8:30 am

CWD2 Continuous-wave mode-locked singly resonant optical parametric oscillator synchronously pumped by a laser diode-pumped Nd:YLF laser.

M. J. McCarthy, D. C. Hanna, *Department of Physics, Optoelectronics Research Centre, University of Southampton, Southampton S09 5NH, U.K.*

The wide bandwidth of the parametric interaction in nonlinear crystals makes the synchronously pumped optical parametric oscillator (OPO) potentially the most widely tunable source of ultrashort pulses. For practical use, a continuous wave (cw) pump source is desirable, so that each pulse in the train is identical. A desirable feature of a practical and reliable system would be the use of laser diode-pumped sources. To get sufficient peak power for cw synchronous pumping of a singly resonant oscillator (SRO) from the present generation of mode-locked diode pumped lasers, somewhat shorter pulses are needed than those typically generated by active mode-locking.[1] Utilizing the techniques of additive-pulse mode-locking and efficient second-harmonic generation in an external resonant enhancement cavity, we have developed an ultrashort pulse cw mode-locked source pumped by a diode laser, with sufficiently high peak power for synchronous pumping of a SRO in an extracavity configuration.

The laser pump source was a frequency-doubled self-starting additive-pulse mode-locked Nd:YLF laser pumped by a laser diode. A similar configuration has been described in earlier work on Nd:YAG.[2] With a 3-W laser diode pump source, 540 mW of average output power was achieved in pulses of 2.4-ps duration FWHM at 125-MHz repetition rate. This corresponds to a pulse peak power of ~1.7 kW. Frequency doubling was performed in an external resonant enhancement cavity as described in reference 2. The nonlinear crystal was $MgO:LiNbO_3$, temperature tuned for 90° phase matching of 1047 nm frequency doubling to 523 nm. With 440 mW of average power at 1047 nm incident on the enhancement cavity, 300 mW of average output power at 523 nm was typically achieved in pulses of ~2-ps duration. This represents a pulse peak power of ~1.1 kW.

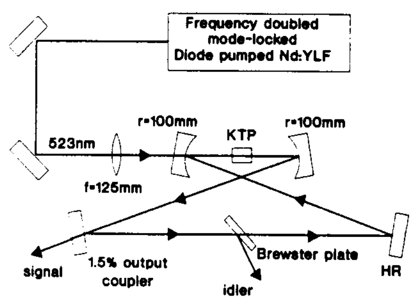
The OPO cavity was a ring configuration as shown schematically in Fig. 1. Oscillation threshold corresponded to 61 mW of average power at 523 nm incident on the KTP crystal. This represents a peak power of ~230 W, and a peak power density of ~57 $MWcm^{-2}$. The OPO yielded a slope efficiency of 21% with respect to power incident on the OPO cavity, giving rise to an average signal output power of 42 mW at the maximum available pump power of 255 mW. This represents an external conversion efficiency of 16% of pump into tunable signal output in a circular TEM_{00} beam. At this pump level the depletion was ~79%.

The OPO was angle tuned in the crystallographic *xy* plane. The combined tuning range of the signal and idler is shown in Fig. 2.

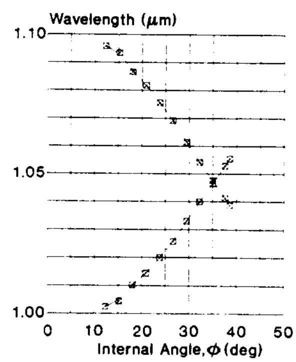
Operation was quite stable with ~4% amplitude noise on the output without any active stabilization. The OPO pulse duration was measured to be 2.2 ps FWHM, with a corresponding spectrum of 0.56 nm FWHM.

The high conversion efficiency with useful output powers, good stability with bandwidth-limited and diffraction-limited performance demonstrated by this device make it a promising source for general use in the study of ultrafast phenomena.

1. G. T. Maker and A. I. Ferguson, Opt. Lett. **14**, 788 (1989).
2. M. J. McCarthy, G. T. Maker, and D. C. Hanna, Opt. Commun. **82**, 327 (1991).



CWD2 Fig. 1. Schematic diagram of the OPO.



CWD2 Fig. 2. Tuning curve of the OPO.