Understanding Absorptive Lenses

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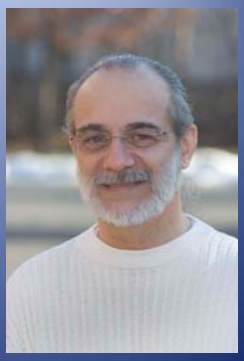


What is Light?

- Many theories that surround what light is
- Corpuscular Theory
  - Sir Isaac Newton
  - Light made up of tiny "corpuscles"
  - Travel in a straight line
  - Supported by a shadow

Wave Theory

The Propagation of Light

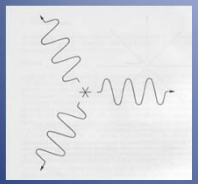
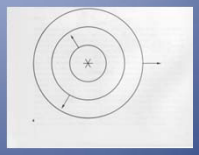


Figure 2: Wavefronts



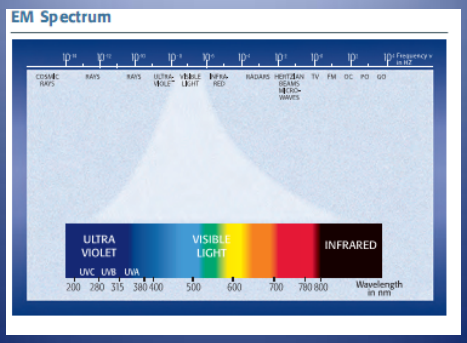
Light and Sight

- Light is a form of electromagnetic (EM) radiations produced by the sun or by physical means such as fire or a light bulb.
- Carried in energy packets called photons
- When photons contact matter, physical and chemical reactions occur
- When light reaches the retina, it stimulates the retinal cells
  - Produces chemical reactions that are converted to electrical energy
  - Transported to the brain through the optic nerves and visual pathway
  - Visual cortex of the brain receives electrical impulses where the sensation of sight occurs
- Light is the fundamental element of vision.
  - Without it, vision would be impossible, even with eyes that were perfectly capable of emmetropia

Light and the EM Spectrum

- The Earth's atmosphere is filled with EM wave energy
  - Range from exceptionally long wavelengths to exceptionally short ones
  - Ex. radio waves are meters in length
  - X-rays short (0.1 – 10 nanometers) and high energy. Can penetrate the skin enabling doctors to image the human skeleton
  - Cosmic rays are so short and high energy, they can destroy objects
- The visible spectrum represents a tiny slice of the EM spectrum
- While EM radiations surround us, we only detect a tiny portion of its wavelengths

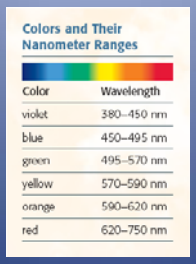
The EM Spectrum



Two Types of Light

- Two types of light radiations, visible and invisible.
- Visible spectrum = 380nm to 760nm
  - Stimulate sight
- When all of these wavelengths are experienced at one time, the viewer sees white
- If a narrow portion is experienced, a particular color is seen
- Major color subdivisions of the eye are violet, indigo, blue, green, yellow, orange and red

Wavelength and Color



Colors and Their Nanometer Ranges

Color	Wavelength
violet	380–450 nm
blue	450–495 nm
green	495–570 nm
yellow	570–590 nm
orange	590–620 nm
red	620–750 nm

Ultra-Violet Light

- UV region = 100nm to 380nm
- This range of invisible light can be subdivided into a UV spectrum.
- UV-V = 100nm to 190nm
  - Filtered by the earth's ozone layer and consider harmless
- UV-C = 190nm to 280nm
  - Filtered by the earth's ozone layer and considered harmless
- UV-B = 280nm to 315nm
  - 90% are filtered by the ozone layer but a portion reaches the Earth
    - Considered harmful to the eye
- All UV-A wavelengths reach Earth
  - Are considered harmful to the eye

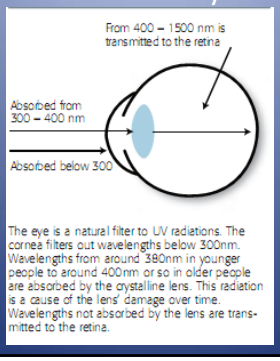
UV Radiations and the Eye

- As the eye ages, the crystalline lens protects the retina from UV damage by absorbing it
- As it does, it becomes a more efficient UV absorber
- It also becomes less clear
- Long-term exposure can cause a cataract to the lens
  - In other words, as the lens absorbs UV light, it exposes itself to potential harm over time

UV Radiations and the Eye con't

- UV-A is mostly absorbed by the crystalline lens
  - Can penetrate much deeper into the eye, where it can damage the retina
- UV-B is primarily absorbed by the cornea
- The eyebrows, orbital bones, eyelids and eyelashes help protect the eyes from UVR penetration
- Although small amounts of UV-A and UV-B reach the inner eye, their high sensitivity and its cumulative effects make these amounts clinically significant

UV Radiations and Ocular Tissue Sensitivity



UV Dangers

- Nearly everyone is exposed to some level of UV during the day
- The greatest source of reflected UV is from snow
  - Followed by water and sand
  - 10 –12 times as much light intensity as desired when on a beach
- Most common UV damage is sunburn
- UV-A is generally associated with the deeper penetrating conditions of the skin such as wrinkling and thickening

UV Dangers con't

- Association between UV exposure and cutaneous malignancy was first described in 1928
  - The same year that sunscreen was introduced
- Scientists demonstrated the cancer-causing effects of UV on the skin of laboratory animals
  - Using both sunlight and artificial light sources
  - Produced by UV-B radiation in the 290nm to 320nm range
    - The same range that produces burning on human skin

UV Dangers con't

- Age-related macular degeneration (ARMD) is a major cause of reduced vision and vision loss for people age 55 and over
  - It is the third leading cause of blindness worldwide
- Thought to occur from long-term intense exposure of the retina to UV light
- Particularly devastating to seniors

UV Affects on Children and Adults

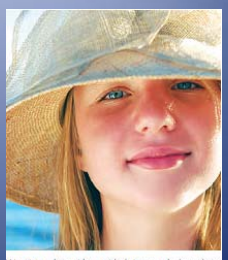
- Everyone is at risk for ocular damage from UV
- Most susceptible
  - Children
  - the elderly
  - persons with light colored or brown irises
  - persons who have had cataract surgery
  - those taking photosensitizing medications
- The crystalline lens of a child under 10 years of age is still relatively clear and does not act as a good UV filter

UV Affects on Children and Adults con't

- 75% of UV radiations pass through a child's crystalline lens directly to the retina
- The average child receives three times the annual UV exposure as an adult
  - This means that kids are more susceptible to exposure from UVR
  - Remember - UVR exposure is cumulative

What Can Be Done To Protect Against UVR Damage?

- Control exposure and exposure levels. For
- Wear a broad-brimmed hat or a visor
  - It is estimated that this step alone can eliminate 50% of incident light exposure to the eyes and the skin around them



Wearing a hat with a wide brim can help reduce UV light exposure to the eyes significantly by simply blocking the light.

Eyewear and UV Protection

- Wrap-around frame designs offer more coverage and, more protection from UVR.
  - Ex. 13cm^3 surface lens area (about ½ inch square) offers 60 – 65% UV protection for the average eye.
  - Increasing the surface to 20cm^3 (about 4/5 of an inch square) increases the protection to 96%

Wrap-around sunglasses offer more coverage and protection from UV exposure.

What's the purpose of sunglasses?

To avoid glare

Avoiding Glare

- Avoiding glare is a major objective of absorptive lenses
- The annoyance or discomfort of vision, or the impairment of it caused by light levels (luminance levels) in the field of vision higher than the level the eye has adapted to

Four Types of Glare

- Distracting Glare
- Discomforting Glare
- Disabling Glare
- Blinding Glare

Distracting Glare

- Caused by light reflected off lens surfaces
- Caused by internal lens reflections causing ghost images
- May obscure the wearer's view
- Most common form – backside lens reflections
  - Wearer sees their own eye reflected
  - Back surface acts like a concave mirror
- Distracting glare can cause visual discomfort, visual confusion and eye fatigue
- Eliminate using AR treatment

Discomforting Glare

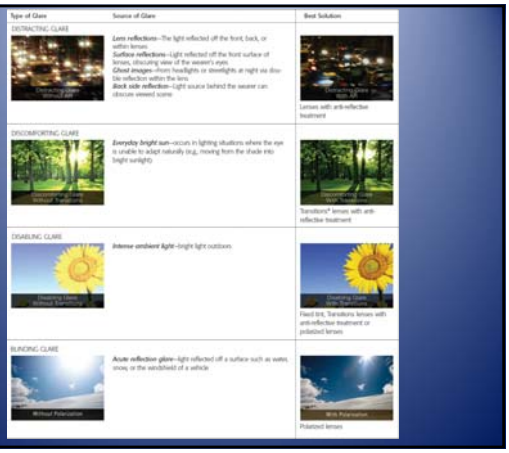
- Caused by either direct or reflected light bright
  - Everyday bright light
  - Person attempts to avoid the glare by blocking it with a hand
  - Can occur in any weather, including overcast days
- Even mild forms can cause discomfort, squinting and/or eye fatigue
- Photochromic lenses best for reducing this type of glare

Disabling Glare

- Light strong enough to interfere with or block vision
  - Also known as veiling glare
- Washes out detail and contrast
- disabling glare is more troublesome for senior citizens
  - Elder eye tends to scatter light more readily due clouding of the crystalline lens
    - (the normal cornea, lens, and vitreous scatter 10%- 20% of incident light)
- Fixed tint, photochromic and polarized lenses are all good recommendations for handling disabling glare.

Blinding Glare

- Occurs as strong incident light reflects off smooth surfaces
  - Example: snow, water, sand or blacktop.
- Can block vision
- Vision can be overwhelmed
- Polarized lenses are the best option



Solving Glare Problems

- Distracting Glare
  - AR treatment
- Discomforting Glare
  - Photochromic lenses
- Disabling Glare
  - Fix tint or photochromic lenses
- Blinding Glare
  - Polarized lenses

Polarized lenses

- When light bounces off of a surface, it can become plane polarized
  - Light that is reflected off of shiny surfaces
- Light in the horizontal is reflected while the light in the vertical is "flattened"
- Filter made of minute particles aligned in rows

Polarized lenses

- Filter is oriented 90° to the reflected light
  - Lenses have a marking so they can be oriented properly
- Vertical light passes through – horizontal light is blocked
- Like a rope and Venetian blinds
- What do you see when you turn a polarized lens 360°?

Polarized lenses vs. tinted lenses

- Tinted lenses reduce brightness
  - Based on the color density
- Alleviate some distracting and discomforting glare
- Do not reduce blinding glare
- Polarized lenses reduce brightness
- Also reduce plane polarized glare (blinding) and disabling glare
- This is why they have become the standard for all outdoor sunwear needs

Is there evidence that certain lens colors enhance performance?

- No, only anecdotal
- Why do so many companies tout certain colors for activities like golf, tennis, boating, etc?
- Can color help some people with certain tasks?
- How do you decide which to use for a task?

Colors

- Grey: Neutral density filter
  - Simply lowers the light level without changing the relative color of objects
- Yellow: Contrast filter
  - Increases the darks and the lights of the world
- Brown, red, orange
  - Absorb blue light and provide contrast enhancement

A Case for Photochromics

- A discussion of photochromics begins with the discussion of the human eye and how it adapts to light
- When eye encounters light, it does three things with it
  - Changes its speed
  - Changes its direction
  - Changes the amount entering the eye

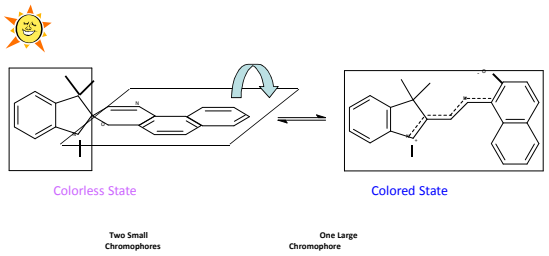
Potential Problems Light Causes The Eye

- Light outdoors is 25 times more power than indoor light
- Bright light & glare can be a problem causing fatigue, headaches and eyestrain
- Night vision may be affected if filters are not worn during the daytime
- UV poses a threat to the long-term health of the eye

The Solution

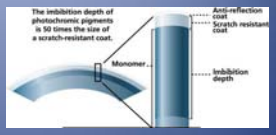
- The way to alleviate these concerns is to
  - Regulate light levels
  - Control glare
  - Protecting the eye from harmful UVR
- How?
  - Use photochromic lenses to recreate natural vision
    - Makes vision sharper, clearer, bolder and more comfortable
    - Photochromic lenses do all of this without any kind of medication for the patient

Molecular Transformation In the Photochromic Process



Imbibition

- Transitions Optical's proprietary surface technologies – Imbibition and Trans-Bonding™
- Imbibition - photochromic compounds driven 0.15mm into the front surface
- Molecules become permanently imbedded into the surface and part of the lens
- Cannot scratch or peel off

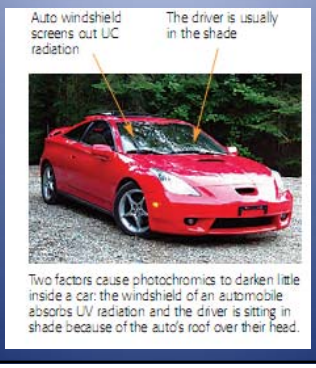


This cross sectional diagram illustrates the relative thicknesses of AR treatment, anti-scratch coating and the photochromic dye depth of the Imbibition process on a lens. Notice how substantially larger the dye depth is to the other two items.

Transbonding

- Some materials are not ideal photochromic substrates
  - Ex. = polycarbonate
- Trans-Bonding used with these
- Applies proprietary surface treatments in a series of layers
  - Provides outstanding adhesion, scratch resistance, optical purity and photochromic performance
- Helps apply Transitions photochromic technology to lens materials previously considered unsuitable

Driving & Photochromic Lenses



Two factors cause photochromics to darken little inside a car: the windshield of an automobile absorbs UV radiation and the driver is sitting in shade because of the auto's roof over their head.

DriveWear

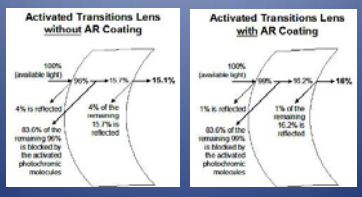
- Known as DriveWear® Activated by Transitions®
- Use Transitions technology and advanced dyes
- Respond to visible light as well as UV light
- They are also polarized using Younger's NuPolar technology

DriveWear con't

- Control light under varying outdoor lighting conditions
  - Because they are activated by UV and natural light
  - Because they use photochromic and polarized lens technology
- They work in …
  - Overcast low light
    - Turn a high-contrast green/yellow
  - Daylight conditions behind the windshield of an automobile
    - Turn a copper color
  - Bright outdoor light
    - Turn a dark reddish brown
- Polarizer is always reducing reflected glare

AR treatment and Photochromic Performance

- Virtually no loss of photochromic ability when an AR treatment is used
- AR treatment makes the photochromic lens even clearer indoors and fights distracting glare



NOTE: There is some attenuation of the photochromic performance due to absorption of the UV by the materials in the AR treatment.

Transitions® VI lenses

- Transitions VI offers consistent performance across all materials
- As clear as regular, hard-coated lenses indoors and at night.
- Become sunglass dark outside (12% transmission in Gray @ 23°C/73°F.
- Faster getting dark, reaching 18% transmission in only one minute

Transitions® VI lenses con't

- Block 100% UVA and UVB
- Provide UV 400 protection
- Compatible with all major AR treatments
- With AR treatment, they are even clearer than hard-coated lenses
- Available in the most popular materials and designs

Transitions Vantage

- Both polarized and photochromic
- Nearly clear indoors, dark to sunglass density outdoors
- Photochromic molecules align in the darkened state to create the polarizing effect
- Don't darken behind a car's windshield

Questions Please

Thanks for Attending!

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