POCKEL EFFECT

Model No: HO-ED-P05

AIM: -

To plot the graph and study the birefringence with respect to applied voltage in an electro optic crystal (Lithium niobite ($LiNo_3$))

Components and Equipments: -

- He-Ne laser with mount
- Polarizer and analyzer
- Electro optic crystal (Lithium niobite ($LiNo_3$)) with mount
- Detector with mount
- Output measurement unit
- 2KV DC power supply

Theory: -

As all of us know, many crystals exhibit birefringence naturally. There are certain crystals which are not birefringent naturally but become birefringent by application of an electric field. The phenomenon generally is called electro optic effect.

Transmission of the laser light through the crystal exhibiting birefringence is given by

$$T = T_0 \, Sin^2 \, (\Pi \, D_n L \, / \, \lambda) \qquad \text{..} \qquad 1$$

Where T is the transmission, T_0 is the intrinsic transmission of the assembly taking into account all the losses; D_n is the birefringence (ie the difference in the refractive index of two polarizations), L = length of crystal, λ = wave length of the laser.

The birefringence is increasing function of the applied voltage, so that the transmission will be an oscillatory function of the applied voltage.

The max. transmission occurs when;

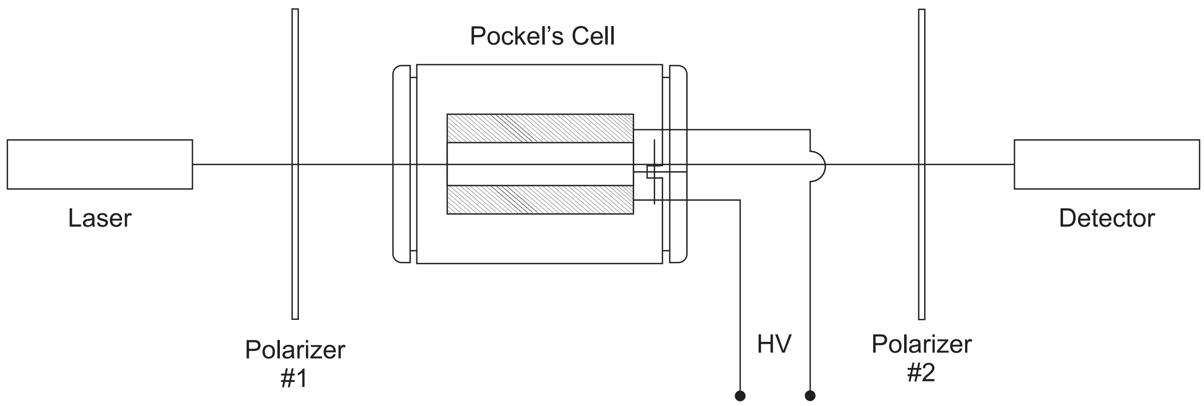
$$Dn = ½ \lambda /2 \quad \ldots\ldots \quad 2$$

This occurs at voltage called half voltage denoted as V ½

$$V½ = \lambda d / 2r_{22} n_0^3 l \quad \ldots\ldots \quad 3$$

where l is gap between two electrodes, r_{22} is the electro optic coefficient, n_0 is the ordinary refractive index and λ is the wavelength of light.

Half wave voltage depends upon the nature of the material and increases with wavelength.



Procedure :-

1. Arrange the electro optic set up shown in the figure.

2. Carefully align the crystal along with so that light beam passes accurately along the axis of the crystal.

3. Rotate and position the first polarizer so that light beam passes through it with maximum intensity. This is to make sure that the light entering the crystal is polarized.

4. Rotate and position the second polarizer (analyzer) so that the light transmitted through it is minimum.

5. Connect the high voltage DC supply to the electrodes kept closely on both sides of the crystal parallel to the light beam.

6. Turn on the supply and gradually increase applied voltage from 0V to 2000V in steps of 100V, measuring the light reaching the detector at every 100V interval.

7. Record the voltage and output current reading at each 100V interval. The output current increases up to a point of input voltage and after that the output current decreases with the increase in voltage.

8. Plot the meter reading as a function of applied voltage.

9. Determine the value of V ½. Determine the extinction ratio, which is the ratio of the meter reading at V ½ to meter reading at V= 0.

10. Use the following equations for further calculation.

$$P(V\tfrac{1}{2}) = P(V)\,\mathrm{Sin}^2(\Pi\, D_n L / \lambda)$$

$$D_n = \lambda / \Pi\, L\, \sin^{-1} \sqrt{\;} P(V) / P(V\tfrac{1}{2})$$

Were P (V) is the meter reading at voltage V
P (V ½) is the half wave voltage
L = length of the crystal (2.5mm)
λ = wave length (632nm)

Solve the equation for several values of V and plot it as a function of voltage.

Calculations

Half wave voltage from the graph =
Extinction ratio = detector out put at half wave voltage / detector output at zero voltage.

Result:-

1. The intensity variation is plotted as a function of applied voltage.
2. Half wave voltage =

   Extinction ratio =
3. Birefringence Vs applied voltage graph is plotted.