Optics of Isotropic Materials

Chapter 4 of Nesse

Isotropic Minerals

- Velocity of light is the _____ in all directions
- Chemical bonds holding the material together are the _____ in all directions
- Light traveling through the isotropic material 'sees' the _____ electronic configuration, irregardless of direction

Isotropic Minerals

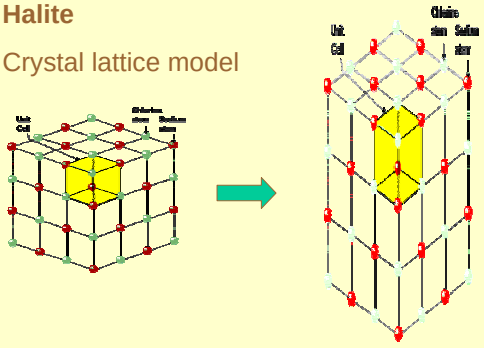
- Isometric (cubic) system
- 23 described in Nesse
- Examine:
  - Halite – $NaCl$
  - Sylvite - KCl
  - Fluorite – CaF_2
  - Garnet – $(Mg,Fe^{2+},Ca,Mn)_3(Al,Fe^{3+},Cr)_2(SiO_4)_3$
  - Periclase – MgO
  - Analcime – $Na(Al,Si_2)O_6{\bullet}H_2O$
  - Volcanic Glass

Isometric Minerals

- If an isometric mineral is deformed or strained, then the chemical bonds holding the mineral together will be effected – some will be stretched, other compressed
- Result is that the mineral may appear anisotropic

Halite

Crystal lattice model



Indicatrix

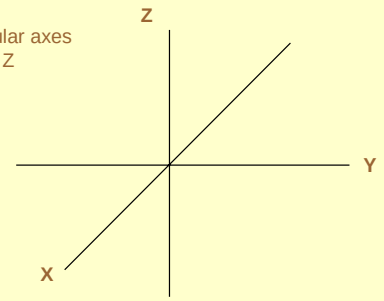
- To examine how light travels through a mineral, an indicatrix is used
- **INIDICATRIX –**

  _____
  _____
  _____
  _____

- (A figment our our imagination, does not actually exist)

Isotropic Indicatrix

3 mutually perpendicular axes – X, Y and Z



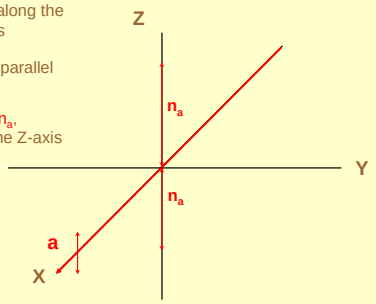
Consider how 3 plane polarized light rays travel through the indicatrix

Isotropic Indicatrix

Ray a, travels along the X indicatrix axis

Ray a vibrates parallel to the Z-axis

RI for Ray a = n_a, plotted along the Z-axis

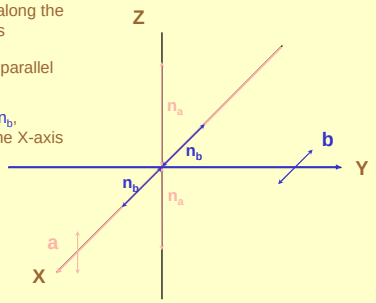


Isotropic Indicatrix

Ray b, travels along the Y indicatrix axis

Ray b vibrates parallel to the X-axis

RI for Ray b = n_b, plotted along the X-axis

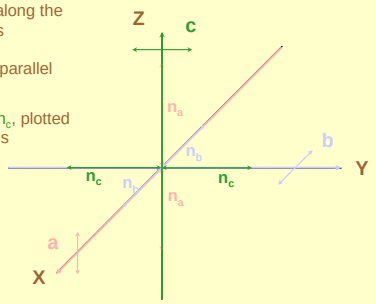


Isotropic Indicatrix

Ray c, travels along the Z indicatrix axis

Ray c vibrates parallel to the Y-axis

RI for Ray c = n_c, plotted along the Y-axis



For Isotropic Minerals $n_a = n_b = n_c$. Light traveling in all directions has the same RI.

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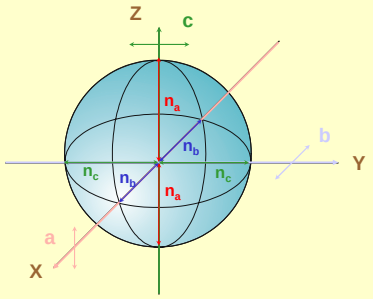
Isotropic Indicatrix



For Isotropic Minerals the Indicatrix is a sphere, with a radius = $n_a = n_b = n_c$.

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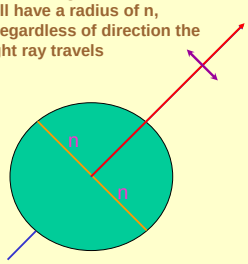
RI of a Random Light Wave Travelling Through the Isotropic Indicatrix

For Isotropic minerals, any slice through the indicatrix will have a radius of n, irregardless of direction the light ray travels



Indicatrix (in 2D)

Light Ray traveling through the indicatrix

A **Wave Normal** is constructed through the centre of the indicatrix

(For Isotropic minerals the wave normal and direction of propagation of light are parallel)

A slice through the centre of the Indicatrix perpendicular to the Wave Normal is taken (Wave Front).

Index of Refraction (n) of the Light Ray is the radius of this slice that is parallel to the **Vibration Direction of the Light.**

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Isotropic Indicatrix

- Indicatrix not needed to tell the index of refraction is the same in all directions in a isotropic mineral
- Indicatrix is introduced to prepare for its application with anisotropic minerals

Isotropic vs Anisotropic

- Distinguished easily under the microscope, by crossing the polars
  - Isotropic minerals will appear _____ and stay _____ as the stage is rotated
  - Anisotropic minerals will allow _____ to pass, and thus will be _____ other than black

Isotropic Minerals

- Why are isotropic minerals dark?
  - _____ the polarization direction of light
  - Light passes through the mineral and is _____ by the upper polar
- Why do anisotropic minerals appear light?
  - _____ the polarization of light
  - Light ray is _____ as it passes through the mineral, some component passes the upper polar
  - Exhibit '_____' every 90° of rotation