Photoelasticity

→ Easy to use; simple; relatively inexpensive

→ Provide full field map of differences in principal stresses.

→ Both 2D and 3D possible.

Material / Sample Restrictions

1. Transparent, non-crystalline material.
2. Optically isotropic when free of stress.

→ Create optical anisotropy when stressed;

"Temporary double refraction or birefringence".

Biorefringence

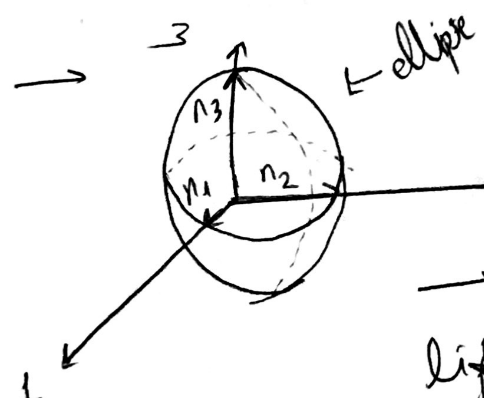
. optical property of having refractive index that depends on propagation direction of light.

Optical Anisotrophy

. (which can be temporarily induced due to applied stress)

→ can be represented as index ellipsoid.

→



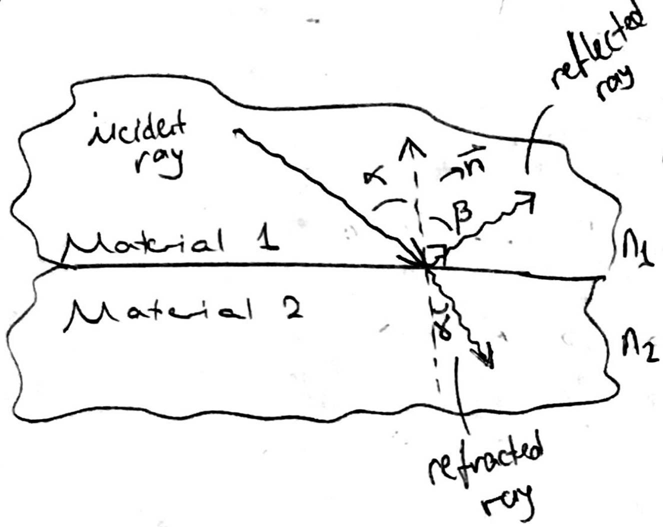
• n_1, n_2, n_3 --- principal indices of refraction of the material at a point.

→ Any radius can represent the direction of light propagation through a point.

↘

- $\eta_{air} = 1.0003$
- liquids, $\eta = 1.3 - 1.5$
- $\eta_{H_2O} = 1.33$
- solids, $\eta = 1.4 - 1.8$
- $\eta_{glass} = 1.5$

η can vary slightly with λ being transmitted (dispersion)



Two transparent materials.

- α = angle of incidence
- β = angle of reflection
- γ = angle of refraction

→ $\boxed{\alpha = \beta}$

→ $\boxed{\dfrac{\sin\alpha}{\sin\gamma} = \dfrac{n_2}{n_1} = n_{21}}$ -- index of refraction of material 2 with respect to 1.

→ if material 1 has n_1 greater than material 2, η_2, there exists a critical α, α_c, for which $\gamma = 90^\circ$ and no light is refracted.

- $\eta_1 > n_2$, $n_{21} < 1$

Total internal reflection

Eqn of an ellipse. Light exhibiting this behaviour is known as eliptically polarized.

→ 2 special cases

① if $a_x = a_z = a_y$ and if $\delta = \left(\frac{2n+1}{4}\right)\lambda$, $n = 1, 2, 3, \ldots$

Makes ① reduced to; $\boxed{E_x^2 + E_y^2 = a^2}$ — circularly polarized light

② When linear phase difference (δ) between E_x and E_y

and $\delta = \frac{n\lambda}{2}$, $n = 0, 1, 2, \ldots$

$\boxed{E_y = \left(\frac{a_y}{a_x}\right)^2 E_x}$ ∴ Straight line, back to plane or linearly polarized light.

Reflection and Refraction

→ So far, light propagating in free space

→ Interesting effects, however, when light interacts with some physical material.

→ free space, light velocity is $\boxed{c = 3 \times 10^8 \text{ m/s}}$ in any other medium, velocity would reduced. (v)

$\boxed{\frac{c}{v} = n}$ n = index of refraction of medium.

In gases, n is only slightly > 1