Polarization

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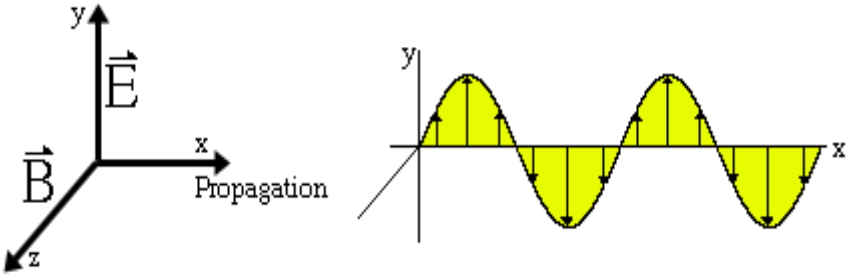
Introduction of Polarization

What is Polarization?

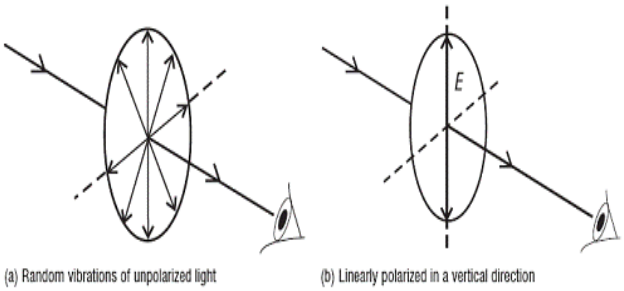
Polarization is a property of waves of light or other sources of radiation whose oscillations are restricted in certain directions. A light beam with wave oscillations occurring in a single plane of space is said to have total plane polarization. Light with an equal amount of oscillations in all directions and no preferred orientation is unpolarized. Unlike light, sound waves vibrate back and forth along their directions of propagation and thus are not polarizable.



Polarization is constant when waves hold a particular orientation at all times. Alternatively, polarization can rotate with each wave cycle.

Polarization is important in wireless communications systems. The physical orientation of a wireless antenna corresponds to the polarization of the radio waves received or transmitted by that antenna. Thus, a vertical antenna receives and emits vertically polarized waves, and a horizontal antenna receives or emits horizontally polarized waves.

Light emitted by the sun, by a lamp in a classroom, or by a candle flame is unpolarized light. Such light waves are created by electric charges that vibrate in various directions, and therefore createelectromagnetic waves that also vibrate with no preferred orientation. The concept of unpolarized light can be rather hard to visualize.

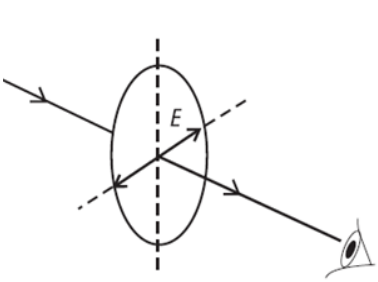


Planes of polarization:

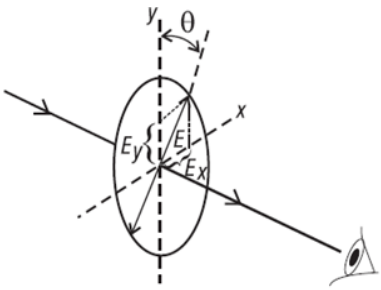
The plane containing an electric vector and the direction of motion of a wave is called the plane of polarization.

If a light wave is polarized in the direction of a positive y-axis and the direction of propagation of the polarized wave is in the positive x-axis, then the x-y plane is the wave's plane of polarization. Similarly, if a light wave is polarized in the direction of a positive z-axis and propagates along an x-axis then the x-z plane is the wave's plane of polarization.

In figure (a) below, many light sources (e.g., incandescent bulbs, arc lamps, the sun) produce unpolarized light.



c) Linearly polarized in a horizontal direction



(d) Linearly polarized in a direction making an angle θ with the vertical

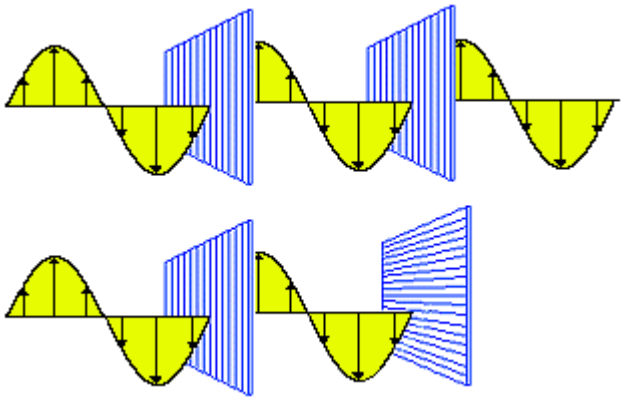
In contrast, figure (b) shows vertically polarized light while figure (c) shows horizontally polarized light. Each is an example of linearly polarized light. Figure 1 (d) shows linearly polarized light that makes an angle ? with the vertical axis y. In this case, the tilted E-vector can be described by referencing its components, Ex and Ey.

A special case of elliptical polarization — called circular polarization — happens when Ex equals Ey and they are out of phase by 90°.

Polarizers:

A polarizing sheet that is used to polarize light is called a polarizer.

Polarizers are used to remove undesired components of light from a light wave by passing light of one polarization and absorbing or reflecting other polarizations. A common ordinary life example of a polarizer is found in polarizing sunglasses. The material in the lenses passes light w



hose electric field vibrations are perpendicular to certain molecular alignments, while absorbing light whose electric field vibrations are parallel to the molecular alignments.

The following equation can be used to calculate the intensity of light passing through a linear polarizer:

I(?) = I0 cos2 (?)

where I(?) is the light intensity passed by the polarizer and I0 is the incident light intensity. The angle of the E-field with respect to the transmission axis is defined as ?.

Analyzers:

When a polaroid disc is used to test polarized light, it is called an analyzer. Analyzers are discs or sheets that are used to check whether light is polarized or non-polarized.

How to Polarize Light

It is possible to transform unpolarized light into polarized light. Polarized light waves are light waves whose the vibrations occur in a single plane. The process of transforming unpolarized light into polarized light is known as polarization. There are a variety of methods of polarizing light. The four methods discussed on this page are:

- Polarization by Transmission
- Polarization by Reflection
- Polarization by Refraction
- Polarization by Scattering

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Reference links:

- http://en.wikipedia.org/wiki/refraction
- http://www.ndt-ed.org/.../HighSchool/Electricity/electriccharge.htm
- http://www.science.hq.nasa.gov/kids/imagers/ems/waves3.html
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