

Comparison of 2nd harmonic generation in 1 and 2D nonlinear periodic crystals

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Using high powered nanosecond pulses we examine the wavelength and temperature dependence of 2nd harmonic generation in 2D hexagonally poled lithium niobate. These results are compared with both standard PPLN and the results from high power picosecond experiments.

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Recently Berger [1] introduced the idea of nonlinear photonic crystals (NPC) as the generalisation to higher dimensions of one dimensional quasi-phase matched structures. In a NPC the linear refractive index is constant while the second order susceptibility tensor varies periodically. Recently we fabricated what we believe is the first such two dimensional NPC in lithium niobate and our initial characterisation of the crystal has been reported elsewhere [2]. This crystal which was used here was poled in a hexagonal pattern and was 7mm wide, 10mm long and 0.3mm thick. The poled fraction was $\sim 30\%$ and the period was $18.05\mu\text{m}$.

We present here the results of a direction comparison of the 2nd harmonic generation in a one and two dimensional nonlinear periodic crystal. The PPLN crystal used had the same period as the 2D crystal and had a length of 12mm. These results were taken using a high power nanosecond pump source based on a sequence of cascaded fibre amplifiers operating near 1533nm. The pulses were focused onto the crystal and the focal spot diameter was $150\mu\text{m}$. Due to the symmetry of the crystal the output consisted of two 2nd harmonic peaks symmetrically positioned about the remaining fundamental. In addition several distinct quasi-phase matched green spots could be seen due to sum frequency generation within the crystal. The peak power of the pulses was 1kW and the pulse width was 5ns. In Fig. 1 we show both the temperature and wavelength dependence of the 2nd harmonic conversion efficiencies of the crystals. As can be clearly seen the 1D crystal has a much narrower tuning curve and has a different peak temperature. The difference in peak temperature is due to the different lengths of k-vectors used for phase matching. The reason for the increased bandwidth of the 2D crystal is believed to be due to the two dimensional nature of the crystal. Note also that the PPLN crystal has a higher peak efficiency than the HeXLN crystal. This is caused by the difference in relative magnitudes of the corresponding Fourier coefficients in 1 and 2D.

In conclusion we have presented the results on the characterisation of the first two dimensional nonlinear photonic crystal. Due to the nature of the lattice structure the crystal has an extremely wide SHG bandwidth making it ideal for the frequency doubling of ultrashort pulses.

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- [1] V. Berger, Phys. Rev. Lett. **81**, 4136-4139 (1999)
[2] N. G. R. Broderick *et al.* Phys. Rev. Lett. (in press)

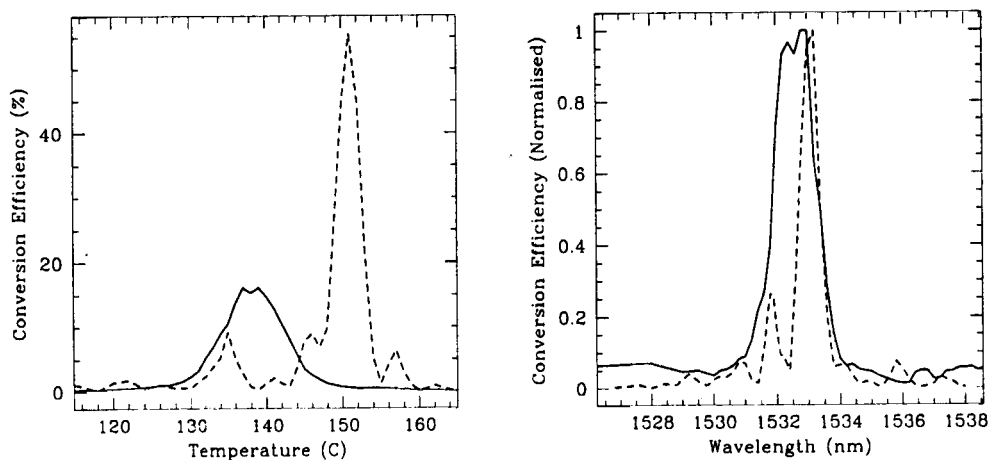


FIG. 1. The temperature and wavelength dependence of the PPLN crystal (dashed lined) and the 2D structure (solid line). In Fig.b the curves have been normalised to have a peak of unity while the actual efficiency is as in Fig.a.