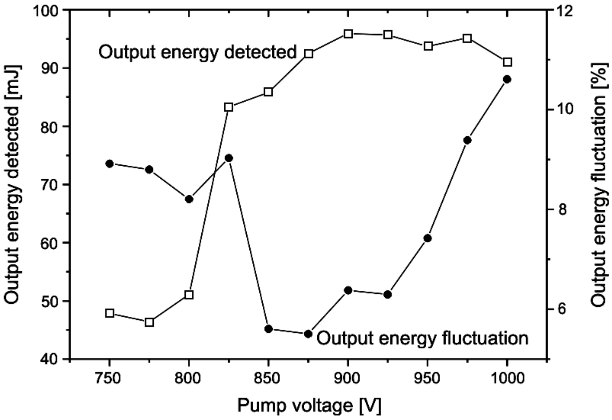

Fig. 5. Output energy of the line cavity and its fluctuation.

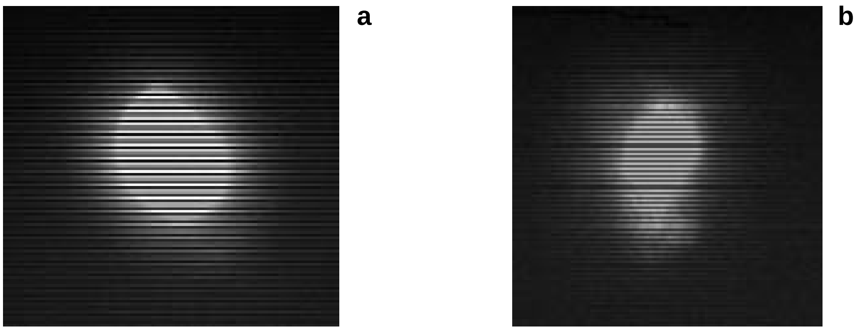

Fig. 6. Profile of far-field spots: line cavity (**a**); compound cavity (**b**).

that the divergence angle of the compound cavity is smaller than that of the linear cavity (Fig. 6).

It is very difficult to adjust the light path of compound cavity, since the light of the main cavity and the assistant cavity of two side should coaxal stringent. The output energy would decrease prodigious as the mirror M_3 or M_4 was taken away.

4. Summary

In the summary, compound SBS resonator is a novel PCR which has higher energy output along with steady passive Q-switched pulse. The width of it is 25 ns. It can output 90 mJ energy and the divergence angle of output beam is smaller than 1.5 mrad.

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