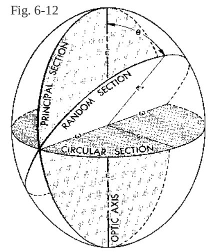
Optic Figures

Conoscopic observations of uniaxil minerals

Uniaxial Indicatrix

Fig. 6-12



- Circular Section is normal to the optic axis (all ω 's)
- Principal Sections have ω and true ε (max & min n's)
- Random Sections (ε' and ω)
  - Always have ω!!

Any cut through center of a uniaxial indicatrix will have w as one *semiaxis*

Convergent Light Observations

- Use high magnification
- Insert Condenser and Bertrand lens
- Observe interference figures
  - Optic axes
  - Isogyres
  - Isochromatic lines
  - Optic figures
  - Optic sign

Conoscopic Viewing

A condensing lens below the stage

A Bertrand lens above it

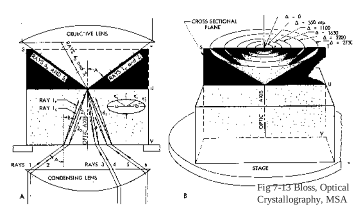


Fig 7-13 Bloss, Optical Crystallography, MSA

Light rays are refracted by condensing lens & pass through crystal in different directions

Thus exhibit different properties

Only light in the center of field of view is vertical & like ortho

Interference Figures are very useful for determining optical properties of crystals

Microscope as a Conoscope

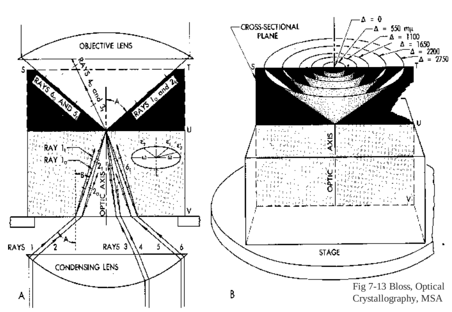


Fig 7-13 Bloss, Optical Crystallography, MSA

Optic Axes

- Directions along which minerals appear isotropic with X-polars
- Minerals with this orientation are easy to identify in thin section
- Uniaxial minerals have one optic axis
- Biaxial minerals have two optic axes

Isogyres

- These are dark zones that appear in optic figures
- They locate where the vibration directions are perpendicular to the polarizers
- They form a simple cross for uniaxial minerals but a complex separating pair of lines for biaxial figures

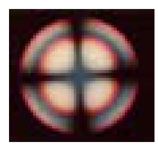
Isochromatic Lines

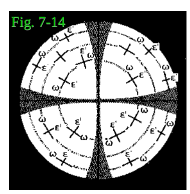
- These are lines of equal interference that appear in iconoscope observation
- In uniaxial figures they appear as concentric rings
- In biaxial figures they are concentric, but more complex arrangements.

Uniaxial Figures

- Optic axis figure is a simple cross
- Flash figure is a cross that disperses rapidly
- Flash figures separate in the direction of the c axis. Test with a 1st order plate

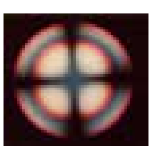
Uniaxial Figure

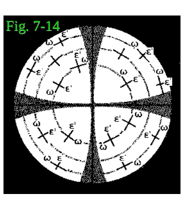




- Circles of isochromes
- Note vibration directions:
  - ω tangential
  - ε' radial & variable magnitude
- Black cross (isogyres) results from locus of extinction directions
- Center of cross (melatope) represents optic axis
- Approx 30^{o} inclination of OA will put it at margin of field of view

Uniaxial Figure





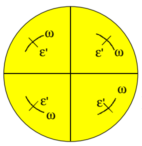
- Centered axis figure as 7-14: when rotate stage cross does not rotate
- Off center: cross still E-W and N-S, but melatope rotates around center
- Melatope outside field: bars sweep through, but **always** N-S or E-W at center
- Flash Figure: OA in plane of stage
  Diffuse black fills field brief time as rotate

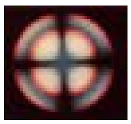
Uniaxial Optic Sign

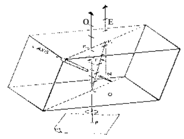
- Positive sign for addition in 1st and 3rd quadrants
- Negative sign for addition in 2nd and 4th quadrants

Optic Sign Determination

For all crystals remember ε' vibrates in plane of ray and OA, ω vibrates normal to plane of ray and OA



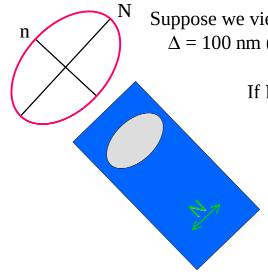




(+) crystals: ε' > ω so ω faster

1) Find a crystal in which the optic axis (OA) is vertical (normal to the stage)
2) 2) Go to high power, insert condensing and Bertrand lenses to → optic axis interference figure

Accessory Plates

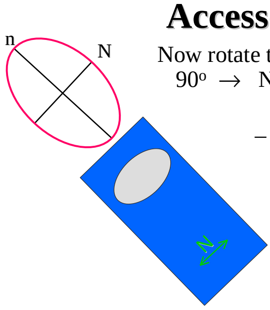


Suppose we view an anisotropic crystal with Δ = 100 nm (1-order gray) at 45º from extinction

If N_{gyp} || N_{xl} → Addition

- Addition since ray in xl || N_{gyp}
- already behind by 100nm & it gets further retarded by 550nm in the gypsum plate
- 100 + 550 → 650nm
- On your color chart what will result?
- Original 1º grey → 2º blue

Accessory Plates

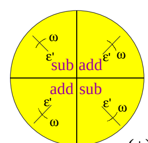


Now rotate the microscope stage and crystal 90º → N_{gyp} || n_{xl} (Δ still = 100 nm)

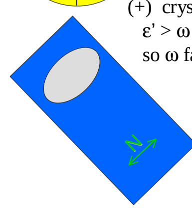
– N_{gyp} || n_{xl} → Subtraction

- Now the ray in the crystal that is parallel to N_{gyp} is ahead by 100µm
- 550µm retardation in gypsum plate → 450nm behind
- On your color chart what will result?
- 1º orange

Optic Sign Determination



(+) crystals: ε' > ω so ω faster



Inserting plate for a (+) crystal:

→ subtraction in NW & SE where n||N

→ addition in NE & SW where N||N

Whole NE (& SW) quads add 550nm

- isochromes shift up 1 order

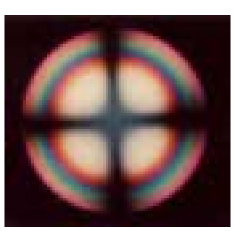
Isogyre adds → red

In NW & SE where subtract

- Each isochrome loses an order

Near isogyre (~100nm)

- get yellow in NW & SE

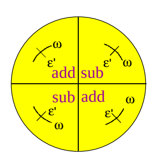


(+) OA Figure without plate

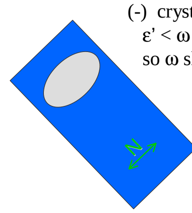
Positive Case

(+) OA Figure with plate
Yellow in NW is (+)

Optic Sign Determination



(-) crystals: ε' < ω so ω slower



Inserting plate for a (-) crystal:

→ subtraction in NE & SW where n||N

→ addition in NW & SE where N||N

Whole NW (& SE) quads add 550nm

- isochromes shift up 1 order

Isogyre still adds → red

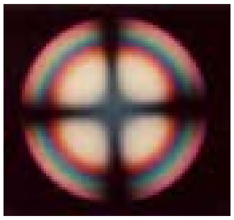
In NE & SW where subtract

- Each isochrome loses an order

Near isogyre (~100nm)

- get 650 blue in NW & SE
- and 450 yellow in NE & SW

Negative Case



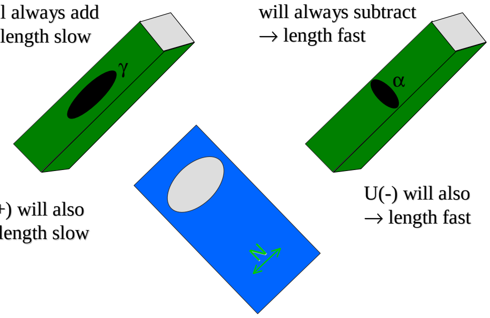
(-) OA Figure without plate
(same as (+) figure)

(-) OA Figure with plate
Blue in NW is (-)

Sign of Elongation

If γ || elongation
will always add
→ length slow

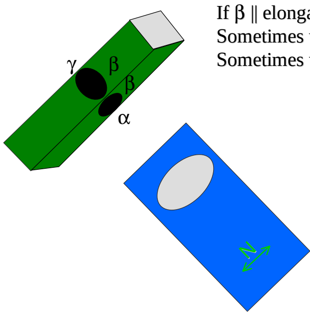
If α || elongation
will always subtract
→ length fast



U(+) will also
→ length slow

U(-) will also
→ length fast

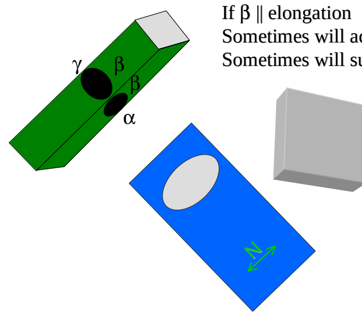
Sign of Elongation



If β || elongation
Sometimes will add → length slow
Sometimes will subtract → length fast

Sign of Elongation

If β || elongation
Sometimes will add → length slow
Sometimes will subtract → length fast



Platy minerals may
appear elongated too

Can still use sign of
elongation on edges