Objectives

At the end of this course the learner will be able to:

- Define anti-reflective and blue light treatment.
- Comprehend how anti-reflective and blue light treatment is applied to a spectacle lens.
- Explain how anti-reflective and blue light treatment achieve their desired function.
- Comprehend how anti-reflective and / or blue light treatment can positively and / or negatively affect visual comfort.

1

Definition

What is anti-reflective treatment?

2

Anti-Reflective Treatment

What is it?

- Anti-reflective is a treatment placed on a spectacle lens intended to reduce reflections induced by that lens.
- It allows more available light to pass through the spectacle lens that can be used for vision.

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Anti-Reflective Treatment

What is it?

- ANSI Z80., Section 6.1.6.1 states:
  - Anti-reflective treatment may reflect no more than 2.5% of the incident light striking the surface of the lens.

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Anti-Reflective Treatment

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Application

How is it anti-reflective applied to a lens?

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Application

Step 1 – Hard Coat

Dip Coat (Front & Back) – The lens is cleaned through a series of chemical baths to remove the factory hard coat, and then a specialty hard coat is applied.

Spin (Back only) – The lens has a hard coat applied from the factory which is left in place.

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Dip & Spin Coat - Pros

Dip **Spin**

8

Dip & Spin Coat - Cons

Dip **Spin**

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Application

Act as a primer for adhesion.

Provides scratch-resistance & durability.

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Application

Step 2 – AR

Chemicals are loaded into the crucible.

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Application

Step 2 – AR

Lenses are loaded into the carrier.

Generally contains 120 lenses or 60 pairs.

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Application

Step 2 – AR

Vacuum brings atmosphere to zero gravity.

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Application

Step 2 – AR

Laser super heats each chemical, causing it to vaporize.

The chemical vapor adheres to the lens.

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Application

Step 2 – AR

The process of chemical application repeats until the desired ‘stack’ is achieved.

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Application

Step 2 – AR

The lenses are then brought out of the AR coater and the process is re-started.

This time, each lens is flipped in the carrier so the opposite side will receive the AR coat.

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How Does it Work

How does anti-reflective neutralize lens reflections?

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How Does it Work?

White light – Made up of component colors, each consisting of a specific wavelength.

Each wavelength will produce a reflection.

Since we know the wavelength of the component color, we also know the wavelength of the reflection.

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How Does it Work?

Destructive Interference –

Using destructive interference for each color, anti-reflective treatment can neutralize reflections from the surface of the lens.

Allows light energy to pass through the lens freely.

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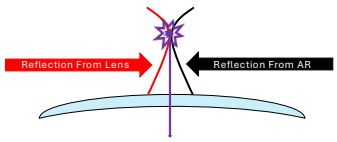
How Does it Work?



Destructive Interference

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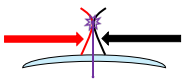
How Does it Work?

1. Ambient light strikes the front of the lens
2. The red component portion of the white light contacts the layer in the AR stack for red
3. From that layer, a reflection is produced *out of phase* with the light reflecting off the lens
4. The crest of one reflection strikes the trough of the other, collide with each other, and destruct



Destructive Interference

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How Does it Work?

Lens reflections are proportional to the index of refraction.

The reduction of reflections becomes more important as the index of refraction increases.

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How Does it Work?

Reflex color

The AR stack determines reflex color

- Green reflex color = not all green is neutralized
- Blue reflex color = not all blue is neutralized

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How Does it Work?

What about the back of the lens?

Some anti-reflective treatments go beyond the visible spectrum to neutralize reflections from ultraviolet (UV) light.

This is how anti-reflective treatment provides UV protection.

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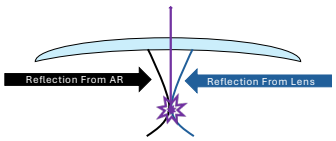
How Does it Work?

Backside UV Protection



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Blue Light Treatment

How does a blue light treatment eliminate blue light?

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Blue Light Treatment

Blue light lenses reduce blue light exposure by:
- Filtration
- Reflection

Filtration is accomplished by the lens material

Reflection is accomplished by the treatment

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Blue Light Treatment

Destructive vs. Constructive Interference

Destructive =

Constructive =

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Blue Light Treatment

Blue light protection offered by 'reflecting' blue light

Observation of reflection will alert to the portion of blue light being targeted

- **Blue-violet** reflections indicate blue light closer to the lower end of the blue light spectrum, or nearer 400nm
- **Blue-indigo** reflection indicates blue light closer to mid-range of the blue light spectrum, or nearer 450nm

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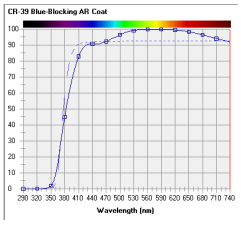
Blue Light Treatment

Blue light treatments do not meet the definition of anti-reflective treatment.

Reflectance is the opposite of transmittance.



Darryl Meister's Spectacle Optics

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Anti-Reflective Treatment & Photochromic Lenses

How does anti-reflective treatment influence photochromic lenses?

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AR & Photochromic Lenses

What is the influence of AR on a photochromic lens?

Positive?

- Does AR help a photochromic lens to perform better, in all wearing conditions?

Negative?

- Can AR on a photochromic lens hinder its performance?

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AR & Photochromic Lenses

Photochromic properties are applied to lenses by one of three methods:

- Embedded
- Imbibed
- Film

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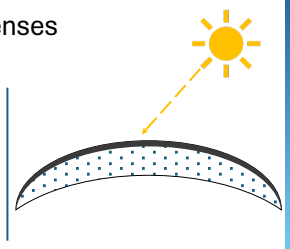
AR & Photochromic Lenses

Embedded:

- Photochromic molecules are added to the lens material
- Once activated, they become UV inhibitive
- Creates a uniform color, regardless of Rx



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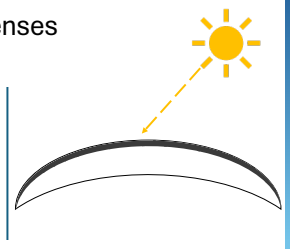
AR & Photochromic Lenses

Imbibed:

- Photochromic molecules are applied to the front surface of the lens
- Creates a uniform color, regardless of Rx



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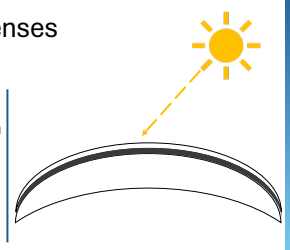
AR & Photochromic Lenses

Film:

- Photochromic molecules are applied via a photochromic film
- Used for polycarbonate lenses
- Creates a uniform color, regardless of Rx



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AR & Photochromic Lenses

All methods require UV *and* ambient light.
More considerate of the ambient light exposure.

Pro	Con
• Can increase the effectiveness of 'works in the car' variations	• The 'works in the car' variations may get too dark
• Helps in low-light conditions • Cloudy, shade, etc.	• Cold weather and high UV conditions may make regular photochromic lenses too dark

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Anti-Reflective Treatment & Polarized Lenses

How does anti-reflective treatment influence polarized lenses?

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AR & Polarized Lenses

What is the influence of AR on a polarized lens?

Positive?
- Does AR help a polarized lens to perform better, in all wearing conditions?

Negative?
- Can AR on a polarized lens hinder its performance?

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AR & Polarized Lenses

When recommending a polarized lens, one goal is to decrease the amount of ambient light that reaches the eye.

- Increases visual comfort
- Decreases eye strain
- Polarization decreases bright reflected light

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AR & Polarized Lenses

When recommending a polarized lens, our ***main*** goal is to decrease the amount of UV light that reaches the eye.

- Increases UV protection for the eye and surrounding skin of the lids
  - Large lenses
  - Wrap frames
  - UV filtering lens material

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AR & Polarized Lenses

Ambient Light

- When reflecting off your eye and cheek, creates an annoying reflection on the back of the lens
- Greatly decreases wearing comfort

AR on the back of a polarized lens increases wearing comfort by eliminating annoying reflections.

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AR & Polarized Lenses

Ambient Light

- When contacting the front of the lens, AR will allow more ambient light to pass through the lens.
- This decreases the light filtration of the lens

AR on the front of a polarized lens may decrease wearing comfort by allowing too much light through the lens.

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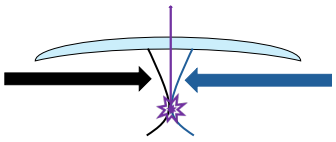
How Does it Work?

Backside UV Protection



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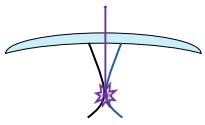
AR & Polarized Lenses

- Reduces UV reflections that may contact
  - Cornea
  - Sclera
  - Lids
- Special attention is paid to lids



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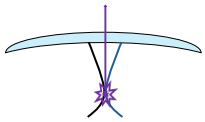
AR & Polarized Lenses

- 20% of UV that strikes the back of a lens contacts the eyelids
- 5% - 10% of all skin cancers occur*



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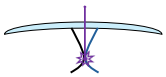
How Does it Work?

Backside UV Protection



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AR & Photochromic Lenses

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