# 70-mm 길이의 주기적으로 분극반전된 stoichiometric lithium niobate 이용한 광매게 발생기

# Optical parametric generator using a 70-mm long periodically poled stoichiometric lithium niobate

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Efficient optical parametric generation (OPG) have been interested in spectroscopic and medical applications as a tool for a tunable light source. Also Quasi-phase-matching (QPM) method in ferroelectric crystals allows efficient OPG and flexible design of emission wavelength. Among the crystals, stoichiometric lithium niobate (SLN) has significant advantages of the low coercive field, high nonlinearity and low Mg doping level to suppress optical damage compare to congruent lithium niobate (CLN). Extension of interaction length is especially important to reduce the operation threshold of OPG, which is enable to use of a compact pump laser. In this work, we report on a 70-mm-long and 1-mm-thick periodically poled 1-mol% Mg-doped stoichiometric $LiNbO_3$ (PPMgSLN) with a QPM period of 30.0-31.8 um and demonstrate efficient OPG pumped by a passively Q-switched microchip Nd:YAG laser.

Using a electric field poling method at room temperature, a periodical poling system was reported in the previous works [1-2], and utilized also in this work. We first measured a P-E hysteresis loop using a liquid electrode (LiCl solution) with a symmetric triangular pulse which has a maximum electric field of 5 kV/mm and a pulse width of 2 s. The coercive field and the spontaneous polarization were determined to be 3.9 kV/mm and 76.6 uC/cm$^2$, respectively. The domain wall velocity (inversely proportional to switching time) depending on applied electric field was measured by poling current with a rectangular pulse. The zero-velocity field, where the domain wall velocity becomes zero was calculated to be 0.6 kV/mm .

Fig. 1 shows periodically poled domain image after etching and average domain duty ratio obtained by microscopic image analysis. The result shows good uniformity along the whole device length of 70-mm-long with 1-mm-thick. Average domain duty ratios on the +Z surface and -Z surface were 0.64 and 0.44, respectively.

Microchip-laser pumping and single-pass frequency conversion can reduce system complexity and total cost for tunable all-solid state IR generation. The generator was pumped by a commercial diode-pumped passively Q-switched 1.064-um microchip laser with 6.8-kHz repetition rate and 6-ns pulse duration (FWHM). During the experiment the PPMgSLN crystal was kept at 190 °C. A generated signal wavelength at a QPM period of 30.6 um was 1.61 um. For efficient generation of output power, we considered the confocal parameter x, $x=L/b$ here, L is crystal length and $b$ is focusing parameter. According to the Ref. 3, we are expecting the highest efficiency at the case of x = 2.4. In our measurement with the parameter of x = 2.4, the signal slope efficiency of 41 % and the threshold of 127 mW (19 uJ) were achieved. The maximum signal output power was 45 mW at 240-mW pump.

In summary, we successfully fabricated a 70-mm-long QPM device from 1-mm-thick 3-inch diameter wafer of 1.0 mol% MgO-doped SLN crystal and demonstrated an efficient OPG with a compact ns-pulse Nd:YAG microchip laser. We obtained a low threshold of 127 mW and a high slope efficiency of 41 % at signal power. This compact wavelength tunable system can be used as a portable system for remote sensing of environmental gas detections and biomedical applications such as a laser therapy.



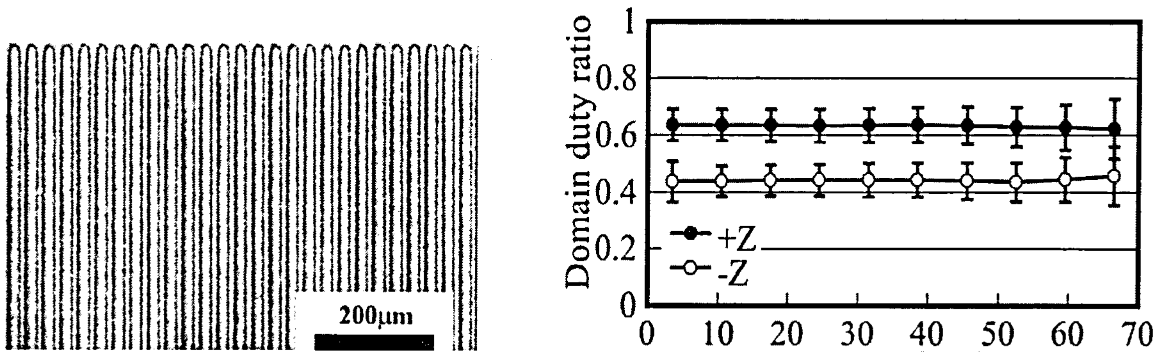


Fig. 1 Periodically poled domain image and averaged domain duty ratio at 70-mm long.

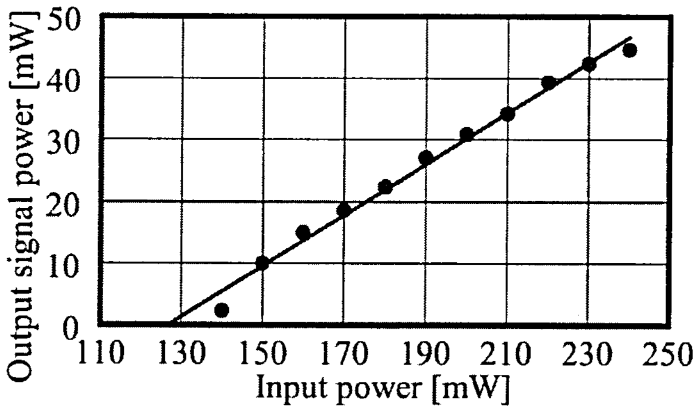


Fig. 2 Optical parametric output power as a function of input power at signal wavelength of 1.62 um.

## References


[1] M. Maruyama, H. Seki, Y. Kato, H. Nakajima, S. Kurimura, N. E. Yu, Y. Nomura and K. Kitamura, "Periodical poling by selective nucleation for short-period QPM structures", CMF7, *CLEO/QELS 2003*, LA Long Beach, USA (2003).

[2] N. E. Yu, S. Kurimura, Y. Nomura, M. Nakamura, K. Kitamura, J. Sakuma, Y. Otani, and A. Shiratori, "Periodically poled near-stoichiometric lithium tantalate for optical parametric oscillation", Appl. Phys. Lett. **84**, 1662 (2004).

[3] G.D. Boyd and D.A. Kleinman, J. Appl. Phys. **39**, 3597 (1968).