QE-12

LOW THRESHOLD SINGLY RESONANT OPTICAL PARAMETRIC OSCILLATOR IN BULK PERIODICALLY POLED LITHIUM NIOBATE

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Summary

The development of periodically poled lithium niobate (PPLN) for quasi-phase-matched second order nonlinear applications has attracted much interest over the last few years. Compared to birefringence phase-matching, quasi-phase-matching (QPM) allows access to new wavelengths and to higher nonlinear coefficients. The periodic domain inversion in lithium niobate can be achieved using high voltage pulses [1,2,3]. Recently the first optical parametric oscillator (OPO) was demonstrated in bulk PPLN, pumped by a Q-switched Nd:YAG laser at 1.064 μm [3]. When the aim is the parametric generation of tunable radiation at shorter wavelengths (around 1 μm) in PPLN, it is necessary to achieve shorter periods (6-7 μm) and it becomes more difficult to maintain the regularity of the domain reversal pattern because the growth of the inverted domains is less controllable.

We will report a quasi-phase-matched optical parametric oscillator pumped by the second harmonic of a single frequency Q-switched Nd:YAG laser which produces pulses of 15 ns duration, at a repitition rate of 2 KHz. Both the frequency doubling to 532 nm and the parametric oscillation are performed in periodically poled lithium niobate crystals. The nonlinearity for both crystal was ~15 pm/V [1], close to the theoretical limit of 21 pm/V. This indicates that the quality of the gratings was rather good (duty cycle close to 50/50 and reduced randomness in the position of the domain walls). The OPO has been operated in 'singly resonant' and 'doubly resonant' configurations. The threshold in the singly resonant case was ~0.14 J/cm^2, more than one order of magnitude below the damage limit. The maximum output power of the idler, in singly resonant operation, was ~0.5 mW for 9 mW of average pump power. The corresponding pump depletion was ~20%. OPO tuning from 945 nm to 1225 nm was achieved by changing both the period of domain reversal (from 6.8 to 6.85 μm) and the temperature of the crystal. The estimated total cavity loss per round trip was ~4%, significantly lower than the value measured by us in earlier samples [2]. Although the OPO was pumped with 10 mW of green light no evidence was observed of significant photorefractive damage, indicating the benefit of the periodic poling in preventing beam distortion.

1. J. Webjörn, V. Pruneri, P.St.J. Russell, and D.C. Hanna, to be published in Elec.Lett.
2. V. Pruneri, J. Webjörn, P.St.J. Russell, J.R.M. Barr, and D.C.Hanna, to be published in Optics Comm.
3. L.E. Myers, G.D. Miller, R.C. Eckardt, M.M. Fejer and R.L. Byer, and W.R. Rosenberg, Optics Lett. **20**, 52 (1995).