Retardation Plate

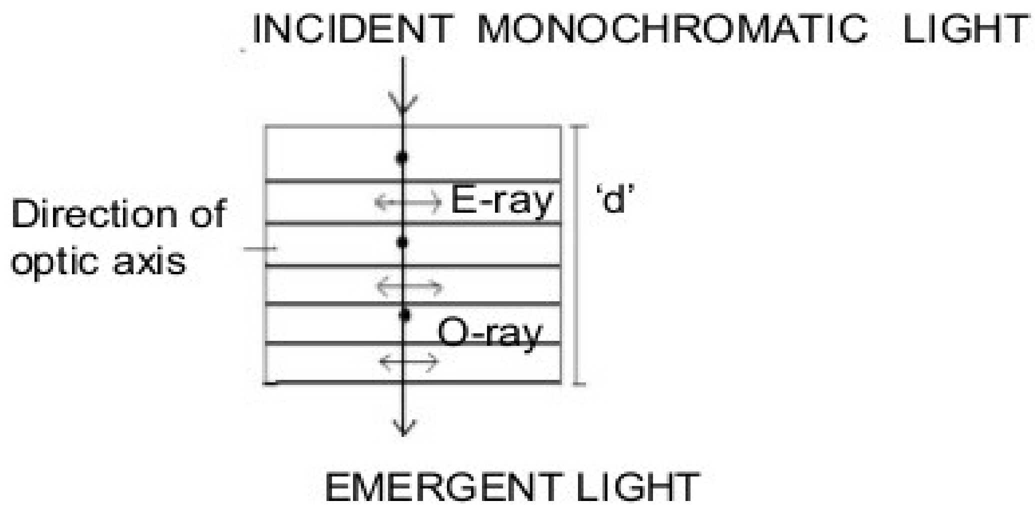
B.Tech-I

PHASE RETARDATION PLATE

A doubly refracting uniaxial crystal plate of uniform thickness having refracting surface parallel to direction of optic axis and capable of producing a definite phase difference between the ordinary and the extraordinary ray, is called phase retardation plate.

A retardation plate is an optically transparent material which resolves a beam of polarized light into two Orthogonal components; retards the phase of one component relative to the other; then recombines the components into a single beam with new polarization characteristics.

SCHEMATIC VIEW :



PHASE DIFFERENCE :

In calcite crystal , the velocity of E-ray (Ve) is greater than that of O-ray, the difference in time taken by these waves to cross the plate thickness 'd' can be given as :

$\Delta T = To - Te$ ----- 1

Here *To* and *Te* are the time taken by O-ray and E-ray to cross the plate of thickness *d*.

$To = d/Vo.$

$Te = d/Ve.$

$\Rightarrow \Delta T = (d/Vo) - (d/Ve).$

So, path difference occurs between E-ray and O-ray on passing through the plate, which can be given as :

$\Delta = c \,.\, \Delta T$

$\Delta = c\,\{(d/Vo) - (d/Ve)\}$

$\Delta = d\,\{(c/Vo) - (c/Ve)\}$

$\{n1 = c/Vo \quad , \quad n2 = c/Ve\}$

$\Delta = d(n1 - n2)$

Here n1 and n2 are the refractive indices of calcite crystal plate for O-ray and E-ray respectively. Hence phase difference between E-ray & O=ray is :

$o = (2\pi * \Delta n * d) / \lambda$

QUARTER WAVE PLATE

A doubly refracting uniaxial crystal plate having refracting faces parallel to the direction of the optic axis , having a thickness such as to create a path difference of $\lambda/4$ or a phase difference of $\pi/2$ between the O-ray and the E-ray , is called *Quarter wave plate*.

For quarter wave plate :

$\Delta=(n1-n2)d=\lambda/4$

where λ is the wavelength of the incident light.

$d=\lambda/\{4(n1-n2)\}$

A quarter-wave plate consists of a carefully adjusted thickness of a birefringent material such that the light associated with the larger index of refraction is retarded by 90° in phase (a quarter wavelength) with respect to that associated with the smaller index. Any linearly polarized light which strikes the plate will be divided into two components with different indices of refraction. The 2 components travel along same direction but with different speed and a phase difference of $\pi/2$ will be introduced between them. One of the useful applications of this device is to convert linearly polarized light to circularly polarized light and vice versa. This is done by adjusting the plane of the incident light so that it makes 45° angle with the optic axis. This gives equal amplitude o- and e-waves. When the o-wave is slower, as in calcite, the o-wave will fall behind by 90° in phase, producing circularly polarized light.

HALF WAVE PLATE

A doubly refracting uniaxial crystal plate having refractive faces parallel to the direction of the optic axis ,having a thickness such as to create a path difference of $\lambda/2$ or a phase difference of π between the O-ray and the E-ray , is called a *Half wave plate.*

Here, $\Delta = (n1 - n2)d = \lambda/2$

and $d = \lambda / \{4(n1\text{-}n2)\}$

A retarder that produces a $\lambda/2$ phase shift is known as a half wave retarder. Half wave retarders can rotate the polarization of linearly polarized light to twice the angle between the retarder fast axis and the plane of polarization. Placing the fast axis of a half wave retarder at 45° to the polarization plane results in a polarization rotation of 90°.

A half-wave plate. Linearly polarized light entering a wave plate can be resolved into two waves, parallel (shown as green) and perpendicular (blue) to the optical axis of the wave plate. In the plate, the parallel wave propagates slightly slower than the perpendicular one. At the far side of the plate, the parallel wave is exactly half of a wavelength delayed relative to the perpendicular wave, and the resulting combination (red) is orthogonally polarized compared to its entrance state.