CW QUASI-PHASE-MATCHED SECOND HARMONIC GENERATION OF BLUE LIGHT IN POLED OPTICAL FIBRE

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Abstract

We report CW blue light generation by quasi-phase-matched frequency doubling in single-mode optical fibre, thermally poled in vacuo. An efficiency improvement of ~40× is reported. The measured bandwidth is very close to the theoretical prediction.

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Summary

Periodic thermal poling of fibres is a promising technique for efficient quasi-phase-matched second harmonic generation [1]. An initial value of 1 pm/V was reported by Myers et al. for the second order nonlinearity in thermally poled silica [2]. The main difficulty associated with thermal poling is the spreading out that appears when patterned electrodes are used to create the $\chi^{(2)}$ grating stucture. Recently, we discovered that poling in vacuo avoids the electrical breakdown in air which gives rise to this spreading out [3]. In a previous paper [4] we created a $\chi^{(2)}$ structure in a multimode fibre by poling in a vacuum evaporator using one periodic and one uniform electrode. The pitch of the mask was 20 μm, and a tilt between the fibre and the electrode pattern of about 45° was therefore necessary in order to achieve the pitch necessary ($\sim$28 μm) for quasi-phase-matching (QPM) at 830 nm. In this paper the same periodic poling technique has been applied to a single-mode fibre. A mask of pitch 28

μm was used to create a grating suitable for frequency doubling of 860 nm light. Second harmonic generation of blue light was achieved by using a tunable CW Ti:Sapphire laser as pump. The second harmonic power as a function of the fundamental wavelength is shown in fig.1. Computer simulations of a perfect grating of the same length (6 mm) indicate that the experimental bandwidth of the main phase matching peak at 860 nm is very close to the predicted theoretical value of 1.3 nm. We relate the presence of side peaks at longer wavelengths to a chirp in the grating. In fig.2 the measured square-law dependence of the second harmonic signal on the fundamental power is presented. The maximum blue light power detected was about 400 pW, corresponding to a fundamental power in the fibre of 100 mW. In the previous experiment [4] these values were 20 pW and 200 mW, respectively. An increase of a factor around 40 in the conversion efficiency has thus been obtained. However, the effective nonlinear coefficient is still more than one order of magnitude lower than the value expected in a structure of poled fibre with a nonlinearity of 1 pm/V [2]. We believe that this reduction is related to a combination of grating imperfections (slight chirping and randomness in the lengths of the individual poled sections), and inexact overlap between the poled layer and the fibre core. Considerable improvements are expected by optimization of the poling process, in particular by improving the overlap between the fundamental and SH modes within the poled region.

References

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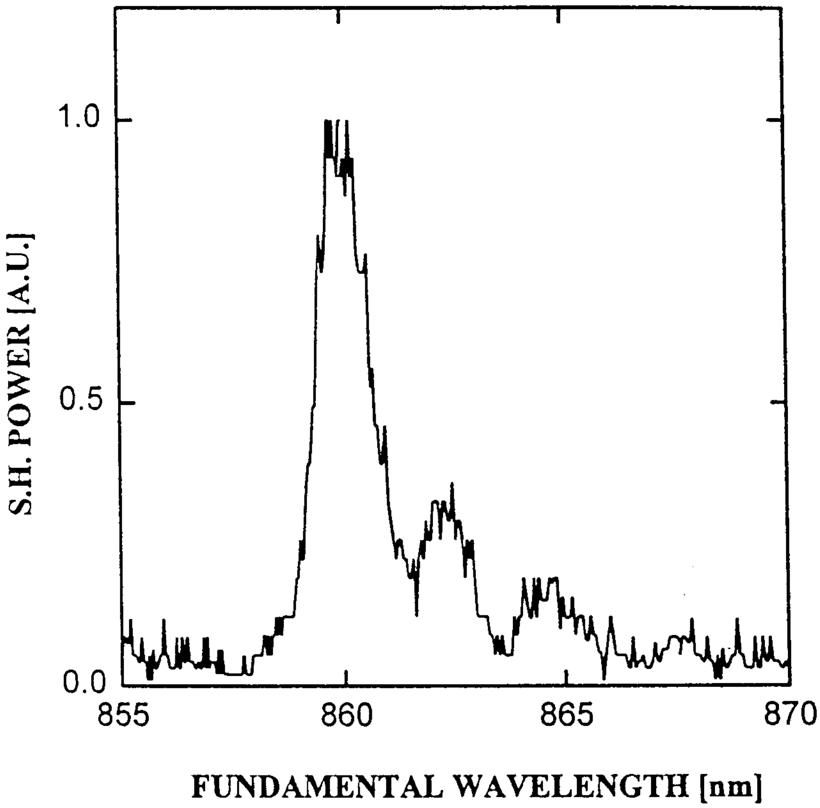
1.0
0.5
0.0
855
860
865
870
S.H. POWER [A.U.]
FUNDAMENTAL WAVELENGTH [nm]

FIG. 1

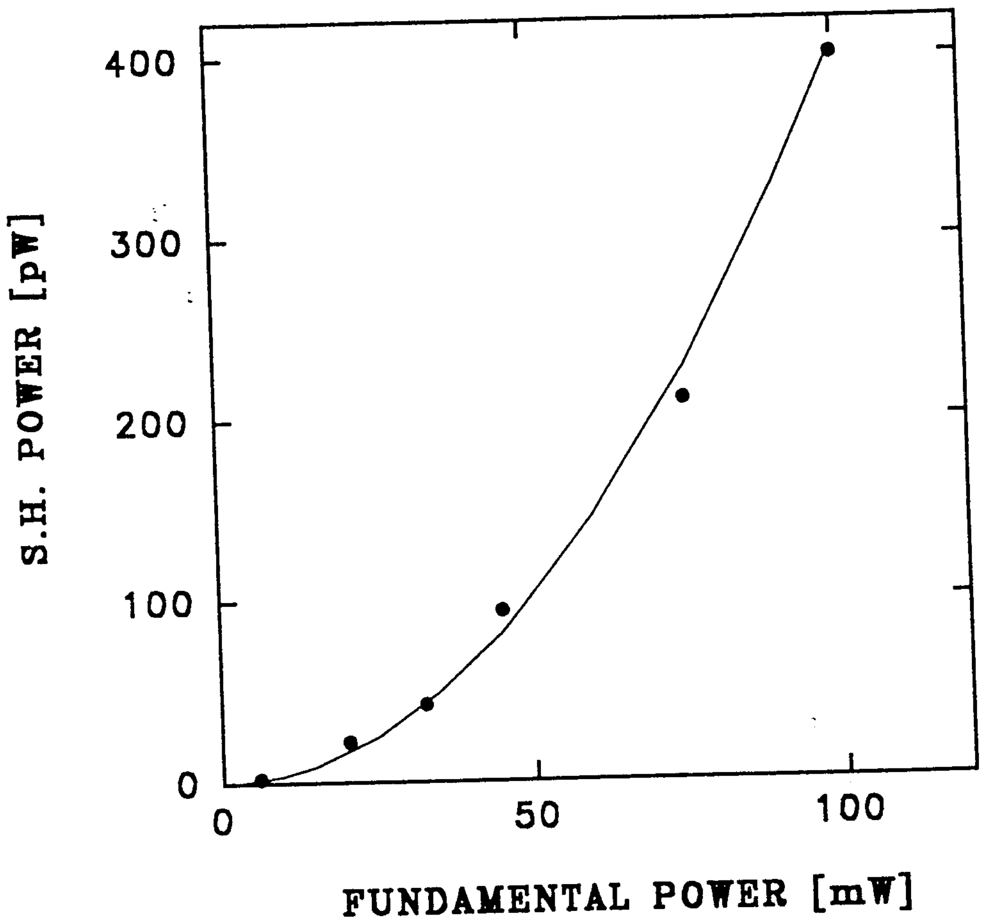

FIG. 2