3. Theory of Polarization

Apart from interference and diffraction, polarization is an important property of light. Without special equipment, human eyes or even optical detectors cannot identify the polarization of a light wave. Light is a transverse wave. We define the direction of polarization by the direction of the electric field vector, ***E***. Light from common sources such as light bulbs is unpolarized, meaning that the plane of vibration of the electric field vector changes rapidly in a completely random fashion.

However, when light interacts with matter, the plane of vibration of the electric field vector may become fixed in a particular direction (linear polarization) or the plane of vibration may rotate or otherwise vary in a uniform manner (circular or elliptical polarization).

Polarized light can be described by the two orthogonal components of its electric field, E_y and E_z,

$$
\begin{aligned}
E_y &= E_{oy}\cos(\omega t - kx) \\
E_z &= E_{oz}\cos(\omega t - kx - \delta)
\end{aligned}
\qquad (1)
$$

Where E_{oy} and E_{oz} are the amplitudes of the electric field along y and z axes, respectively; and δ is the phase delay between these components. The value of the phase delay determines the type of the polarization of a light wave as

$\delta=0$, linear
$\delta\neq 0$, elliptical
$\delta=\delta(t)$ random, unpolarized
$\delta=\pi/2$, $E_{oy}=E_{oz}$, circular
$\delta=\pi/2$, $E_{oy}\neq E_{oz}$, elliptical, major/minor axes aligned along y and z axes.

A polarizer used in this equipment is a special device that selectively passes only the component of the electric field parallel to the optical axis of the polarizer. When unpolarized light passes through a polarizer, it becomes linearly polarized parallel to the direction of the optical axis of the polarizer.