Optical parametric oscillation beyond 6.3μm in periodically-poled lithium niobate

L. Lefort, K. Puech, Y. P. Svirko, G. W. Ross, P. G. R. Smith and D.C. Hanna

Optoelectronics Research Centre

University of Southampton

Southampton SO 17 1 BJ

tel: +44 1703 593101

fax:+44 1703 593142

e-mail: kp@orc.soton.ac.uk

Abstract

Periodically poled lithium niobate has long been considered a very relaible material for use in optical parametric oscillators operating out to the absorption edge at ~ 4.5μm. The very high gains achieved when using mode-locked pulses to synchronously pump such devices, however, permit oscillation *even* with strong idler absorption.We present an analysis of operation under such conditions. Calculations indicate that operation to ~7μm should be possible. Oscillation at idler wavelengths out to 6.3μm has been observed.

Optical parametric oscillation beyond 6.3μm in periodically-poled lithium niobate

L. Lefort, K. Puech, Y. P. Svirko, G. W. Ross, P. G. R. Smith, and D. C. Hanna
Optoelectronics Research Centre, University of Southampton, UK
Tel: +44 1703 593101, fax:+44 1703 593142

Efficient sources of tunable coherent radiation in the near and mid-IR are necessary for many applications including spectroscopy, communications etc. In this contribution we report on the generation of tunable IR radiation obtained from a periodically poled lithium niobate (PPLN) based optical parametric oscillator (OPO).

The quasi-phase matched three wave interaction in PPLN serves to significantly enhance the utility of the material in that it allows access to a larger nonlinearity and permits phase matching in a large spectral range. Thus, high parametric gain can be achieved with modest pump power. A useful consequence of this high parametric gain is that a large idler absorption loss in the material can be tolerated, and consequently parametric oscillation can be achieved even with idler wavelengths well into the IR absorption edge of the material [1]. PPLN has an added advantage over bulk lithium niobate, in this respect, since the IR absorption is weaker for the extraordinary polarisation, as used in a PPLN device, than it is for the ordinary polarisation [2].

We discuss a simplified analysis of parametric oscillation in the presence of strong idler absorption (i.e. $\alpha L \gg 1$, where L is the crystal length) which provides useful guidelines to actual threshold and output power. The absorption loss reduces the parametric gain by a factor α/Γ and correspondingly, the oscillation threshold increases by a factor $2\alpha L$, where Γ is parametric gain coefficient in the absence of idler absorption. The results show that useful output power can be produced at wavelengths well into the IR absorption edge of PPLN. This is confirmed by our experimental observations. The extent to which the IR tuning range can be usefully extended is ultimately limited by the optical damage threshold of the material.

We also include a discussion of optical parametric generators which appear to offer promise for significant further extension of infrared tuning at reasonable efficiencies.

References

1. L. Lefort, K. Puech, S. D. Butterworth, G. W. Ross, P. G. R. Smith, D. C. Hanna and D. H. Jundt , Submitted to Optics Commun. '98.

2. L. E. Myers, R. C. Eckardt, M. M. Fejer, R. L. Byer, and W. R. Bosenberg, in Nonlinear Frequency Generation and Conversion, M. C. Gupta, W. J.Kozlovsky, D. C. MacPherson, eds., Proc. SPIE 2700, 216, 1996.

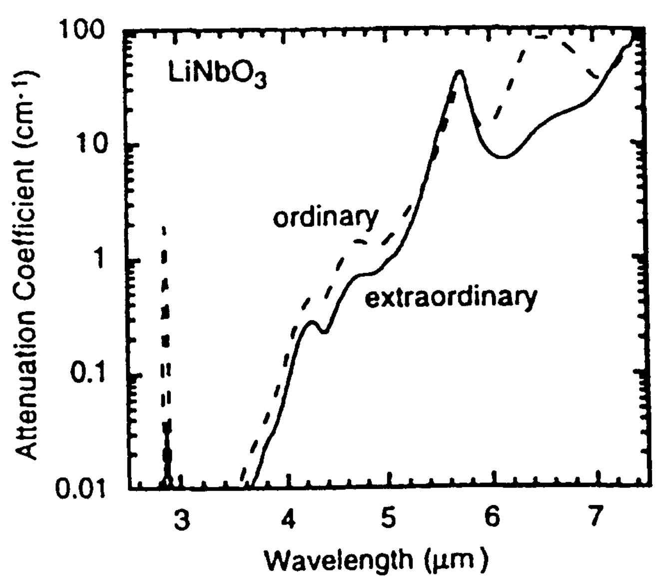

Fig. 1. Absorption coefficient for the ordinary and extraordinary wave in PPLN, **cf ref.2.**