Ophthalmic Optics Review 2019

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Ophthalmic Prism

Prism Effects in Periphery of Lens

Decentration

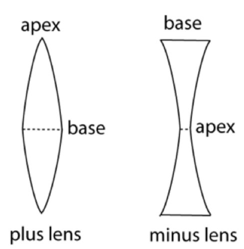
Major Reference Points

Correction of Vertical Prism Effect

Thickness Difference Across a Prism

Ophthalmic Prism / Prism Effects

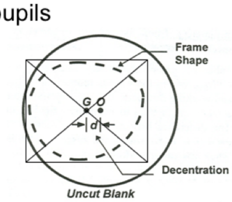
Prism Effects in the Periphery of a Lens



Ophthalmic Prism / Prism Effects

Decentration

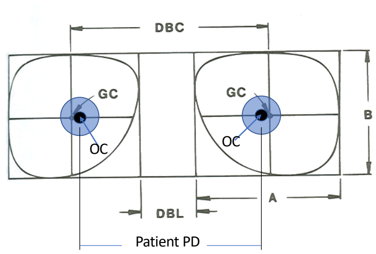
Lenses are decentered so that the OC of each lens coincides with the centers of the patient's pupils



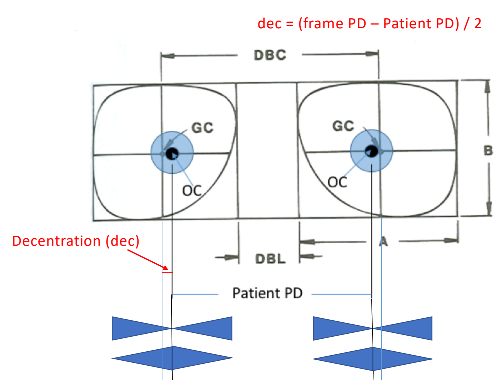
Optical Characteristics of Lenses

Major Reference Points

Optical Center & Geometrical Center



Ophthalmic Prism / Prism Effects



Ophthalmic Prism

What happens when PD in Rx doesn't match Patient PD?

Minus Rx

PD larger than Patient PD: BI prism from each lens*
Creates demand for Divergence (NFV)

PD smaller than Patient PD: BO prism from each lens
Creates demand for Convergence (PFV)

Plus Rx

PD larger than Patient PD: BO prism from each lens*
Creates demand for Convergence (PFV)

PD smaller then Patient PD: BI prism from each lens
Creates demand for Divergence (NFV)

*occurs when reading with distance Rx

Ophthalmic Prism

What happens to Phoria when PD is not correct?

Minus Rx

PD larger than Patient PD: BI prism from each lens*
Phoria appears more ESO than actual

PD smaller than Patient PD: BO prism from each lens
Phoria appears more EXO than actual

Plus Rx

PD larger than Patient PD: BO prism from each lens*
Phoria appears more EXO than actual

PD smaller then Patient PD: BI prism from each lens
Phoria appears more ESO than actual

*occurs when reading with distance Rx

Ophthalmic Prism

Who benefits from induced prism at near?

Minus Rx

PD larger than Patient PD: BI prism from each lens*
Benefits the EXO patient

Plus Rx

PD larger than Patient PD: BO prism from each lens*
Benefits the ESO patient

*occurs when reading with distance Rx

Ophthalmic Prism / Prism Effects

Correction of Vertical Prism Effect

With Anisometropic Spectacle Rx:

Greatest concern for prismatic effects is for presbyopic patient looking down to use multifocal segment when reading.

Solutions include:

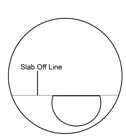
Slab Off Prism
Double Slab Off Prism
Dissimilar Segments
Compensated R Segments
Prism Segments
Multiple Corrections
Contact Lenses
Fresnel Prism
Fresnel Adds

Ophthalmic Prism / Prism Effects

Correction of Vertical Prism Effect

Slab Off Prism

Bi-centric grinding



Plastic lens: applied to back surface
Glass lens: applied to front surface

Results in the removal of base down prism
Applied to lens with least plus or most minus power

Slab off line at segment top for segmented bifocal
Slab off line slightly above near verification circle on PAL

Ophthalmic Prism / Prism Effects

Correction of Vertical Prism Effect

Slab Off Prism

Reverse Slab Off Prism

Base down prism is cast into the near portion of the lens
Applied to lens with most plus or least minus power

Double Slab Off Prism

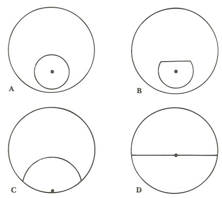
Done with high minus lenses
Remove base down from each lens
Reducing prism effect in downgaze and reducing imbalance

Ophthalmic Prism / Prism Effects

Correction of Vertical Prism Effect

Dissimilar Segments

Use two different types of multifocal segment
Create prism to neutralize prism in downgaze due to aniso Rx



Ophthalmic Prism / Prism Effects

Correction of Vertical Prism Effect

Compensated R Segments

R (ribbon) Segments are available with Segment OC in positions ranging from 4 to 10mm below segment top.

Maximum prism is limited

Ex: +2.00D can create (0.6 x 2.00) = 1.2 prism diopters

Ophthalmic Prism / Prism Effects

Correction of Vertical Prism Effect

Prism Segments

Prism provided by segment

Rarely Used

Expensive
Thick
Special Order
Limited Availability

Ophthalmic Prism / Prism Effects

Correction of Vertical Prism Effect

Multiple Corrections

Different Distance & Near Corrections

Eliminate need for downgaze with near Rx

Ophthalmic Prism / Prism Effects

Correction of Vertical Prism Effect

Contact Lenses

Contact Lenses usually fit to move with the eye in downgaze so prism not induced in downgaze

Can use multifocal CL, monovision, reading Rx over CLs

Ophthalmic Prism / Prism Effects

Correction of Vertical Prism Effect

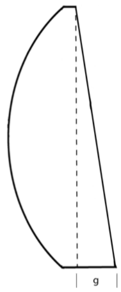
Fresnel Prism / Fresnel Add

Used for temporary applications

Reduce contrast and Visual Acuity

Ophthalmic Prism / Prism Effects

Thickness difference across a prism



Thickness attributed to prism:

$$g = \frac{dP}{100(n-1)}$$

Where:

d = lens diameter
P = prism power
n = index of refraction

Aberrations & Lens Design

Aberrations

Chromatic
Monochromatic

Principles of Corrected Curve Design

Aberrations

Chromatic Aberration
Characteristic of Lens Material

Monochromatic Aberrations
Characteristic of Lens Design

Spherical Aberration
Coma
Oblique Astigmatism*
Curvature of Field (Image)**
Distortion

*most important
**second most important

Aberrations

Monochromatic Aberrations

Spherical Aberration*
Coma*
Oblique Astigmatism*
Curvature of Field (Image)*
Distortion**

*defocus
**shape problem

Aberrations

Monochromatic Aberrations

These are usually ignored:

Spherical Aberration
Coma
Distortion

These are controlled through base curve selection:

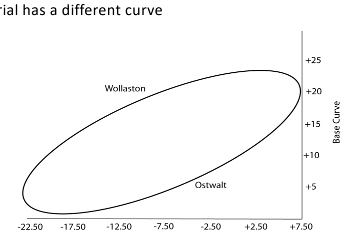
Oblique Astigmatism
Curvature of Field (Image)

Optical Characteristics of Lenses

Principles of Corrected Curve Design

Corrected curve lenses are designed to minimize aberrations through proper base curve selection.

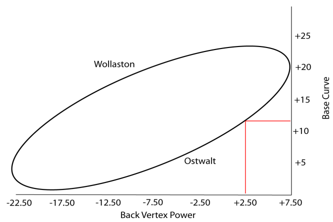
Based on the work of Ostwalt
Each lens material has a different curve



Optical Characteristics of Lenses

Principles of Corrected Curve Design

Base curves are selected to minimize Oblique Astigmatism (and also reduce Curvature of Field):



Anisometropia & Aniseikonia

Concerns with Anisometropia

Spectacle Magnification

Eikonic Lens Design

Anisometropia

There are 3 Major Concerns for Anisometropia

1. Children developing Amblyopia
2. Induced Prism in Lateral / Vertical Gaze
3. Aniseikonia

Anisometropia

Children Developing Amblyopia

Occurs when one eye is rarely / never used

Examples:

OD: +4.00
OS: Plano

OD requires more accommodation at both distance and near

OD: +2.00
OS: +4.00

OS requires more accommodation at both distance and near

Anisometropia

Induced Prism in Lateral / Vertical Gaze

Lateral Prism:

Not a problem in small or moderate amounts

Vertical Prism:

Can be a problem with as little as 1.00D of anisometropia
For typical reading position this creates 1 prism diopter imbalance

Vertical Prism most problematic with presbyopia (trying to look down through bifocal segment)

Anisometropia

Aniseikonia

Unequal Size and / or Shape of retinal image

Optical Characteristics of Lenses

Spectacle Magnification

Shape & Power Factors

$$SM = \left(\frac{1}{1 - \frac{t}{n} P_1} \right) \left(\frac{1}{1 - dP_V} \right)$$

Shape Factor — Power Factor

Where:

t = lens thickness

n = index of lens

P_1 = front surface power

P_V = back vertex power

d = distance from lens to entrance pupil of eye (vertex distance + 3mm)

Optical Characteristics of Lenses

Spectacle Magnification

Iseikonic Lens Design

Shape Factor

Front Surface Power (P1)
Lens thickness (t)
Increasing P1 or t increases magnification (decreases minification)

Power Factor

Back Vertex Power (Pv)
Distance from lens to entrance pupil
Increasing vertex distance increases magnification (plus lens) or minification (minus lens)

Optical Characteristics of Lenses

Spectacle Magnification

Iseikonic Lens Design

Parameters we can manipulate to change SM:

Front Surface Power (P1)
Lens thickness (t)
Vertex Distance

For Most Plus Lens:

Decrease Magnification:

Decrease Base Curve (flatten)
Decrease Lens Thickness
Decrease Vertex Distance

For Most Minus Lens:

Increase Magnification:

Increase Base Curve (steeper)
Increase Lens Thickness
Increase Vertex Distance

Lens Materials & Standards

Characteristics of Lens Materials

Refractive Index
Dispersion
Specific Gravity

Impact Resistance

Physical Characteristics of Lenses

Lens Materials

Refractive Index & Dispersion

$$n_d = \frac{velocity\ of\ helium\ light\ in\ a\ vacuum}{velocity\ of\ helium\ light\ in\ an\ optical\ medium}$$

Dispersion (chromatic aberration) is determined by index
higher index: more dispersion
measured using Abbe Value: higher is better optical quality

Common Lens Materials:

Crown Glass (n = 1.523, Abbe Value = 59)
CR39 (n = 1.49, Abbe Value = 58)
Polycarbonate (n = 1.586, Abbe Value = 29)
Trivex (n = 1.53, n = 45)

Physical Characteristics of Lenses

Lens Materials

Specific Gravity

Specific Gravity gives an indication of the weight of a lens
higher Specific Gravity: heavier lens

Specific Gravity: ratio of lens material to water

Common Lens Materials:

Crown Glass (specific gravity: 2.54)
CR39 (specific gravity: 1.32)
Polycarbonate (specific gravity: 1.22)
Trivex (specific gravity: 1.11)

Impact Resistance

Impact Resistance varies between lens materials

Glass (must be tempered)

- Thermal Tempering
- Chemical Tempering
- Increase impact resistance by increasing thickness

CR 39 Plastic

- Increase impact resistance by increasing thickness

Polycarbonate / Trivex

- More impact resistant than CR 39
- Can use thinner lenses for dress eyewear
- Use thicker lenses for safety applications

Impact Resistance

FDA requires ALL prescription spectacle lenses to be impact resistant enough to pass drop ball test

Higher impact resistance standard for safety eyewear then for dress eyewear

Dress eyewear: 5/8 inch steel ball (0.56oz) dropped 50 inches

Safety eyewear: 1 inch steel ball (2.4oz) dropped 50 inches

Impact Resistance

Impact Resistance varies between lens materials

Any coating applied to a lens will DECREASE its impact resistance

Coatings are harder than the lens material and therefore more likely to shatter and cause lens to break

Polycarbonate and Trivex are more impact resistant than Glass and CR 39 because they are softer materials

They absorb impact and become deformed, but not shattered

Properties of Ophthalmic Lenses

Physical Characteristics

Optical Characteristics

Physical Characteristics of Lenses

Geometry of Lens Surfaces

Spherical
- Same radius of curvature at every point on the surface

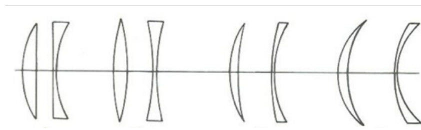
Cylindrical
- Two radii, one is infinite
- Two surface powers, one is plano

Toric
- Two radii, neither is infinite
- Two surface powers, neither is plano

Aspheric
- Literally: not spherical
- Radius of curvature varies from center to periphery of lens

Physical Characteristics of Lenses

Base Curve (Lens Form)



Base Curve: the least plus power on front surface of spectacle lens

Lens Form: the relationship between front and back surfaces of spectacle lens

Physical Characteristics of Lenses

Lens Form

Plano / Convex
Plano / Concave
Biconvex
Biconcave

Meniscus

Front Toric (plus cylinder design)
Back Toric (minus cylinder design)
Bitoric

Physical Characteristics of Lenses

Lens Form: Modern Spectacle Lens Design

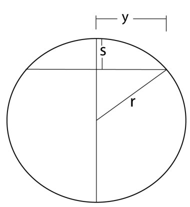
Meniscus Design
Plus Spherical Front Surface
Minus Spherical/Cylindrical Back Surface

Exceptions: Eikonic Lens Designs

Physical Characteristics of Lenses

Lens Form Influences:

Optical Quality (aberrations)
Thickness (flatter lenses are thinner)
Cosmetic Appearance (reflections and thickness)



Approximate Sag Formula

$$s = \frac{y^2}{2r}$$

Physical Characteristics of Lenses

Why do we care about sagittal depth?

1. Provides a way to estimate lens power (Lens Clock)

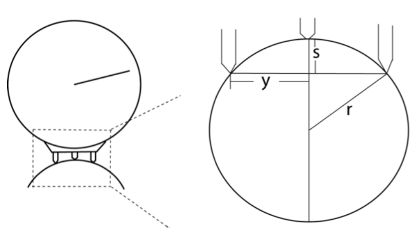
2. Influences lens thickness

Physical Characteristics of Lenses

Lens Clock

Estimate surface power
Direct measurement of sagittal depth

$$P = \frac{2(n-1)s}{y^2}$$



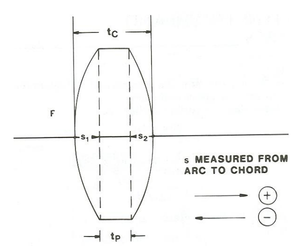
Physical Characteristics of Lenses

Lens Thickness

$$ET = CT - S_1 + S_2$$

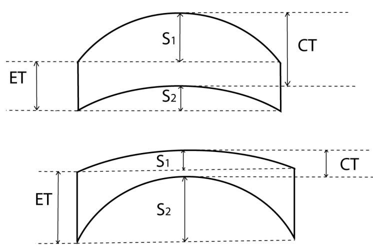
Influences:

Power
Base Curve
Lens Diameter
Index
Minimum Thickness
Center Thickness for Minus
Edge Thickness for Plus



Note that s_1 is + and s_2 is -

Physical Characteristics of Lenses



$$ET = CT - S_1 + S_2$$

Physical Characteristics of Lenses

Power: increase power, increase thickness

Base Curve: flatten base curve, decrease thickness

Diameter:* decrease diameter, decrease thickness

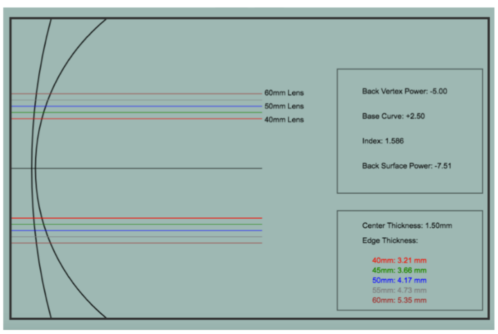
Index: increase index, decrease thickness

Decrease Minimum Thickness:* decrease thickness

Example: use Trivex (allows 1.0mm CT on minus)

* Significant impact

Physical Characteristics of Lenses



Physical Characteristics of Lenses

Example: Rx: -5.00DS Diameter: 60mm

Edge Thickness

CR 39: 6.8mm

High Index (1.70): 5.42mm

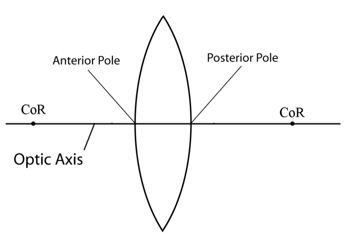
Polycarbonate: 5.35mm

CR 39 and 1.70 lenses use 2.2mm CT
Polycarbonate use 1.5mm CT

Optical Characteristics of Lenses

Major Reference Points

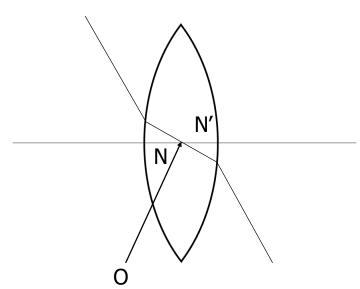
Optic Axis & Lens Poles



Optical Characteristics of Lenses

Major Reference Points

Optic Center & Nodal Points

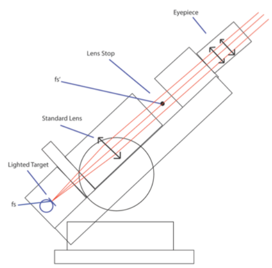


Optical Characteristics of Lenses

Verification of Lens Prescriptions: Lensometer

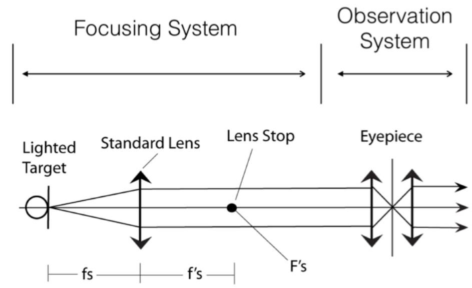
Consists of two basic elements:

- Focusing System
  - Lighted Target
  - Standard Lens
  - Lens Stop
- Observation System
  - Keplerian Telescope



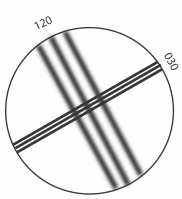
Optical Characteristics of Lenses

Verification of Lens Prescriptions: Lensometer



Optical Characteristics of Lenses

Verification of Lens Prescriptions: Lensometer



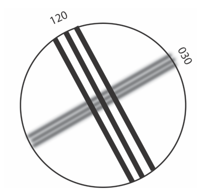


Image is in focus 090 degrees from meridian being measured:

Sphere is in focus (left image) at +1.00D (power in 120 = +1.00)
Cylinder in focus (right image) at -1.00D (power in 030 = -1.00)

Rx: +1.00 -2.00 x 120

Optical Characteristics of Lenses

Verification of Lens Prescriptions: Lensometer

Amount of target movement determined by power of lens:

$$x_S = f_S^2 P_V'$$

Xs = movement of light target

f_S^2 = focal length of standard lens

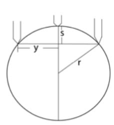
P_v' = back vertex power

Example: x_s = +2.5mm for +20D standard lens and a +1.00D "unknown" lens

Optical Characteristics of Lenses

Verification of Lens Prescriptions: Lens Gauge

Determine **surface power** by measuring sagittal depth



$$P = \frac{2(n-1)s}{y^2}$$

Can determine:

Approximate Power: P1 + P2
Cylinder Power: difference between meridians on back surface
Add Power: difference in front surface powers of lens and segment
Slab Off Prism: difference in reading for distance portion vs reading at slab off line (typically top of segment)

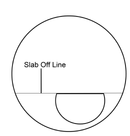
Optical Characteristics of Lenses

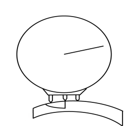
Verification of Lens Prescriptions: Lens Gauge

Measuring Slab Off Prism

Compare lens clock reading in vertical meridian for distance portion of lens to lens clock reading at slab off line

Difference in diopters is amount of prism in prism diopters

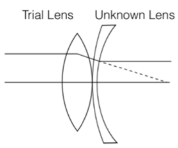




Optical Characteristics of Lenses

Verification of Lens Prescriptions: Hand Neutralization

Measuring Neutralizing (Front Vertex) Power



Neutralize motion seen through lens

Lens power is same magnitude but opposite sign of neutralizing lens

With Motion: net minus for lens combination

Against Motion: net plus for lens combination

Optical Characteristics of Lenses

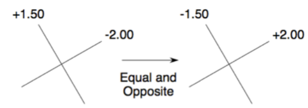
Verification of Lens Prescriptions: Hand Neutralization

Measuring Neutralizing (Front Vertex) Power

Example

What is front vertex power:

Neutralizing lenses: -2.00 @ 030 / +1.50 @120

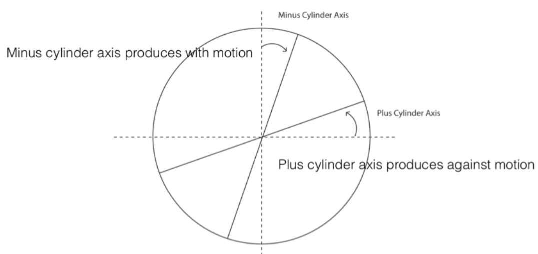


+2.00 = –3.50 x 30

Optical Characteristics of Lenses

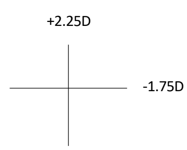
Verification of Lens Prescriptions: Hand Neutralization

Identify principal meridians by rotating the lens



Optical Characteristics of Lenses

Writing & Transposing Lens Prescriptions



In minus cylinder:

Sphere: most plus power (+2.25)
Cylinder: difference between powers (-4.00)
Axis: most plus meridian (090)

Rx: +2.25 -4.00 x 090

Optical Characteristics of Lenses

Writing & Transposing Lens Prescriptions

Cylinder Transposition in Three Steps

1. Add the sphere and the cylinder powers to obtain the new sphere power

2. Change the sign of the cylinder

3. Rotate the cylinder 090 degrees

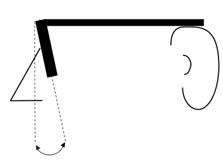
Example: Plus cylinder form: -2.50 +0.50 X 090
What is minus cylinder form?

1. –2.50 + (+0.50) = -2.00
2. +0.50 becomes –0.50
3. 090 + 090 = 180

Result: -2.00 –0.50 X 180

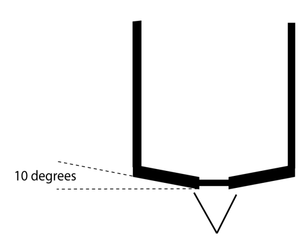
Optical Characteristics of Lenses

Effect of Lens Tilt



Pantoscopic Tilt

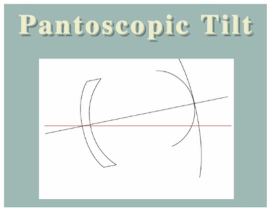
Positive Face Form



Optical Characteristics of Lenses

Effect of Lens Tilt

Introduces Oblique Astigmatism



Sphere Power Increase (very small)

Introduction of Astigmatism

Plus Sphere creates Plus Cylinder
Minus Sphere creates Minus Cylinder

Axis is same as axis of rotation
Pantoscopic (Retroscopic) Tilt: axis 180
Face Form (positive and negative): axis 090

Optical Characteristics of Lenses

Effect of Lens Tilt

New Sphere Power

$$S' = S_O\left[1 + \frac{\sin^2\alpha}{2n}\right]$$

Cylinder Power

$$C' = S'\tan^2\alpha$$

Optical Characteristics of Lenses

Effective Power

Two Considerations:

Need to change lens power as vertex distance changes

Accommodative demand changes for near objects as vertex distance changes

Optical Characteristics of Lenses

Effective Power

Due to effectivity:

Minus lens becomes more minus when vertex distance decreases
Plus lens becomes less plus (more minus) when vertex distance decreases

To compensate:

Minus Powered CL: decrease Rx compared with spectacle Rx
Plus Powered CL: increase Rx compared with spectacle Rx

Happens for ALL powers, clinically significant at +/- 4.00D

Optical Characteristics of Lenses

Effective Power

$$P_{COMP} = \frac{P}{1 - dP}$$

$$P_{CL} = \frac{P_{SPEC}}{1 - dP_{SPEC}}$$

d (vertex distance) is positive for movement toward the eye and negative for movement away from the eye

To find Spec Rx (given CL Rx:

$$P_{SPEC} = \frac{P_{CL}}{1 + dP_{CL}}$$

Optical Characteristics of Lenses

Effective Power

Due to effectivity:

Compared to emmetropia:

Myopes have lower demand for accommodation with spectacles

Hyperopes have a higher demand for accommodation with spectacles

All Contact Lens wearers have the **SAME** accommodative demand as emmetropes

Therefore:
Myopes accommodate more with CLs
Hyperopes accommodate less with CLs

Optical Characteristics of Lenses

Spectacle Lens Processing

Lens Manufacturing

Most lenses are initially fabricated as lens blanks by a lens manufacturer

Two Types of Lens Blanks

Finished Blank
- front and back surfaces are finished (ground and polished)
- have final power for Rx
- have to be edged to fit frame
- ex: single vision sph and common sph + cyl combinations

Semi Finished Blank
- front surface is finished (base curve)
- back surface needs to be ground and polished
- then edged to fit frame
- ex: bifocals, high Rx lenses, sph + cyl (because of orientation)

Optical Characteristics of Lenses

Spectacle Lens Processing

Surfacing: grind correct curve and polish surface

Edging: cut lenses to correct shape and size and finish edge

Frame Measurements & Specifications

Physical Characteristics

Measurements/Specification

Considerations for High Prescriptions

Physical Characteristics & Biological Compatibility of Frame Materials

Plastics

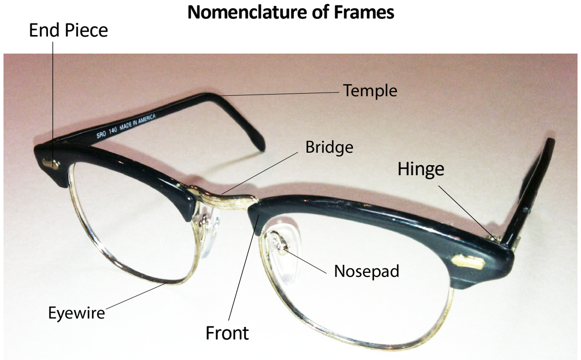
Also called zylonite (zyl)

- Cellulose Acetate
- Cellulose Acetate Proprionate
- Blended Nylons
  - Polyamides
  - Co-polyamides
  - Gliamides

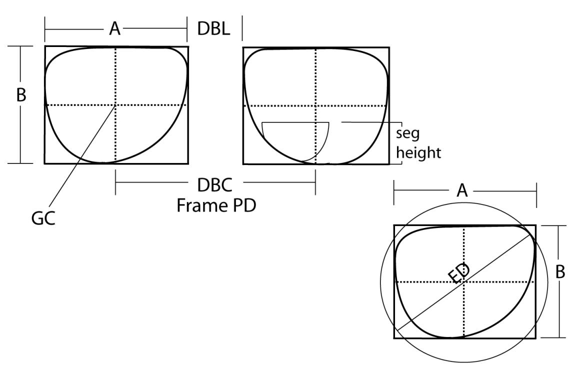
Metals

- Monel (alloy)
  - May contain nickel (allergy potential)
  - Plate with palladium or other nickel free material
- Titanium
  - Lightweight
  - Durable
  - Corrosion resistant
  - Hypoallergenic

Fitting, Adjustment, Specification, and Nomenclature of Frames



Fitting, Adjustment, Specification, and Nomenclature of Frames



Optical & Frame Considerations: High Rx Lenses

Optical Considerations

Consider the factors that determine lens thickness

Lens Diameter
Index of Refraction
Minimum Thickness
Base Curve
Lens Prescription

Problems with High Rx Lenses:
Prism in lens periphery

Minus
Edge Thickness / Multiple Ring Effect
Plus
Center Thickness
Magnification
Ring Scotoma

Optical & Frame Considerations: High Rx Lenses

Frame Considerations

Choose a frame that has a Frame PD = Patient PD
This eliminates the need for decentration (assuming no prism in Rx)

Smaller Eye Sizes
Lens diameter has more effect on lens thickness than any other factor

For High Minus
Consider plastic frames
Hide the edges
Reduce / eliminate the multiple ring effect
Don't choose frames wider than patient's face

For High Plus
Frame with adjustable nose pads
Reduce vertex distance (reduces magnification)

Multifocal Spectacle Correction

Types

Segment Center Locations

Image Jump

Total Displacement

Placement of Optical Centers

Segment Height & Placement

Multifocal Lenses

Types

Fused

All glass multifocal segments are fused except the glass executive bifocal/trifocal

Achieve add power through a change in index of refraction
Index of segment is higher than index of lens

Multifocal Lenses

Types

One Piece

All plastic multifocal segments are one piece
Glass executive multifocal segments are one piece

Achieve add power with a change in curvature of front surface between main lens and segment

Multifocal Lenses

Types

Progressive Addition Lenses

PALs are a special case of one piece multifocal design

Use continuous change in curvature from distance portion of the lens to the full add portion

PALs are "aspheric" in that they are not spherical surfaces

Multifocal Lenses

Types

Progressive Addition Lenses

Usually have characteristics of either:

Hard Design

Larger Near Portion
Harsh Contours (more unwanted astigmatism)
Shorter Corridor

Soft Design

Small Near Portion
Softer Contours (less unwanted astigmatism)
Longer Corridor

Multifocal Lenses

Types

Progressive Addition Lenses

Usually have characteristics of either:

Hard Design

Better for patient who is “eye mover”
Due to wider reading portion

Soft Design

Better for patient who is “head mover”
Due to less unwanted astigmatism

Multifocal Lenses

Types

Progressive Addition Lenses

There are many specialty PAL designs

Designed for computer/intermediate use
Designed for smaller B (vertical) frame dimensions

Multifocal Lenses

Types

Blended Bifocals

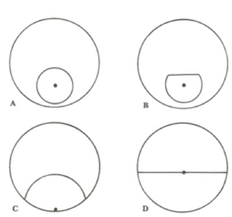
Rarely used

Unlike PAL, there is no functional advantages, only cosmetic

Include areas of unwanted astigmatism

Multifocal Lenses

Segment Center Locations



Multifocal Lenses

Differential Displacement (Image Jump)

Image jump is the prismatic effect at the top of the segment

Amount of image jump is found using Prentice’s Rule

Image Jump = (dist to seg OC) x (add power)

Example: image jump from FT35 +2.00 Add

Image jump = (0.5)x(2.00) = 1.0 prism diopter, base down

Image jump is always base down if present

No Image Jump:

Executive Bifocal & PAL

Multifocal Lenses

Total Displacement (vertical)

Prismatic effect in downgaze at the reading level (RL)

Combine prism from distance Rx and prism from near Rx

Prentice's Rule (twice)

Once for distance:
Prism from distance = (dist from OC to RL)x(Dist Rx vert meridian)

Once for near:
Prism from near = (dist from seg OC to RL)x(Add Power)

Multifocal Lenses

Total Displacement (horizontal)

Prismatic effect in downgaze at the reading level (RL)

Combine prism from distance Rx and prism from near Rx

Prentice's Rule (once if segment inset correct)

Once for distance:
Prism from distance = (dist from OC to LOS)x(Dist Rx horiz meridian)

If segment inset is **not** correct (add):

Once for near:
Prism from near = (dist from seg OC to LOS)x(Add Power)

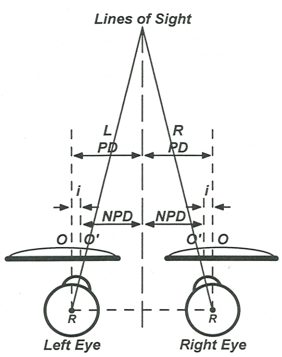
Multifocal Lenses

Placement of Optical Centers

Lateral Placement

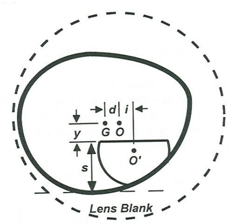
Distance: Distance PD

Near: Inset: (Dist PD – Near PD)/2



Multifocal Lenses

Placement of Optical Centers



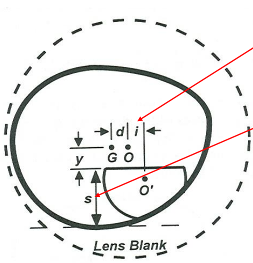
Vertical Placement

Distance: ½ B dimension

Near: determined by seg type and height

Multifocal Lenses

Specifying Segment Height & Placement



inset

Segment Height

Segment Height

Bifocals are typically fitted at lower limbus/lower lid margin

Trifocals are typically fitted higher than bifocal (lower pupil margin)

Tints & Absorptive Coatings

Specification of Lens Tints & Coatings

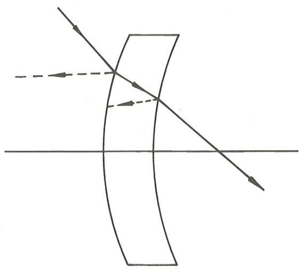
Characteristics of Photochromic Lenses

Relationship Between Lens Thickness & Spectral Transmission

Special Occupational Requirements

Absorptive Lenses

Specification of Lens Tints & Coatings



Absorptive Lenses

Specification of Lens Tints & Coatings

Transmission of a simple lens:
- Transmission = Incident – Reflected – Absorbed

Transmission of a Lens System
- The product of individual lens transmissions
- $T = T_1 T_2 T_3 \ldots$

Transmission should be specified as percent Transmission

Absorptive Lenses

Specification of Lens Tints & Coatings

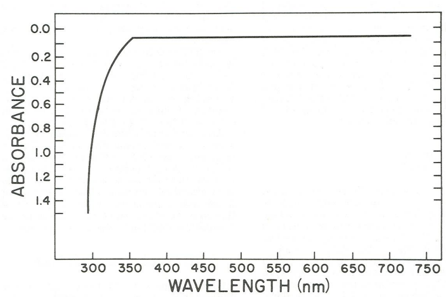
Selective Absorption

Apparent color of lens is a result of the transmission of visible light through the lens

A green lens transmits more green light than any other color

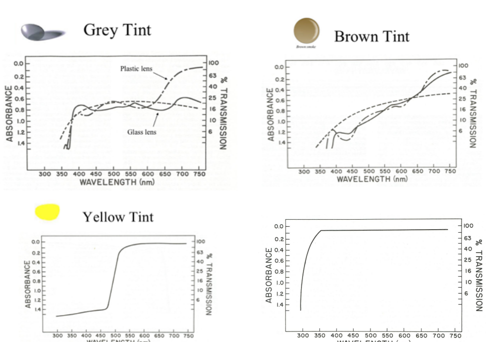
Absorptive Lenses

Specification of Lens Tints & Coatings



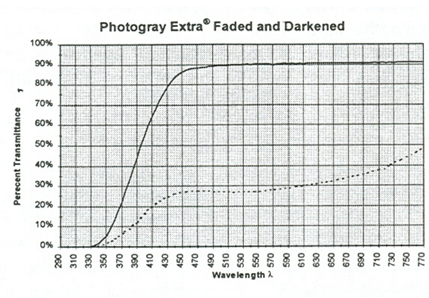
Absorptive Lenses

Specification of Lens Tints & Coatings



Absorptive Lenses

Characteristics of Photochromic Lenses



Absorptive Lenses

Characteristics of Photochromic Lenses

Transmission is affected by:

Intensity of Incident Light
Wavelength of Incident Light
Temperature
Length of Exposure

Absorptive Lenses

Relationship Between Lens Thickness & Spectral Transmission

Optical Density

Optical Density is a way of expressing the transmission of light through a lens or filter.

Once the density is known for a given thickness, the density of any thickness can be determined by use of proportion.

Optical Density = $-\log_{10}T$

The density for a lens consists of:

2 surface densities (based on reflection)
Media density

Absorptive Lenses

Relationship Between Lens Thickness & Spectral Transmission

Optical Density

For a lens with absorptive tint incorporated into the lens material (this is the case for most glass lenses), the transmission will vary across the lens depending on its thickness.

Minus lenses appear darker in the periphery
Plus lenses appear darker in the center

For plastic lenses, tint is usually applied after manufacturing and lenses absorb the tint evenly across the lens without regard for thickness and so tints appear uniform across the lens.

Absorptive Lenses

Special Occupational Requirements

Typical Occupational Application of Absorptive Lenses

Welding

Use very dark (low transmission) gray lenses
- Concern about high UV exposure
- And high levels of visible radiation

IR Exposure

Glass Work
- Work with molten glass

Blast Furnace
- Industries with molten metal

Use Therminon tint (blue-green)