

现代应用光学

基于掺镁周期极化铌酸锂晶体的内腔单共振连续可调谐光参量振荡器

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摘要: 为了用简单、紧凑的谐振腔获得稳定的激光输出, 大的调谐范围和转换效率, 设计了信号光单共振V型光学参量振荡(OPO)腔, 采用内腔式抽运周期极化掺镁铌酸锂晶体(PPMgLN)的光学参量振荡技术获得了连续中红外宽波段调谐激光的输出。用808 nm半导体激光抽运Nd:YVO4晶体产生的1 064 nm激光作为光参量振荡的基频光, 通过V型腔灵活控制激光光斑并改变PPMgLN的极化周期和控制温度实现了2 249~3 706 nm中红外的连续宽波段调谐激光输出。在半导体激光抽运功率为10.5 W, 极化周期为29.98 μm , 控制温度为411 K的情况下获得了最高650 mW的中红外激光输出, 对应的中心波长为3 466 nm, 线宽为2.6 nm, 具有较好的单色性。在7.5 W的入射功率下, 最高808 nm抽运光到闲频光的转化效率达7.73%, 对应输出功率为580 mW。

关键词: 掺镁周期极化铌酸锂晶体 光学参量振荡 内腔单共振 温度调谐

Intra-cavity Singly Resonant Optical Parametric Oscillator Based on Magnesium-doped Periodically Poled Lithium Niobate

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Abstract: To obtain stable laser outputs, bigger turning ranges and higher transfer efficiencies by a simple and compact resonance cavity, a V-type Optical Parametric Oscillator (OPO) pumped by a 1 064 nm Nd:YVO4 laser is designed, and broadband wavelength-tunable, continuous-wave (CW) mid-infrared laser sources are obtained. The Nd:YVO4 laser crystal is pumped by a 808 nm semiconductor laser to generate a 1 064 nm laser as the fundamental frequency light, and the V-type cavity is used to control laser spots and to change the grating period and temperature of the PPMgLN to obtain the 2 249 to 3 706 nm tunable idler output. With an 808-nm pump power of 10.5 W and a polarized period of 29.98 μm , a maximum idler output power up to 650 mW at 3 466 nm is achieved under the PPMgLN to be set at 411 K, which shows a better monochromaticity and is corresponding to a center wavelength of 3 466 nm and line width of 2.6 nm. Moreover, when 808 nm pump power is 7.5 W, the maximum optical-to-optical conversion efficiency can be up to 7.73% and the corresponding output power is 580 mW.

Keywords: Magnesium-doped periodically poled lithium niobate crystal Optical Parametric Oscillator(OPO) Intra-cavity singly resonant Temperature-tuning

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参考文献:

- [1] 陈东, 张伯昆, 胡燮, 等. 基于差频中红外激光的痕量气体高分辨光谱检测研究[J]. 光子学报, 2012, 41(6): 678-683. CHEN D, ZHANG B K, HU X, et al.. Research on the high resolution trace gas detection based on the difference-frequency mid-infrared spectrometer[J]. Acta Photonica Sinica, 2012, 41(6): 678-683. (in Chinese)
- [2] 罗乐, 周军, 刘成岳, et al.. 红外激光心肌打孔的理论模型和实验验证[J]. 光子学报, 2005, 34(6): 817-819. LUO L, ZHOU J, LIU CH Y, et al.. Theoretic model of making vessels in myocardium by infrared laser and experiment validating [J]. Acta Photonica Sinica, 2005, 34(6): 817-819. (in Chinese)
- [3] 李爱珍. 单极型量子级联激光器的发明及其进展[J]. 中国激光, 2010, 37(9): 2213-2220. LI A ZH. The invention and advancement on unipolar quantum cascade lasers[J]. Chinese Journal of Lasers, 2010, 37(9): 2213-2220. (in Chinese)
- [4] 卞进田, 聂劲松, 孙晓泉. 中红外激光技术及其进展[J]. 红外与激光工程, 2006, 35(S3): 188-193. BIAN J T, NIE J S, SUN X Q. Mid-infrared laser technology and its progress[J]. Infrared And Laser Engineering, 2006, 35(S3): 188-193. (in Chinese)
- [5] 檀慧明, 林洪沂, 张搏麟. 基于PPMgLN的中红外全固态可调谐光参量振荡器[J]. 中国激光, 2010, 37(9): 2303-2308. TAN H M, LIN H Y, ZHANG B L. Mid-infrared tunable all-solid-state optical parametric oscillator based on PPMgLN [J]. Chinese Journal of Lasers, 2010, 37(9): 2303-2308. (in Chinese)
- [6] 杨剑, 李晓芹, 姚建铨, 等. 基于周期极化铌酸锂晶体的高功率可调谐光参量振荡器[J]. 中国激光, 2008, 35(10): 1459-1462. YANG J, LI X Q, YAO J Q, et al.. High-power temperature-tunable periodically-poled lithium niobate optical parametric oscillator[J]. Chinese Journal of Lasers, 2008, 35(10): 1459-1462. (in Chinese)
- [7] MYERS L E, ECKARDT R C, FEJER M M, et al.. Quasi-phase-matched optical parametric oscillators in bulk periodically poled LiNbO3[J]. Journal of the Optical Society of America B, 1995, 12(11): 2102-2116.
- [8] DING X, SHENG Q, CHEN N, et al.. High efficiency continuous-wave tunable signal output of an intracavity singly resonant optical parametric oscillator

based on periodically poled lithium niobate[J]. Chinese Physics B, 2009, 18(10): 4314-4318. [9]LIN S T, LIN Y Y, TU R Y, et al.. 3- μm continuous-wave singly resonant OPO [C]. Conference on Lasers and Electro-Optics/Quantum Electronics and Laser Science Conference and Photonic Applications Systems Technologies, San Jose, California,2008: OPOs II