
Modern Optics II: Nonlinear Optics

SHEET V

Electro-optics effects

June 2017

Exercise 1

Continuing with the parameters from Exercise Sheet IV (a 3 mm thick uniaxial negative BBO-crystal used for SHG from 1064 nm, with the phase-matching process following the ooe scheme), Show that when the crystal is oriented at 0° relative to the optical axis, rather than the phase-matched angle, the efficiency is minute. Express this as a ratio

$$\frac{\eta_{zero-deg}}{\eta_{phase-matched}} \quad (1)$$

How is this ratio is the crystal is oriented at 90° relative to the optical axis?

Exercise 2

The electro-optic coefficient d_{63} for ammonium dihydrogen phosphate (ADP) is $8.5 \text{ pm}\cdot\text{V}^{-1}$. We suppose that the input wave is linearly polarized in the $x - y$ plane, and propagates along $+z$.

1. Find the new principal axis of the crystal.
2. Find the quarter-wave voltage at the wavelength of a HeNe laser. ADP belongs to the group of symmetry ($\bar{4}2m$).
We give the value of the refractive index $n_o[632.8 \text{ nm}] = 1.5222$.

Exercise 3 *Electrooptic effect with KDP*

KDP is an uniaxial crystal ($n_o = 1.51$, $n_e = 1.47$), which belongs to the point symmetry group $\bar{4}2m$ and has therefore only three non-zero elements (2 being identical). Its electrooptic tensor writes as

$$r_{ij} = \begin{bmatrix} 0 & 0 & 0 \\ 0 & 0 & 0 \\ 0 & 0 & 0 \\ r_{41} & 0 & 0 \\ 0 & r_{41} & 0 \\ 0 & 0 & r_{63} \end{bmatrix}$$

where $r_{41} = 8.6 \times 10^{-12} \text{ m/V}$, and $r_{63} = 10.6 \times 10^{-12} \text{ m/V}$.

1. Write the index ellipsoid, when the external field is $\mathbf{E} = E_x \hat{\mathbf{e}}_x$
2. Calculate the new refractive indices for an external field of 10^6 W/m .