주기적으로 분극반전된 1 mol% MgO-doped stoichiometric $LiTaO_3$ 이용한 광매개진동

Optical parametric oscillation with periodically-poled 1 mol% MgO-doped stoichiometric lithium tantalate

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In the past decade, periodically-poled ferroelectric crystals have been widely used in the field of nonlinear optics because of a quasi-phase matching (QPM) technique. Minimum requirement for QPM is the periodic modulation of nonlinearity so that ferroelectric materials with low coercive field have become fascinating in this field. Stoichiometric lithium tantalate (SLT) has attractive advantages of low coercive field (~1.7 kV/mm), which leads to large aperture QPM devices for high power operation.

In this work we successfully fabricated a 1-mm thick, 35-mm long QPM device in 1 mol% MgO-doped SLT and demonstrated a singly resonant optical parametric oscillation (OPO) using 1064 nm pumping of a Q-switched Nd:YVO_4 laser. Furthermore, the OPO performances were compared between 0.5 mol% and 1 mol% MgO-doped SLT crystals to prove the improvementof device poling quality and the enhanced resistance to photorefraction in 1mol% MgO-doped one.

A crystal was grown using the double crucible Czochralski method with a dopant of 1mol% MgO. Periodically-patterned photoresist was formed which was covered by a metal film on the +Z surface of a 1-mm thick SLT wafer. A single-pulse electric field of 2.1 kV/mm for 1.8 second was applied. The fabricated QPM structures have ten periods from 30.0 to 30.8 μm and 31.0 to 31.8 μm with 0.2 μm segment step and the domain pattern penetrated very well into the 1-mm thick wafer. A singly resonant OPO at the signal wave was pumped by a Q-switched Nd:YVO_4 laser which was operated at 14 ns and 10 kHz repetition rate with pump beam diameter of 230 μm. A linear cavity was composed of two concave mirrors with AR-coating at pump wavelength and HR-coating at signal wavelength where the reflectivity of output coupler is 95 %. The OPO wavelengths as a function of QPM period was shown in Fig. 1 at several temperatures. The tuning range of signal and idler waves were 1510~1850 nm and 2504~3602 nm, respectively for temperature range of 30~170 °C. Especially the emission of idler waves is useful for application of sensitive detection of environmental pollution gas such as Ethane.

We also measured the total (signal and idler) power depending on temperature ranging from 30 to 175 °C. The oscillation threshold was 300 mW, which was independent on temperature as shown

in Fig. 2(a). The average slope conversion efficiency was ~ 65 % with the maximum output power of 655 mW at 1.3 W input power while no AR-coating on device surfaces. We believe that the current MgO-doping level such as 1 mol% can be eliminated the photorefraction in SLT crystal. However, in a periodically-poled 0.5 mol% MgO-doped SLT device we observed relatively lower conversion efficiency with the same cavity configuration as presented in Fig. 2(b). As our previous report [1], we obtained the lower conversion efficiency even if with the same device length due to the photorefractive effect. The 1mol% MgO-doped SLT is one of the most promising material not only for OPO device but also other nonlinear interactions because of lower coercive field and higher resistance of photorefraction.

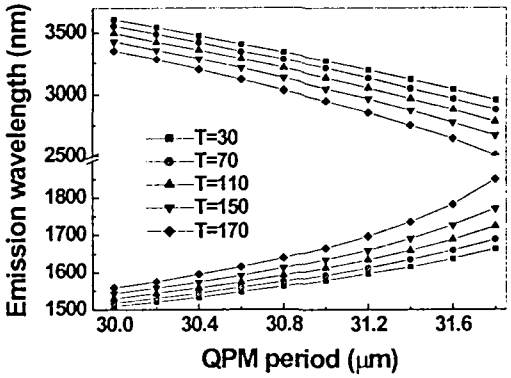

Fig. 1. Emission wavelength as function of temperature depending on QPM period.

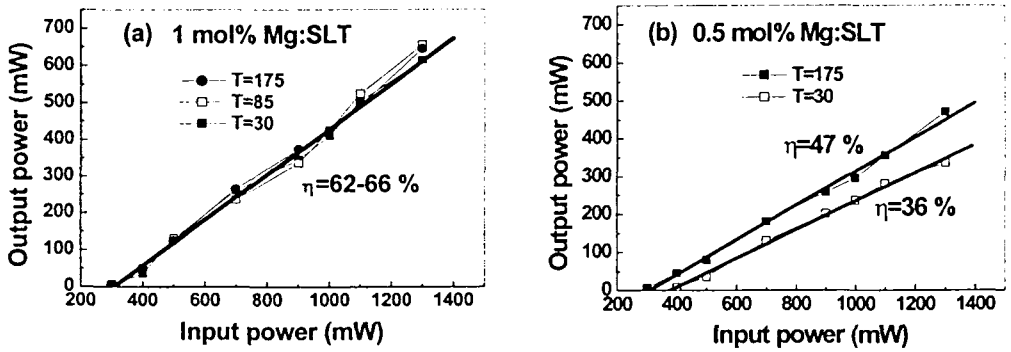

Fig. 2. Total output power versus input power at several temperatures.

Reference

1. N. E. Yu, S. Kurimura, M. Nakamura, Y. Nomura, K. Kitamura, J. Sakuma, Y. Otani and A. Shiratori, *Techical Digest of CLEO/QELS 2003*, **CMF2** (2003).