CHAPTER 6

266nm PUMPED BBO OPO

The 266nm UV fourth harmonic generated was employed in pumping a barium borate parametric oscillator. The main aim of pumping this BBO OPO is to achieve an output in the blue region. A 266nm pumped OPO has been demonstrated using a configuration with intracavity pump steering mirror. Experimental details are outlined and discussed in this chapter.

6.1 Experimental Setup

A 266nm harmonic separator (CVI BSR-25) $T_{\text{max}}$ at 532nm and a normal 266nm mirror ($45^\circ$, UNP) were used to steer the fourth harmonic output of the KD*P (its generation described in the Chapter 5). A beam dump was placed before the first reflector. An aperture was placed between the two reflectors to extract only the major or central portion of the UV and not including the scattered residue surrounding the beam. Another aperture was placed after the telescope to obtain a cleaner beam for pumping the OPO. A straight cavity was set up after a 1:0.4 telescope system which comprised of a 250mm planoconvex and a 100mm planoconcave lenses. Both lenses are UV graded lenses. The BBO crystal was cut at $39.1^\circ$ and had dimensions of $6 \times 4 \times 12\text{mm}^3$. The cavity length was measured 2cm with cavity mirrors made up of a UV graded 500nm high reflector (99.9%) and a BK7 glass mirror with 90% reflectivity at 488-514.5nm. No oscillation
was observed using this simple cavity. The BBO crystal and output mirror were taken out from the configuration and the UV pump beam was found to be absorbed by the quartz mirror. This is something that should not occur unless the quality of the UV graded mirror is very poor.

The cavity configuration as used by Bosenberg et. al \(^4\) was set up instead of the normal longitudinally pumped OPO cavity. The schematic representation of this experimental setup is shown in Fig. 6.1. Energy of the UV were measured after the first aperture and also before the BBO crystal. At the first point, the energy was found to be about 23 mJ at maximum. This corresponds to the maximum phase matching temperature for the fourth harmonic. After the intracavity pump steering 266nm mirror that is before the BBO crystal, the energy was measured to be 16mJ with a beam diameter of 2mm. This would give a density of 0.2 GW/cm\(^2\). The overall cavity length between the cavity mirrors was 4.8cm. This was acheived with the maximum reflector held in a mirror flipper and the 266nm mirror that reflect the UV pump beam into the crystal placed in a corner mounting so that we could reduce the cavity length by reducing the amount of space taken up by the mirror mountings. The cavity mirrors comprised of a 99.9% reflectivity mirror at 500nm and a 90% reflectivity mirror at 488-514.5nm. These were BK7 glass substrate mirrors. Oscillation was observed with output in the blue. This OPO output was detected on an Lamda LS2000 optical multichannel analyser (OMA).
Fig. 6.1 The experimental arrangement for the UV pumped BBO OPO.
6.2 Experimental Results and Discussion

Maximum energy obtained was 2.8mJ at 347nm and pumping energy of 18 mJ. The plot of OPO output energy as a function of 266nm input is given in Fig. 6.2. Threshold was found to be 12.5 mJ for the cavity length of 4.8cm. The pulsewidth of the OPO output was 4 ns (shown in Fig. 6.3) measured using a fast digitizing oscilloscope (HP 54510A) and full width half maximum value of 0.2nm. The peak output is shown in Fig. 6.4. We also observed infra red output which was slightly displaced from the path of the signal output. This was done by blocking the output signal using a filter that blocked green downwards. The filter has a spectral transmission above 570nm. The infrared idler was not detectable on the OMA because of inavailability of a grating for wavelengths above 1100nm. From the phase matching curve in Chapter 2, this idler should in the range of 1200nm to 1400nm.

In order to confirm that what we observed was OPO radiation, tests were carried out. One is by misaligning the OPO mirrors. If it is OPO, slight misalignment would not give any oscillation and the signal would disappear completely. Also in OPO the output wavelength would not stay constant. There would be a few nanometers shift observed 7. We verified that the OPO is actually oscillating and not merely reflection of the UV pump by misaligning the cavity. No oscillation was observed when the cavity was misaligned. To further confirm, the back mirror was blocked and the same
Fig. 6.2  Energy output of the OPO as a function of 266nm pump energy at 347nm.
Fig. 6.3  The OPO output pulse detected on a fast digitizing oscilloscope.
Fig. 6.3 The OPO output pulse detected on a fast digitizing oscilloscope.
Fig. 6.4  Peak output wavelength measured on the multichannel analyser.
observation was made. A glass slide was used to confirm that no UV was still passing through. Then the output was blocked using the same glass slide and we still had the output detected on the OMA. This confirmed that the output is actually from the oscillation of the BBO OPO. Oscillation was still observed even when the cavity length was increased to 8.5cm. The advantages of using this configuration have been discussed in Chapter 4.

A wide tuning range was not obtained using the single crystal. This could be caused by the wide phase matching angular range in 266nm pumping as discussed by A.Fix et. al. For 532nm and 355nm pump light the phase matching angle changes only by 2° (532nm) and 10° (355nm). Operation of BBO OPO in the whole tuning range thus requires only one crystal for each pump cut, for example, at 22° (532nm) and 30° (355nm). For pumping with the fourth and fifth harmonic, the change of phase matching angle is considerably larger and amounts to 21 degrees for 266nm pumping and 41 degrees for 213nm pumping. Efficient operation in the full tuning range requires therefore several crystals cut at angles in the range of 25° to 70°.
References to Chapter 6


