Tunable electro-optically *Q*-switched rf excited partial *Z*-fold CO_2 waveguide laser with two channels

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Abstract. A tunable electro-optically *Q*-switched rf-excited partial Z-fold CO_2 waveguide laser with two channels has been designed. *Q*-switched pulses were obtained from the partial Z-fold channel. The peak power is 730 W, and the pulse width is 150 ns. Cw laser output was obtained from the other channel, which can be tuned by a grating. A stable pulse heterodyne waveform and its Fourier transform (frequency spectrum) were also observed.
[DOI: 10.1117/1.1839226]

Subject terms: partial Z fold; tunable electro-optically *Q*-switched; two channels; rf-excited CO_2 laser.

Paper 030570 received Nov. 13, 2003; revised manuscript received Jun. 22, 2004; accepted for publication Jul. 23, 2004; published online Jan. 7, 2005.

1 Introduction

There has been significant progress in the development of coherent laser radars.[1,2] However, two independent lasers with a complex mechanism for frequency stabilization are often needed in order to obtain stabilized heterodyne signals. The two lasers may suffer from unacceptably large size, weight, complexity, and cost. In order to overcome these limitations, we have designed and described an electro-optically *Q*-switched rf-excited waveguide laser with two equal long-channels,[3–5] but it is very difficult to improve the laser output power in its limited volume, so its applications are also limited. On the basis of the laser structure, we changed the single-channel waveguide for the transmitter laser to a partial Z-fold waveguide. Not only can the pulse laser power be greatly improved, but also the offset frequency stability is high.

For the first time, this paper describes the design and evaluation of a tunable electro-optically *Q*-switched rf-excited partial Z-fold CO_2 waveguide laser with two channels. The laser output directions from the two channels are opposite. Cw laser output can be obtained from one of the channels with grating tuning. Electro-optically *Q*-switched pulsed laser output is achieved from the partial Z-fold channel. The beams of the two lasers are combined onto a HgCdTe detector, and stable pulse heterodyne waveform and its Fourier transform frequency spectrum were also observed. This kind of laser structure has the advantages of higher offset frequency stability than two independent lasers, higher peak pulse power, small size, and low cost; it can well satisfy the requirements for a coherent laser radar.

2 Design of the Laser

The compact tunable electro-optically *Q*-switched rf-excited partial Z-fold CO_2 waveguide laser with two channels that we have designed is shown in Fig. 1. The waveguide is designed around a metal ceramic sandwich, which has a 2.25×2.25-mm^2 cross section. The laser has two channels: a partial Z-fold channel and a single channel. The two channels are excited by the same rf source and placed within a water-cooled stainless vacuum housing, which incorporates an rf feedthrough to enable power to be transmitted to the waveguide. The distance between the two channels is 20 mm. The partial *Z*-fold channel is 3×460 mm in length, and the single one is 460 mm.

There are altogether three cases of waveguide resonators that have low coupling losses. Case I and case III waveguide resonators are often used in waveguide lasers. In a case I resonator, the plane reflector or output mirror is as near as possible to the waveguide end. In a case III resonator, the concave output mirror or reflector is placed at the position where coupling loss is lowest. In a case II resonator, the plane mirror is placed far from the waveguide end. Due to the disadvantages of large size and difficulty of adjusting the resonator, the case II resonator is rarely used. In the laser we designed, a case I waveguide resonator (plane-plane resonator) with a flat total reflector and an 85%-reflecting 150-line/mm diffraction grating blazed at 10.6 μm is used for the single channel. In order to reduce coupling losses for the EH_{11} mode and facilitate inserting a modulator crystal and other optical elements into the resonator, we designed an equivalent case III waveguide resonator (plane-concave resonator) for the partial Z-fold channel.

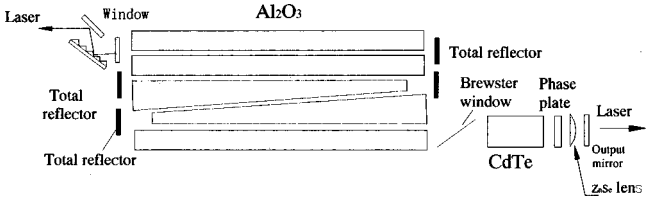

Fig. 1 Structure of the CO_2 laser.