Full length article

1319 nm and 1356 nm dual-wavelength operation of diode-side-pumped Nd:YAG laser

Ming Chena,b, Zhi-chao Wanga,*, Shen-jin Zhanga, Feng Yanga, Feng-feng Zhanga, Lei Yuana, Miao Hea,b, Jia-jia Liab, Xiao-wen Zhanga, Nan Zonga, Zhi-min Wanga, Yong Boa, n, Qin-jun Penga, Da-fu Cua, Zu-yan Xua

a Research Center for Laser Physics and Technology, Key Lab of Function Crystal and Laser Technology, Technical Institute of Physics and Chemistry, Chinese Academy of Sciences, Beijing 100190, China
b University of Chinese Academy of Sciences, Beijing 100190, China

Article info

Article history:
Received 16 July 2015
Received in revised form 30 October 2015
Accepted 4 November 2015
Available online 28 November 2015

Keywords:
Nd:YAG
Dual-wavelength
Diode-side-pumped

A R T I C L E  I N F O

Abstract

We report the first demonstration on a diode-side-pumped quasi continuous wave (QCW) dual-wavelength Nd:YAG laser operating at 1319 nm and 1356 nm. The resonator adopts symmetrical L-shaped flat–flat structure working in a thermally near unstable cavity. By precise coating on the cavity mirrors, the simultaneous oscillation at 1319 nm and 1356 nm is delivered. A maximum dual-wavelength output power of 9.4 W is obtained. The beam quality factor $M^2$ is measured to be 1.9.

© 2015 Elsevier Ltd. All rights reserved.

1. Introduction

Simultaneous dual-wavelength oscillation lasers have various important applications including optical communication, spectroscopy, medical instrumentation, laser radar, environmental monitoring and scientific research of nonlinear optical mixers [1–3]. In recent years, many works were investigated to achieve various kinds of dual-wavelength output [2–12].

The Nd$^{3+}$-doped crystals as the laser gain medium are used not only for getting a high-power single-wavelength laser output but also for achieving an efficient operation of multi-wavelength laser [13–15]. Because of the excellent mechanical and optical characteristics, Nd:YAG crystal is the most prevalent laser gain material for solid-state lasers. Up to now, various dual-wavelength oscillations of Nd:YAG crystal have been achieved in different systems, such as, 1357/1444 nm [2], 1052/1064 nm [3], 1116/1123 nm [4], 1319/1338 nm [7,8], 1074/1112 nm [9,10], 946/1064 nm [12], etc. However, to our best knowledge, 1319 nm and 1356 nm dual-wavelength Nd:YAG laser has never been reported. One of the promising applications for this dual-wavelength laser source is to obtain a radiation source of 6.2 THz by the difference frequency generation (DFG) method, which can be used to analyze the graphene based optically transparent patch antenna radiation characteristics with and without multi walled carbon nanotube (MWCNT) loaded [16]. In addition, by eighth-harmonic generation (EHG) of this dual-wavelength laser, the 164.9 nm and 169.5 nm deep ultraviolet lasers can be obtained, respectively, which have great significance in many scientific fields due to their higher photon energy, such as angle-resolved photoemission spectroscopy (ARPES) [17].

In this paper, we report a diode-side-pumped dual-wavelength Nd:YAG laser at 1319 nm and 1356 nm for the first time. A maximum dual-wavelength output power of 9.4 W is obtained by means of precise coating on the cavity mirrors. The beam quality factor $M^2$ is measured to be 1.9.

2. Experimental setup

Fig. 1 shows the experimental setup of the diode-side-pumped 1319 nm and 1356 nm dual-wavelength Nd:YAG laser. Two identical diode-side-pumped modules were employed in a symmetrical L-shaped flat–flat cavity. The Nd:YAG crystal rod (dopant 0.6%) with a length of 82 mm and a diameter of 3 mm was used as the gain medium in each module with antireflection (AR) coating at the operating lines on both end surfaces. For each laser module, three diode arrays, with a total pump power of 240 W, arranged in a three-fold symmetry around the rod were served as the pump source and each array was consisted of four 20 W diodes operating...
at wavelength of 808 nm in pulse mode. The pump pulse duration and repetition rate were 200 μs and 1 kHz, respectively. A 90° quartz rotator (QR) was placed between the two modules for compensating the thermally induced birefringence. To achieve efficient operation on the 1319 nm and 1356 nm transitions, parasitic oscillation at the 1064 nm line needed to be restrained considering it’s higher cross section for stimulated emission. The parasitic oscillation at the 1064 nm line needed to be restrained considering it's higher cross section for stimulated emission. The cavity mirrors described above, $R_s$ is calculated to be 0.794. Obviously, the experimental reflectivity of the OC for 1356 nm is close to the calculated value.

4. Results and discussion

The emission spectrum was monitored during the entire output power range with a spectrum meter (NIRQuest256-2.5 Ocean optics Inc.). Fig. 3 exhibits the measured laser spectrum at the maximum output power. As can be seen from Fig. 3, dual-wavelength 1319 nm and 1356 nm were operated simultaneously in one beam and no other laser lines were found, which indicates that the dual-wavelength operation can be achieved effectively by present coating design. The measured full width at half maximum (FWHM) of spectral lines at 1319 nm and 1356 nm were 0.62 nm and 0.54 nm, respectively. The spectral intensity ratio of the 1319 nm and 1356 nm is about 0.8:1.

The total output power versus the incident pump power is shown in Fig. 4. Firstly, the total output power grew gradually with the increasing pump power. At a pump power of 305 W, a maximum output power of 9.4 W was measured by a power meter (OPHIR Photonics FL30A-BB-18 ROHS), corresponding to an optical conversion efficiency of 3.1%. The relative lower efficiency is probably due to the smaller stimulated emission cross section and higher quantum defect of the 1319 nm and 1356 nm lines than that of 1064 nm line. At the higher pump power, the roll-over effect of the output power versus the pump power was observed, which was presumably caused by the serious thermal effect making the resonator working into the unstable region [20].

As is well known, the transverse mode profile for each wavelength is an important parameter for dual-wavelength lasers. Since...
دانلود مقاله

http://daneshyari.com/article/734329

امکان دانلود نسخه تمام متن مقالات انگلیسی
امکان دانلود نسخه ترجمه شده مقالات
پذیرش سفارش ترجمه تخصصی
امکان جستجو در آرشیو جامعی از صدها موضوع و هزاران مقاله
امکان پرداخت اینترنتی با کلیه کارت های عضو شتاب
دانلود فوری مقاله پس از پرداخت آنلاین
پشتیبانی کامل خرید با بهره مندی از سیستم هوشمند رهگیری سفارشات