CW synchronously pumped optical parametric oscillators in periodically poled $LiNbO_3$

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Abstract

Synchronous-pumping of optical parametric oscillators in periodically-poled $LiNbO_3$, with 0.5235μm and 1.047μm pumps confirm its suitability for short pulse operation. Tuning from 0.883-1.285μm and 1.67-2.806μm is demonstrated. Prospective tuning is to ~5μm.

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Periodically-poled $LiNbO_3$ (PPLN) has considerable attractions as the nonlinear medium for optical parametric oscillators (OPOs). These include its large nonlinearity (d_{eff} ~20/pm/V), the ability to quasi-phase-match non-critically for any wavelengths within its transmission range (extending to near 5μm), and its reduced susceptibility to the photorefractive effect.

For OPOs operating with pulses of a few picoseconds and less, group-velocity mismatch (GVM) between the interacting waves is an important consideration in that it limits the useful length of crystal to values for which the temporal walk-off between pump, signal and idler pulses is less than the pulse duration. The relatively large GVM in PPLN, compared to KTP and LBO may appear to be a drawback for its use in the short pulse regime. However, defining a figure of merit which includes the GVM indicates that the large nonlinearity dominates and gives PPLN nearly an order of magnitude better figure of merit than KTP and LBO.

To confirm the suitability of PPLN for short pulse OPOs we have demonstrated the first synchronously-pumped OPOs using this material. As pump we have used the 1.047μm output of a cw-diode-pumped additive pulse mode-locked Nd:YLF, or its 0.523μm harmonic. Results for the 1.047μm pump, using a 6mm long, 0.5mm thick PPLN sample, with 30.5μm period, include a tuning range of 1.67-2.806μm, (limited by mirror reflectivity roll-off) by temperature-tuning from 60°C-180°C (figure 1). Signal (idler) slope efficiencies of 33% (25%) have been observed with 75% pump depletion at 3.5 times above threshold. Using the second harmonic and a grating period of 6.4μm in a 300μm thick, 3.2mm long sample we achieved operation from 0.883-1.285μm by temeperature-tuning in the range 75°C to 180°C (figure 2).

Further prospects for synchronously-pumped OPOs based on PPLN will be discussed, in particular the possibility of extending the tuning range to the infrared cut-off at ~5μm.

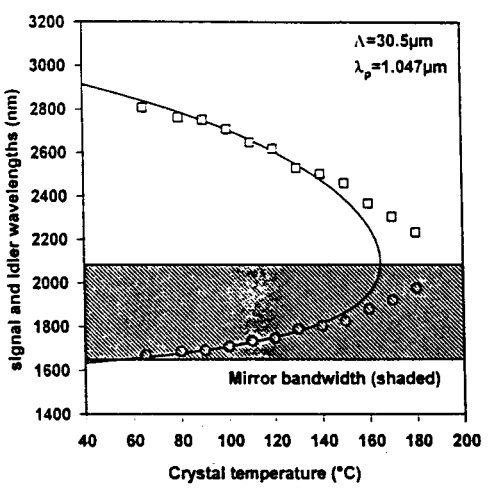

Figure 1. Tuning for 1.047μm pump

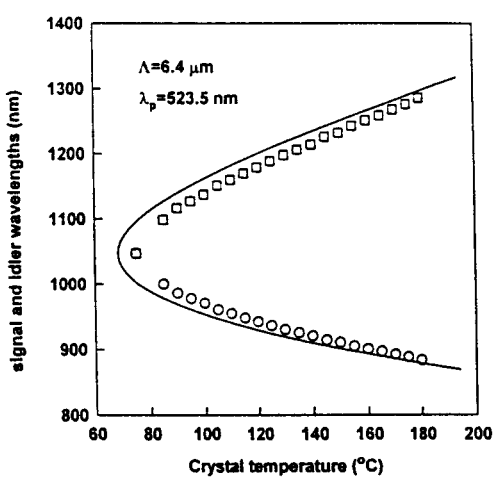

Figure 2. Tuning for 0.5235μm pump

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