Welcome!!!

Basic Optics:
Refractive Error and How Spectacle Lenses Correct It

Course Objectives

To review the basic elements of refractive error, and demonstrate how spectacle lenses correct them.

To present an overview of common lens design and material properties that impact physical & visual performance of today's spectacle lenses.

Basic Anatomy

The human eye works somewhat like a micro-magnifying glass...

...which is why you should never stare at the sun!

Emmetropia - When All is Well

Hyperopia - “Far Sighted”
Plus Power Corrects Hyperopia

Sample RX: +6.00 Sphere

Developed by Susan I. Klacik, ABOC

Myopia - “Near Sighted”

Sample RX: -6.00 Sphere

Developed by Susan I. Klacik, ABOC

Minus Power Corrects Myopia

Sample RX: -6.00 Sphere

Developed by Susan I. Klacik, ABOC

Astigmatism -- Lack of Focus

Sample RX: PL -4.00 x 45

Developed by Susan I. Klacik, ABOC

Astigmatism -- Lack of Focus

Developed by Susan I. Klacik, ABOC

Cylinder Power Corrects Astigmatism

Sample RX: PL -4.00 x 45

Developed by Susan I. Klacik, ABOC
**Presbyopia -- “Short arms”**

Loss of Accommodative Power

**Multifocals Correct Presbyopia**

**Anatomy of a Spectacle Lens**

**Lens Properties**

- Physical properties of lens materials
- Visual properties of lens materials

**Physical Properties**

- Size and Shape
- Index of refraction
- Curvature & Thickness
- Impact resistance
- Specific Gravity
- Tensile Strength
- Chemical Compatibility

**Visual Properties**

- Abbe Value
- Chromatic Aberration
- UV Protection
- Yellow Index
- Transmission of light
- Anti-Reflective
- Chemical Compatibility

The Index of Refraction

Indicates the refractive efficiency of a material.

The higher the index, the more a material deviates light.

To calculate, divide the speed of light in a vacuum by the speed of light as it passes through the material.

1.498 index of refraction CR-39

The Index of Refraction

Combined with lens thickness and curvature work together to create a prescribed lens power.

**Vertex Distance** may also alter the effective power of a prescription lens.

-2.00D

1.498 index of refraction

-5.00D sphere

2 mm CT
**What Makes High Index Thinner?**

- HIGH index materials refract light more efficiently.
- Less curve is required to achieve the same RX.
- Results in thinner lenses for most prescriptions.

**Smaller Frames = Thinner Lenses**

- Smaller frames lead to thinner lenses.
- Manufacturers are reducing center thickness to create a popular trend.
- “Cushion Coat” allows finished materials to pass the FDA drop ball test at 1.0mm CT.

**Specific Gravity (Weight)**

- Specific Gravity is a measure of material weight.
- The lower the specific gravity, the lighter the lenses will be.
- Many new ophthalmic lens materials were developed to be inherently light weight.

**Impact Resistance**

- “Star Fracture” indicates impact resistance.
- “Star Fracture” is especially important for drill mounted frames.

**Tensile Strength**

- Lenses are drilled in various manners to replicate many different drill mount chassis.
- Pull-pressure is applied until the lens material fractures and breaks away.
- Tensile Strength is measured in Kilograms of pull pressure – to the point the material fails.
**Chemical Compatibility**

You must consider the influence of patient’s environment:
- Acetone
- Alcohol
- Cleaning agents

**How Physical Properties of Materials Stack Up**

<table>
<thead>
<tr>
<th>Material</th>
<th>Index of Refraction</th>
<th>Tensile Strength</th>
<th>Heat Resistance</th>
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<tr>
<td>Glass</td>
<td>1.523</td>
<td>90 kg</td>
<td>140º C</td>
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<tr>
<td>CR-39®</td>
<td>1.498</td>
<td>1.20 Polycarb</td>
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<td>Trivex®</td>
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<td>1.17 Sunsensors®</td>
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<td>Spectralite®</td>
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<td>Essilor®</td>
<td>1.740</td>
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**Anatomy of a Spectacle Lens**

**Physical Properties**
- Manufacturing
- Index of Refraction
- Impact resistance
- Specific Gravity
- Tensile Strength
- Chemical Compatibility

**Visual Properties**
- Abbe Value
- Chromatic Aberration
- UV Protection
- Yellow Index
- Transmission of light
- Anti-Reflective Properties

**Abbe Value**

Measure of dispersion

Dispersion separates white light into color components because different wave-lengths of light are refracted at different speeds.

**Chromatic Aberration**

Contributing Factors:
- LOW Abbe Value
- High Power > +2.00 or -3.00
- Prism

Patient Symptoms:
- Peripheral vision seems less “sharp” or “crisp”
- Blurred vision (as compared to previous glasses worn)
- Color distortions (white objects appearing yellow)

**LOW Abbe Value Can Result in Unwanted Color Aberrations**

<table>
<thead>
<tr>
<th>Material</th>
<th>Index of Refraction</th>
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</thead>
<tbody>
<tr>
<td>Hoya MR10</td>
<td>1.670</td>
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<tr>
<td>Hoya MR8</td>
<td>1.600</td>
</tr>
<tr>
<td>Transitions®</td>
<td>1.537</td>
</tr>
<tr>
<td>Spectralite®</td>
<td>1.537</td>
</tr>
</tbody>
</table>
Studies show Ultra-violet and High Energy Visible light can affect eye and overall physical health.

All plastic materials contain UV inhibitor while only some materials contain HEV inhibitor.

The Effect of Light Transmission on Visual Performance

Without visible light we would all be blind!

Quality of Vision is directly proportional to the level of light transmitted to the eye (est. 20/40 night driving)

The more light that reaches the back of the eye, the sharper our measurable visual acuity.

Transmission of Light

Most high index materials reflect more light than standard plastic or glass.

Maximum light transmission is necessary to produce the best visual acuity.

Recommend A/R coating on all high index materials.

Anti-Reflective Treatment

Anti-Reflective treatment is the most effective thing you can prescribe to improve your patients' visual acuity.

The lenses used in the exam lane to determine a patient's refractive error are A/R treated!

How Visual Properties of Materials Stack Up

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Course Objectives Met?