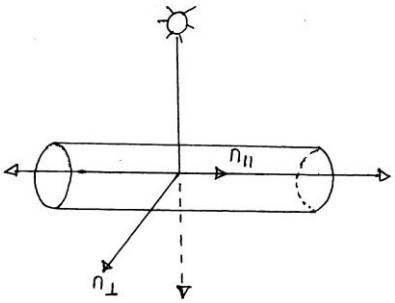
OPTICAL PROPERTIES OF TEXTILE FIBRES

The behaviors shown by a textile fibre when light falls on it are called as optical properties. The optical properties of a fibre include birefringence (basis on light refraction or transmission), dichorism (basis on light absorption) and luster (basis on light reflection).

1. Birefringence:

When a beam of light falling on a textile fibre, it splits up into two refracted beams, one polarized parallel to the fibre axis and other polarized perpendicular to the fibre axis. The difference between the refractive index for light, polarized parallel to the fibre axis and the refractive index for light, polarized perpendicular to the fibre axis is called as birefringence value of fibre.



Birefringence can be formalized by assigning two different refractive indices to the fibre for different polarizations. The birefringence magnitude is thus defined by-

$$\Delta n = n_{\parallel} - n_{\perp}$$

Where $n_{\parallel}$ and $n_{\perp}$ are the refractive indices for light, polarized parallel and perpendicular to the fibre axis respectively. The birefringence of a fibre is due to the orientation of the crystal axis in the crystalline regions and of the individual molecules in the non-crystalline regions. Greater the value of birefringence indicate the most of molecules are lined up parallel to the fibre axis and it will be zero if they are randomly directed.

Refractive Index:

The velocity with which light is transmitted varies with the medium through which it is passing. Refractive index 'n' is defined as the ratio of the velocity of light in a vacuum to the velocity of light in the mtl. Alternative definition is,

$$\text{Refractive index, } n = \frac{\text{sine of angle of incidence}}{\text{sine of angle of refraction}}$$

The refractive index of a material varies with the temperature and with the wave length of the light being transmitted.

Factors affecting the birefringence of textile fibres:

The birefringence value of textile fibres depend on-

- The degree of orientation and
- The degree of asymmetric of the molecular chain (straight/zigzag/with side groups)

Highly oriented fibres will have high Birefringence value. Ideally oriented fibres have different birefringence value. The magnitude of birefringence which ranges from 0.005 for Triacetate to 0.188 for Terylene.

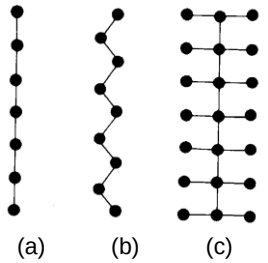


Fig: (a) Straight chain, (b) Zigzag chain & (c) Chain with sidegroup

Measurement of Refractive Indices:

There are various methods for measuring the refractive index of textile fibres.

a. The Becke line method
b. Wavelength varying technique
c. Fibre refractometer
d. Interference technique

2. Dichorism:

The variation in the absorption of radiation by a colored fabric with the direction of polarization of light is called as dichorism, which may result in the difference of depth of shade or even in the actual color. For dyed fibre exhibiting dichorism, its magnitude is used as a measure of orientation of the molecules in the fibre. So, we get-

$$\varphi = k_1/k_2$$

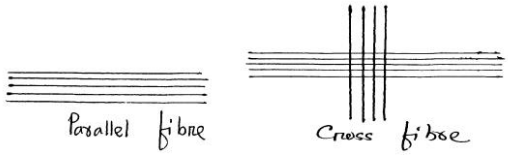
Where, φ = Dichroic/dichroitic constant
K_1 = Absorption co-efficient of light polarized parallel to the fibre axis
K_2 = Absorption co-efficient of light polarized perpendicular to the fibre axis

Requirements of Dichroism:

- ❖ The dye molecule must be asymmetrical so that its absorption of radiation varies with the direction of the electric field exciting the characteristics vibration.
- ❖ The dye molecule must be absorbed on to the fibre molecule in a particular direction so that all the dye molecules make the same angle (or a limited range of angles) with the axis of the chain molecules.
- ❖ The chain molecules must be preferentially oriented.

Cross fibres absorb more radiation than parallel fibre:

When light passes through the two dichroic fibres, there is a greater total absorption if they are crossed than there is if they are parallel. This is because, if the fibres are crossed, the first fibre absorbs a large part of one component and the second fibre absorbs a large part of the perpendicular component. But if the fibres are parallel, the same component is transmitted through both little absorption.

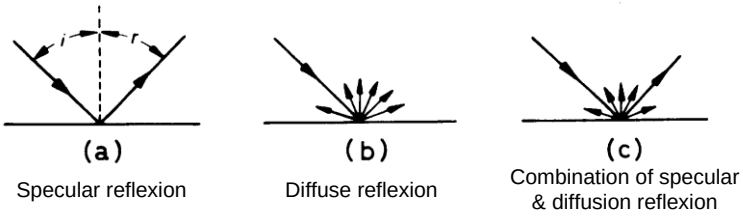


Dichroic constant for direct dyes on cellulose:

Fibre	Dichroic constant
Ramie	9
Viscose rayon	1.4–2.3
Cellophane	1.5

3. Lustre:

Lustre is an important property of textile fibres. When a beam of light falls onto a fibre surface, it may be reflected along the angle of reflection. The reflection may vary with the angle of incidence, with the color and polarization of light. Lustre of textile fibres will be increased with the increase of regular light reflection.



Factors affecting the lustre of textile fibres:

- Falling of light on fibre (across the fibre or along the fibre)
- Incidence angle of the light
- Fibre fineness
- Irregularities of fibre surface
- Cross-sectional shape of fibre
- Amount of small particles (TiO_2) present in fibre
- Maturity of fibre

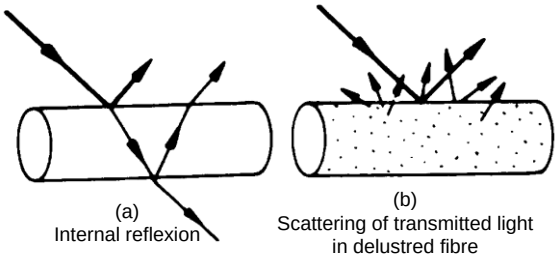


Fig: Fibre without (a) and with (2) small particles-TiO_2

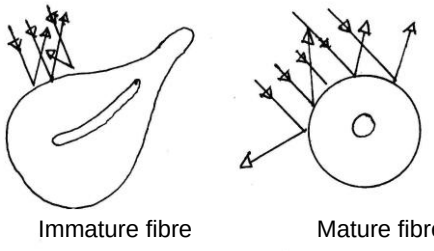


Fig: Immature and matured fibre