주기적으로 분극반전된 stoichiometric $LiTaO_3$ 이용한 광매게발생

Periodically poled stoichiometric lithium tantalate for optical parametric oscillation

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The quasi-phase matching (QPM) technique has dramatically changed the guidelines in developing nonlinear optical materials, which doesn't require birefringence and off-diagonal components for efficient wavelength conversion. Minimum requirement for QPM is the modulation of nonlinearity and ferroelectric materials with low coercive field has become fascinating in periodical poling.

Stoichiometric lithium tantalate (SLT) has attractive advantages of low coercive field (~1.5 KV/mm) [1], high nonlinearity, high optical damage resistance and low thermo-optic coefficients, leading to a large aperture QPM devices for high power operation. Here, we successfully fabricate a long (35-mm) QPM device in near-stoichometric SLT and build up a singly resonant OPO using 1.064μm pumping of a Q-switched Nd:YVO4 laser with 10 kHz repetition rate.

A crystal was grown using the double crucible Czochralski method with a dopant of 0.5mol% MgO in OXIDE company. Periodically patterned photoresist was formed on a 0.5-mm thick SLT wafer and we applied single-pulse electric field of 2.4 kV/mm for 0.22s while observing wall movement with liquid electrodes [2,3]. The fabricated QPM structure has five periods of 30.0, 30.2, 30.4, 30.6 and 30.8μm and the domain pattern penetrated the whole sample. The device length of 35 mm indicates compositional uniformity in the 2-inch wafer.

Fig. 1 shows the experimental setup of singly resonant OPO at the signal wave with two concave mirrors, whose have a 100-mm radius of curvature. The cavity length was 75 mm and the measured pump beam diameter was 200 m (using lens, f=169 mm) at focal plane. The sample of MgO-doped periodically poled SLT (PPSLT) was placed inside an oven, whose temperature stability was within 0.1 °C.

Fig. 2 shows the temperature-dependent tuning curves obtained for five periods. The tuning range of signal and idler waves were 1.53-1.63μm and 3.06-3.49μm, respectively for temperature range of 100-175 °C. We also measured output/input characteristics depending on the temperature ranging from 25 to 185 °C. In the temperature range of 25 to 80 °C we observed a low slope conversion efficiency (S.E.) of 46 % at QPM period of 30.4μm. Huang [4] *el al.*, have reported similar phenomena in PPSLN related photorefractive effect. However, at high temperature ranges (higher than 120 °C) we achieved the S.E. of 65 % for total output power including the signal and idler without AR-coating on the sample surface as shown in Fig. 3.

The oscillation threshold of 106 mW was not dependent on temperature.

In summary, we successfully fabricated near-stoichiometric QPM device in 0.5 mol.% MgO-doped SLT and demonstrated a singly resonant OPO with an interaction length of 35 mm. The generated wavelength range was 1.53 -3.49μm. For future direction, owing to optimization of OPO cavity and AR-coating of sample surfaces we expect more efficient parametric conversion.

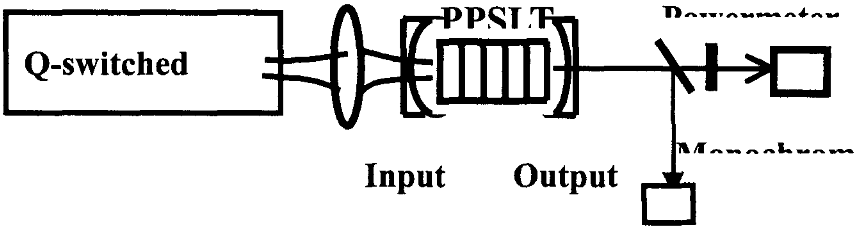

Fig. 1. Experimental setup of QPM-OPO. Pump source is a Q-switched 1.064 m Nd:YVO$_4$ laser.

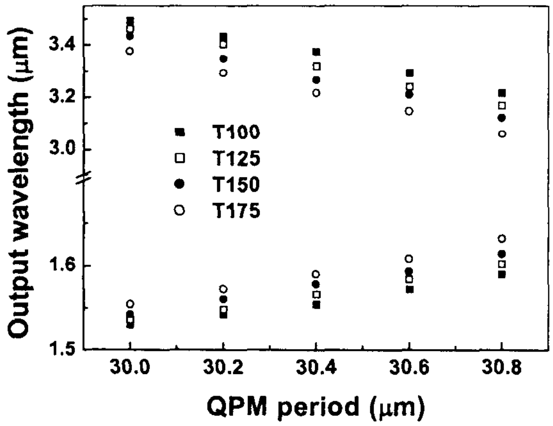

Fig.2. Signal and idler wavelength tuning curves for five periods.

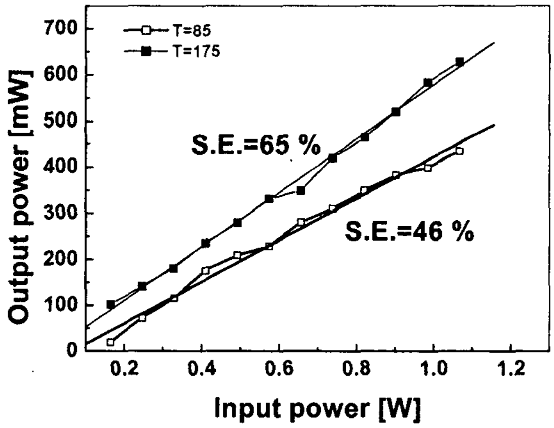

Fig.3. Output power vs. input power.

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