18a-D5-7

Monolithic PPLN Bragg Q-switch and Wavelength Converter

Shou-Tai Lin, Guey-Wu Chang, and Yen-Chieh Huang*

Institute of Photonics Technologies/Department of Electrical Engineering, National Tsinghua University, Hsinchu 30013, Taiwan

*E-mail: ychuang@ee.nthu.edu.tw

1. Introduction

When a *z*-direction electric field is applied to a PPLN crystal, the periodic crystal domains form a diffraction grating through the electro-optic (EO) effect. Based on this idea, we have previously developed an EO PPLN Bragg Q-switch that is fairly insensitive to the device temperature and laser wavelength [1]. In this paper we report a broadly tunable and highly efficient optical parametric generator (OPG) pumped by a low-voltage Q-switched laser using a PPLN Bragg Q-switch cascaded to a PPLN wavelength converter. The output wavelengths of the optical parametric generator can be widely tuned through temperature variation without affecting the performance of the monolithically integrated EO Bragg Q-switch.

2. Experimental Setup and Result

Figure 1 shows the schematic of our Nd:YVO4 laser pumped OPG with an EO PPLN Bragg Q-switch cascaded to a PPLN wavelength converter. Along the grating vector direction, the first 1-cm section of the PPLN crystal has a grating period of 20.3 μm functioning as a Bragg laser Q-switch and the second 3-cm section has a period of 31 μm functioning as a wavelength converter.

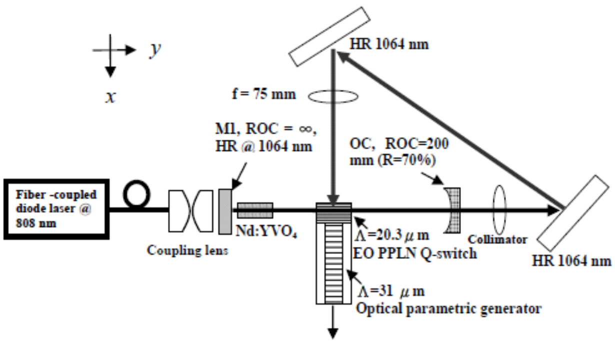

Fig. 1 The schematic of the EO-PPLN Q-switched wavelength conversion laser.

The ±z surfaces of the first 1-cm PPLN section were coated with 50-nm thick NiCr electrodes, on which a voltage is applied to form a Bragg grating during the high-loss state of laser Q-switching. The four side faces (±y and ±x surfaces) of the PPLN crystal were optically polished and coated with anti-reflection dielectric layers at both 1064 nm (reflectance R<0.2%) and 1600 ~ 2000 nm (R<1%). We used a 20.4-W fiber-pigtailed diode laser at 808 nm to pump a 9 mm long, a-cut, 0.25-at.% Nd-doped YVO4 crystal through a set of one-to-one imaging coupling lenses. The 1064 nm Nd:YVO4 laser cavity was formed by a flat high reflecting (HR) mirror M1 at 1064 nm (R>99.8% at 1064 nm) and an output coupler (OC) with a 200-mm radius of curvature (ROC) and 30% output coupling at 1064 nm. The distance between M1 and the upstream surface of the Nd:YVO4 crystal is 1 mm and that between M1 and the upstream *y* surface of the Q-switch is 44 mm. The total cavity length of the 1064-nm laser is around 88 mm.

To Q-switch the laser, we applied a +160 V voltage pulse with a 500 ns pulse width and a 1-kHz pulse rate to the Bragg modulator. We then focused the 1064-nm output pulses to an 80-μm laser waist radius in the center of the OPG PPLN. After overcoming the pump threshold at about 5 W diode power, the Q-switched 1064-nm laser generates pulse energy that steadily increases to 180 μJ/pulse at 20.4-W diode power. Figure 2 shows the tuned wavelength (filled circle) and the corresponding parametric efficiency (open circle) as a function of the PPLN crystal temperature. Throughout the whole tuning range, the OPG output power stayed fairly constant, because the 1064-nm Q-switched pulse energy was insensitive to the temperature variation in the PPLN Bragg Q-switch. The measured parametric efficiency was around 35% in the range of 1.75-1.88 μm (signal) and 2.7-2.44 μm (idler).

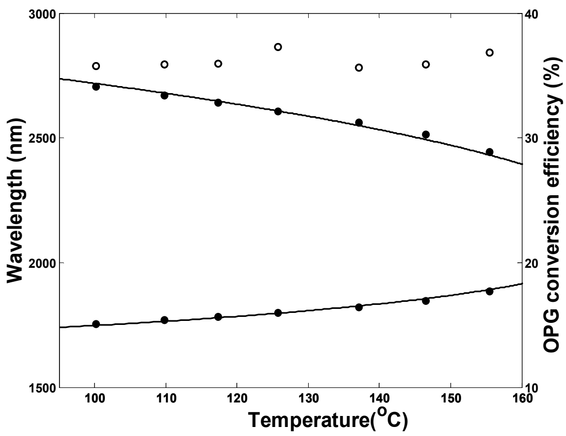

Fig. 2 Temperature tuned parametric wavelengths (filled dots) and correspondingly measured parametric efficiency.

3. Conclusions

We have successfully integrated a temperature insensitive EO PPLN Bragg Q-switch and an optical parametric generator into a monolithic PPLN crystal. Such integration is compact and efficient for solid-state laser applications.

References

[1] Y. Y. Lin *et al.*, Opt. Lett. **32**, 545-547 (2007).