SPECTRAL BACKGROUNDS FROM KDP IN TYPE-I AND TYPE-II PHASE MATCHING *

B. GREEN ** and R.R. ALFANO

Physics Department, City College of New York, New York, N.Y. 10031, USA

Received 25 October 1976

A theoretical comparison is made between the parametric generated light in type I and type II KDP by a spectral broadened light pulse.

In KDP and its isomorphs there are two types of phase matching for a three light wave interaction —called type-I and type II [1–4]. In type-I, both pumping beams propagate as ordinary waves, while in type-II one beam propagates as an ordinary wave and the other propagates as an extraordinary wave. In both processes, the parametric generated beam propagate as an E-wave. Recently, type-II phase-matching has become increasingly more popular than type-I phase-matching for second harmonic generation (SHG) because of its increased conversion efficiency and larger phase matching acceptance angle. The purpose of this note is to theoretically compare, in type-I and type-II, the spectral background produced by the phase matched mixing between two spectrally broadened non-collimated waves in KDP centered at 1.06 μ. Such spectrally broadened light [5] is commonly produced upon the passing of intense picosecond pulses through glass amplifiers. We show that the spectral content of the parametrically generated light depends upon the type of KDP used. Thus, this has important implications in laser fusion with SHG beams.

For simplicity, we will assume that the parametrically generated spectral background is determined by collinear phase-matching between beams in the crystal at λ_1 exactly at 1.06 μ and λ_2, a wavelength within the frequency broadened width, of the 1.06 μ beam. The parametrically generated wave, λ_3, is determined by the conservation of energy and the phase matching angle, θ, is determined by setting the momentum mismatch, ΔK, equal to zero. The calculation of λ_3 and θ to be presented is important for the understanding and control of the spectral background produced by parametrically mixing two waves in KDP.

In type-I we determine λ_3 and θ from the collinear phase matching equation:

$$\Delta K = K_3 n_3^e(\theta) - K_2 n_2^o(\theta) - K_1 n_1^o(\theta) , \tag{1}$$

where e and o stand for extraordinary and ordinary waves respectively. A plot of this calculation is shown in fig. 1a. From the curve of λ_3 vs. θ one obtains

$$(\Delta\theta/\Delta\lambda)_I \simeq 0.0058\ ^\circ/\text{Å} . \tag{2}$$

In type-II λ_3 and θ are determined by the following two phase-matching equations:

Case I:

$$\Delta K = K_3 n_3^e(\theta) - K_2 n_2^e(\theta) - K_1 n_1^o(\theta) , \tag{3}$$

and, Case 2:

$$\Delta K = K_3 n_3^e(\theta) - K_2 n_2^o(\theta) - K_1 n_1^e(\theta) . \tag{4}$$

The two cases arise from the two ways mixing occurs between ordinary and extraordinary beams. The results of these calculations are plotted in fig. 1b. From the curve in this figure, one estimates that

$$(\Delta\theta/\Delta\lambda)_{II} \simeq 0.01^\circ/\text{Å} \tag{5}$$

We can now conclude that

$$(\Delta\theta/\Delta\lambda)_{II} = 17(\Delta\theta/\Delta\lambda)_I . \tag{6}$$

* Support in part by NSF and Philips Grant.

** Philips Fellow.