

Optical Lab Knowledge for the Non-Lab Optician.

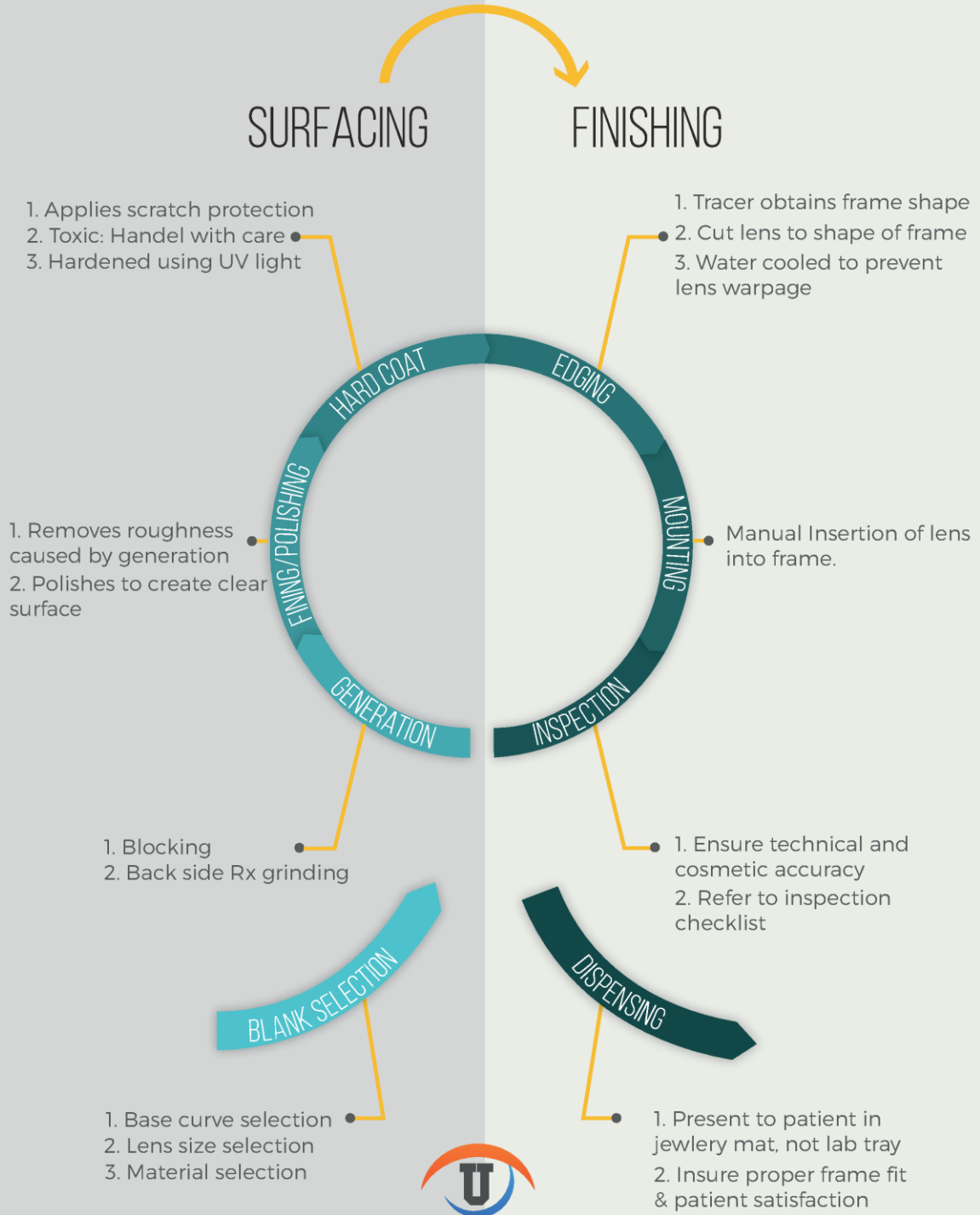
Dispensing opticians and ophthalmic lab technicians unfortunately rarely cross paths. For both, this is unfortunate. Dispensing opticians who know what goes on behind the lab door not only communicate with patients with more authority, it also helps you ask the right questions when calling your lab for assistance. This helps prevent problems from arising both in the lab and on your dispensing floor.

This chapter will discuss the three key processes a dispensing optician should know about what goes on in the lab. 1) Lens fabrication 2) Troubleshooting 3) Lens tinting tips. The purpose of this is not to make you an expert lab technician, but rather to help you become better versed in understanding what goes on behind the lab door.

Lens Fabrication

The lens fabrication process can be divided into two major steps, *surfacing* and *finishing*. Understanding what takes place in each of these steps will help you to understand why certain jobs can be done “in house” and some sent off site. It will also help you foresee challenges lab technicians may face and help you communicate with them regarding these issues. Lab technicians are a wonderful source for information and are typically eager to speak with you about an order. They would much rather you speak with them at the time of placing an order than to have to call you after the fact which will delay the job and threaten customer satisfaction. The following infographic will provide you with a visual map of the lens fabrication process. This chapter will examine each of these steps in further detail.

THE LIFECYCLE OF OPHTHALMIC LENSES

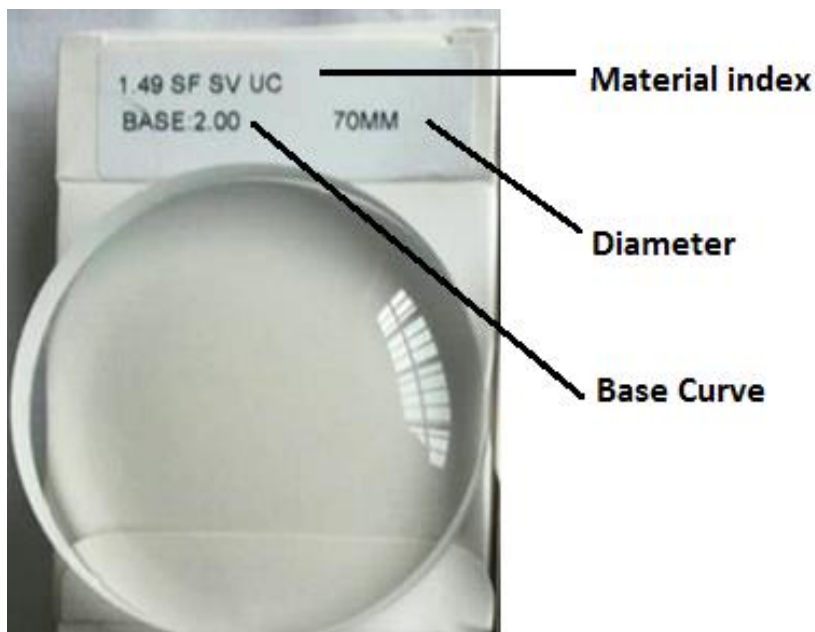


Surfacing

Surfacing is the process by which a prescription is placed onto a lens and preparing its surface prior to being cut for the frame. Although large commercial ophthalmic labs do their own surfacing, this is not a process typically done at the small in-office lab. There are 4 steps involved in surfacing. These are 1) Blank selection 2) Generation 3) Polishing and Fining and 4) Hard coating.

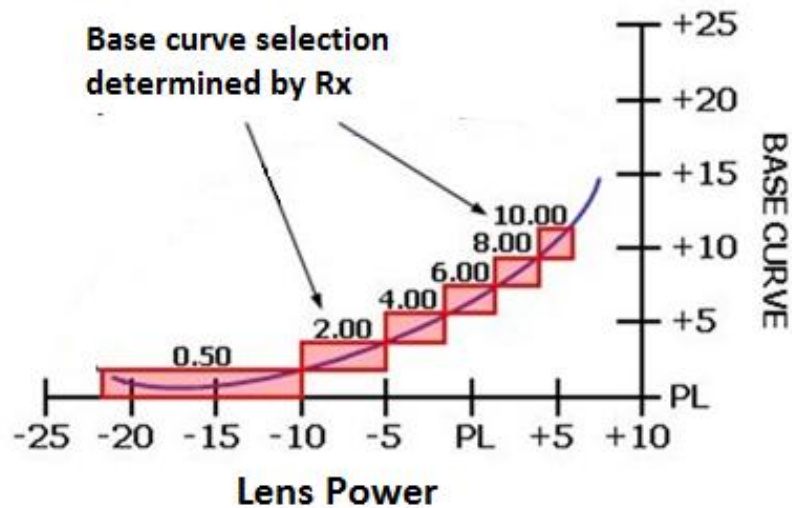
Blank selection

A “blank” is a hockey puck size lens. There is no prescription within the “blank”. The parameters preinstalled in the blank are only the front curvature (base curve), lens material such as polycarbonate, and the overall diameter.



To know which blank to use for a given job, the lab technician inputs the patient’s prescription and frame information into a computer program or uses a nomogram as seen below. Based on the nomogram, the lab technician is provided information about the lens blank to be used. This will include such things as the base curve and blank size needed. The base curve does not affect the final prescription; however, it can affect the lens’ ability to fit well within a frame. For example, an extremely wrapped frame will need a higher base curve in order to have the lens curve better match the frame curve. Similarly, a very flat frame will require a lower base curve lens.

The base curve may also affect off-axis clarity depending on the prescription ground into it. For these reasons, proper base curve selection is important both to ensure the lens will fit well in the frame and to ensure the best possible optical outcome.



Simplified graphical example of base curve selection criteria. Notice how as prescription becomes more plus (+) in power the necessary base curve increases.

Generating

Generation is the process by which the patient's prescription is ground into the back surface of the blank. The generator is a grinding instrument that etches the necessary curves into the back surface of the blank to achieve the desired prescription outcome.

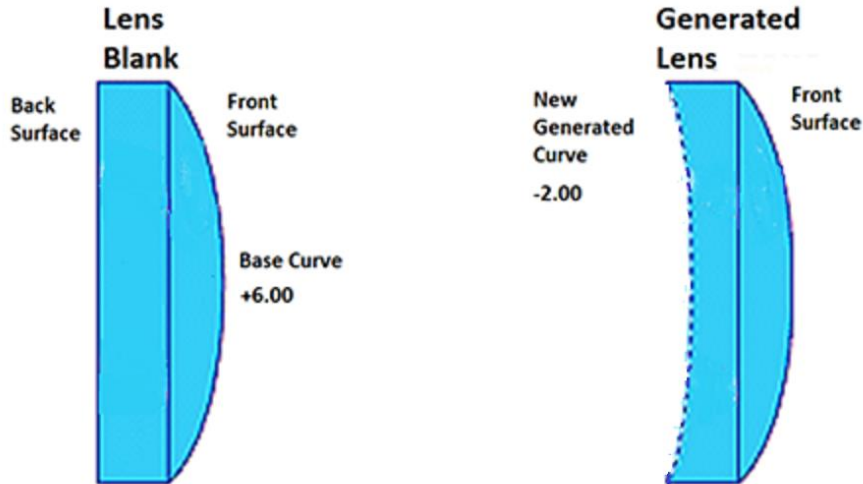
In order to prepare the blank for prescription generation, there must be something fused to the blank to hold it in place in the generator. This is called a "block", and the process of adding the block to the blank is called "blocking".

In order to add the "block", the optical center of the blank must first be determined. The blank is placed in a lensometer and the location of the optical center is found. This is necessary in order to insure the lens is centered properly when the prescription is ground onto the lens. Tape is applied to the front surface of the lens to insure it does not become scratched during the blocking and generation process. The front surface of the blank (base curve) is not modified during the generation process.



Lens blank with block applied and ready for generator

The blank is placed in a blocker which uses heated wax to fuse the block to the blank. Once the block is applied to the blank, it is placed in the generator which grinds the patient's prescription into the blank. Prescriptions are ground onto the **back** surface of the blank.



New lens power equals base curve plus generated curve.

In this illustration, lens power would be $+6.00 + (-2.00)$, creating a -4.00 D lens

Fining and Polishing

When the lens is removed from the generator the back surface is rough, with a frosted appearance, from the process of grinding the prescription onto the blank. This multistep process is called "Fining and polishing". The process involves placing the lenses into a *Finer* which uses a polishing block called a *lap*. The first step in the finer involves the lens being polished by the lap in a circular motion against an abrasive *fining pad* similar to sandpaper to polish out the roughest parts created by the generator.



Typical fining pad

The second step uses a softer fining pad to remove further roughness. Step three polishes the lens again with an even softer fining pad and a polishing solution made of Aluminum oxide to create the crystal clear surface expected in the final product.

The block is detached and the protective tape applied prior to the process is removed by hand. When detaching the block, a small hammer is sometimes used, but if it can be done by twisting the lens, instead of a peeling motion of the block, there will be less chance of causing a lens defect.

Hard Coating

Once generated, scratch protection is applied to the lens. This process is called *Hard Coating*. The process of generating and polishing the prescription onto the back surface of the lens blank will leave the back surface of the lens soft and vulnerable to scratching. For this reason, a *hard coat* is applied to back side of the lens at this time.

A *hard coat* is a scratch protectant layer to prevent the newly generated lens from becoming scratched. The raw hard coat material is rather toxic, so must be handled with caution. Once applied to the lens, the hard coat solution is cured on to the surface of the lens using ultraviolet light to turn the liquid solution into a permanent hard scratch coating. Once cured, the coating is no longer toxic. And the lens can be safely handled.

Finishing

Finishing is the process of edging and mounting the surfaced lens blank for the selected frame. As opposed to surfacing, *finishing* is a process often done at in-office labs. The in-office lab will typically order a pre surfaced lens from a large commercial lab and *finish* it themselves. Finish includes 1) Edging 2) Mounting 3) Inspection and 4) Dispensing.

Edging

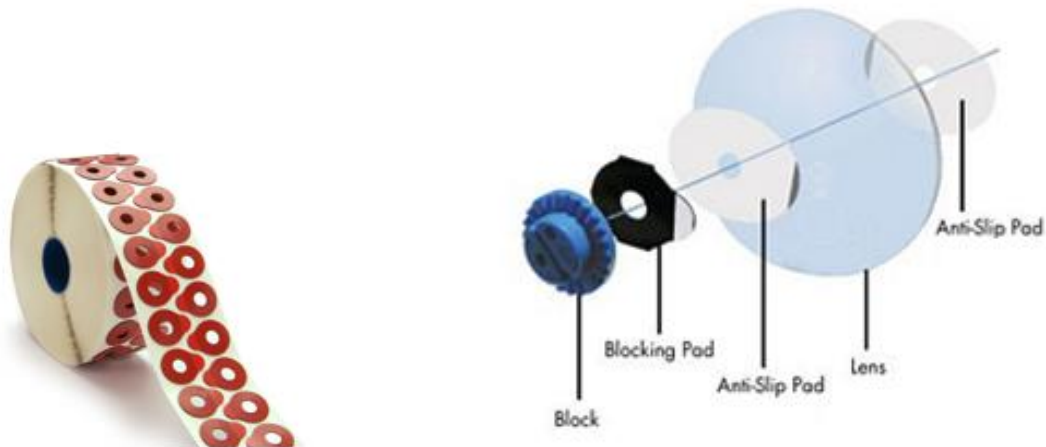
Now that the blank has the patient's prescription ground into its back surface and has been polished, it is time to cut the blank to fit the selected frame using an *Edger*. An edger is a lathe, using a diamond or ceramic grinding wheel, which cuts the blank to the shape of the frame. This process is called "*Edging*".

The lab technician will use either a *pattern* (if provided by the optician or frame manufacturer) or a *tracer* to trace the frame shape directly. A *pattern* is a plastic disc the exact size and shape the lens needs to be in order to fit the frame. This is usually provided by the frame manufacturer to the optical shop that purchases the frame. If a pattern is not available, the lab technician places the frame into a *tracer*, a machine that traces the shape of the frame. The tracer then electronically sends the shape information to the edger to cut the lens into the appropriate shape.



Frame tracer

Once the shape of lens needed is determined, the surfaced blank is prepped to be cut by the edger. Similar to the blocking step in lens generation, in edging the lens also must be blocked to give the edger a way to hold the lens securely while being cut. However, unlike the hot wax needed to hold the lens in a generator, the edging blocks are held in place by lightweight adhesive pads called *blocking pads*.

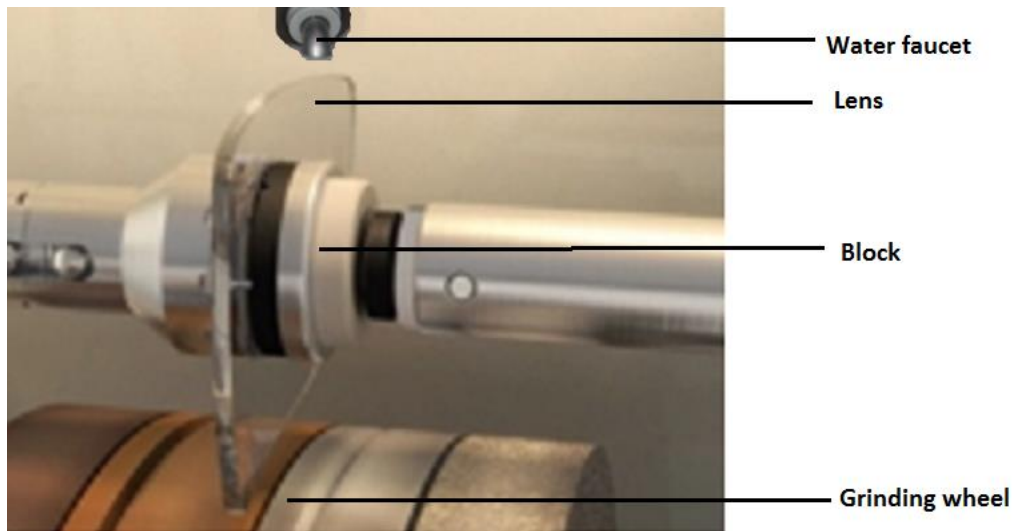


Roll of adhesive edging blocking pads. Illustration of edger blocking pad and block mounting to lens.

Once mounted, the edger proceeds to cut the lens into the desired shape and cuts a groove or bevel in the edge depending on the frame design. Water is frequently pumped onto the lens by the edger to keep the lens from becoming too hot in the process. A hot lens is more prone to warpage, so a flow of water onto the lens is a standard feature of most edgers. Once complete, if the block can be removed using a gentle twisting motion of the lens instead of a peeling motion there will be less chance of creating a lens abrasion.



Typical in-office edger



Lens mounted in edger.

The lens can be ground or polished by a hand edger if needed for a perfect fit into the frame.



Example of manual hand edger.

Edging lenses can create toxic waste from the lens shavings and polishing compounds. These waste materials are funneled by the edger into bins stationed under the edger table. Edging high index materials will create a characteristically and strong odor, so your waste bin will need to be emptied frequently. Investing in a ventilation system for the lab is often a good idea for odor control.

Mounting

Mounting is the process of manually inserting the newly cut lens into the frame. Having a hand edger in the lab is useful for times when small modifications of the lens shape is needed to get a good fit in the frame.

Inspection

Once mounted, the completed job is inspected. An inspection looks to insure the optical center is in the proper placement, checking for scratches or other defects, and insuring there are no gaps between the frame and lens. An inspection checklist can be found on the following page.

Dispensing

The moment of dispense is the only moment the patient sees. All the hard work in the lab is for naught if a bad first impression is given at the moment the patient picks up their new glasses. The following pages give a checklist for dispensing a new pair of glasses.

Inspection & Dispensing Checklist

Inspection:

The following checks *must* be made on all glasses *just before they are given to the patient*:

- _____ Power check
- _____ Prism check
- _____ Tint check
- _____ Lens inspection for defects
- _____ Frame inspection for defects
- _____ Optical centers marked in lensometer
- _____ Adjust frame
- _____ Ensure optical center marks align with patient's PD (if dispensing PAL, must be checked on patient with template on lenses)
- _____ Ensure bifocal line is appropriate height.
- _____ Clean glasses

Dispensing:

Proper Eyeglass presentation and dispensing instruction:

_____ Proper eyeglass packaging.

Are they on a nice presentation mat with a quality eyeglass case?

_____ Exceed Expectations.

Include a cleaning spray bottle, cleaning cloth, or any other product or service.

_____ Provide clean and new-looking reading material for the patient's first look.

Is your reading material dog-eared and worn, or does it look crisp, new, and bright?

_____ Review all benefits of the glasses and premium upgrades.

By the time the patient picks up her glasses, she may have forgotten many of the benefits of the premium upgrades she purchased, such as an antireflective coating or a titanium frame. It is important to review these with her so when she goes home and hears a commercial for two pairs of glasses for \$99, she does not feel buyer's remorse.

_____ Adjust the glasses, even if no adjustment is necessary.

Make the patient feel she is getting that customized fit.

_____ Compliment the patient on her new glasses.

Have you ever bought a nice piece of jewelry and the salesperson did *not* tell you how nice you looked in it? Probably not.

_____ Instruct patients on proper eyeglass care and handling.

1. Always store them in their case.
2. Never clean them with a paper product (Kleenex, paper towels, etc.), which can scratch the lenses. Use only a lint-free cleaning cloth.
3. Show proper cleaning with an eyeglass cleaner and silk cloth and recommend stores that sell them.

Troubleshooting problems at lens inspection

1. Lens haze:

Many times caused by the lens getting to hot. Plastic materials expand when heated, but antireflective coatings do not. So if the lens gets to hot during the edging process the stress caused to the AR coating by the expanding lens may cause the lens to appear hazy. If this is the case, ensure the edger is being properly cooled. It will likely have a water cooling system.

2. Linear scratches:

Scratches can occur at nearly any phase of lens creation. Protecting the lens is the best protection by the use of tape on the surface. Most lab supply stores sell surface protectant tape. By making sure the front surface (base curve) of a lens is taped while the back surface is being generated or making sure both sides are taped when being mounted in the frame or not being worked on, the lab can minimize the chance of scratches happening.

3. Circular scratches in center of lens:

Many times caused the lens being held to tightly in the edger. Modern edgers adjust the pressure based on the material being edged. Excessive pressure and a permanent abrasion such as this is created, to little pressure and the lens slips and is edged incorrectly. Some materials are more prone to scratching, such as polycarbonate, so the edger will loosen its grip slightly. However, if the machine is told it is edging CR39 when it is really edging polycarbonate scratches may occur.

For softer materials, such as polycarbonate, some lab technicians will use two edging pads instead of one for added protection. If the lab technician ensures they have the edger set for the proper material and are using two pads, but the central scratches continue, the edger may need to be recalibrated by the edger's manufacturer technician.

4. Gaps between frame and lens:

This indicates the lens was edges a little too small. This could arise from a poor job of the tracer determining the size of the frame or possibly from the lens having to be manually edged prior to mounting to remove edge flaws from the automatic edger.

5. Rainbow appearance of the Antireflective coating:

This can be an indication that the lens is too large for the frame. Having to tighten the frame around a lens edged too large will cause the lens to warp. The aberrations caused by this warpage will appear as a rainbow or an oil slick on the antireflective coating. The lens may need to be removed from the frame and manually edged to slightly reduce its overall size.

6. Diffuse pinpoint scratches:

This is typically due to dust on the lens prior to application of the antireflective coating. Antireflective coatings are thinner than a grain of dust, so the dust will leave a button-hole within the coating. This will leave small areas on the lens without antireflective coating. These small areas, looking like a pinprick to the naked eye, is actually a spot on lens where a speck of dust prevented the antireflective coating from adhering.

7. Geographic blotching:

This is typically the antireflective coating not adhering to the lens. Although sometimes due to poor quality antireflective coatings, many times it is from the lens containing surface oils such as from fingerprints prior to the antireflective coating being applied.

Tinting tips and tricks

Different lens materials will absorb tints with variable rates of success. The material's polymer dictates how well or poorly a tint will penetrate. The following will help guide you towards both matching the best tint with lens material as well as be able to better educate your patients on how a given tint can be expected to perform on a given lens material.

Polycarbonate:

- The most difficult material to properly tint.
- Most tints use a carbon molecule that binds to a carbon molecule in plastic (CR-39) for its adhesion and stability. Polycarbonate chemical structure makes it resistant to this carbon binding.
- The best way to tint polycarbonate is to tint its scratch coating, however historically the best scratch coats have been resistant to tinting.
- To overcome these limitations, manufacturing labs have recently developed scratch coats better able to absorb tints. However, in general, the best hard coat scratch protectors still make tinting polycarbonate more challenging than other materials.
- Always be sure the lens pairs being tinted are from the same manufacturer and same batch to insure consistent tinting.

Cr-39:

- Wider range of tinting color options and darkness levels than Polycarbonate due to its chemical make-up binding to tints more easily.
- Uncoated CR39 is the most porous of lens materials, making it easier to get a darker tint than other materials.
- Hard coated CR39 is still easier to tint than polycarbonate since the hard coat does not need to be as dense. This is due to CR39 being naturally less prone to scratching than Poly.

Trivex:

- Trivex is easy to tint, but since its material is not very porous the tint will not penetrate very deep. Therefore, harsh cleaners such as alcohol will fade the tint over time.
- Using a tintable hard coat may be the most stable method for tinting Trivex.

High Index:

- Able to be tinted well, however prepare for the process to take on the order of hours to complete. A tint that CR39 requires 10 minutes to complete may take a high index lens 3-4 hours to achieve the same outcome.

Rules for any material:

- Regardless of the material, lenses from different manufactures may tint differently depending on their processing and curing techniques. Even if from the same manufacturer, different batches of the same material may even tint slightly differently. So if replacing just one sunglass lens for a patient, be sure to educate them that the tint may not be a perfect match with the fellow lens. Replacing both lenses is typically the safer option to achieve the best cosmetic effect.
- Be sure to completely clean a lens using lens soap prior to tinting. Oils, dust, or other impurities will affect the uniformity of the tint.
- UV coating should be applied prior to any color tinting. This will prevent the tint color from fading.
- For lenses which you know have been previously hard or scratch coated, you will want to check with the lens manufacturer for their recommended tinting method. Some manufactures hard coatings will accept color and others will not, some manufacture coatings require a lower tint bath temperature or longer tint times. It is always our recommendation to check with the manufacturer first to avoid a tinting misadventure.
- All lens treatments such as tinting, UV treatments, and edge polishing must be done before an AR coat is applied. Tints should be made about 10% darker than intended prior to AR coating applications since the AR coating process will fade the tint by about 10%.
- For gradient tints, if you are experiencing a sharp demarcation between the lighter and darker areas instead of a smooth transition, your tint bath is likely to hot.
- In general, the hotter the tint bath the faster the lens will tint, however there are limits. Get the tint to hot and the color will decompose. Be sure to read the package insert for the color being used for recommended temperatures.

Tinting procedure:

Most in-office finishing labs will have a tint bath with 4-6 wells.



A typical tint bath with 6 wells.

Each tint bath well will contain a liquid dye created by mixing a Heat Transfer Fluid (usually not water) with a dye concentrate (or pill) and heated to 205° F. Using a Heat Transfer Fluid instead of water ensures the fluid within the bath heats quickly and is of a uniform temperature.

Although color concentrates or dye pills are available for nearly any color under the sun, your lab likely will not want to empty a tint bath to make room for a new color every time a new color is needed. Therefore, the tint bath wells will likely each contain one of the three primary colors... Blue, red, and yellow and maybe one for black given its popularity for tint color. From these colors alone almost any other color can be created using the following combinations.

Blue + Yellow = **Green**

Blue + Yellow + Red = **Black to Grey depending on concentration of colors**

Black + extra Red = **Yellowish Brown**

Yellowish Brown + extra red = **Natural Brown**

For more info on creating tints using only primary colors, visit http://optochemicals.com/tinting_colorguide.htm

Although tinting can be done manually, most labs use an electronic mechanical lever connected to a timer. The lever is mounted to the tint bath. It holds the lens and automatically dips the lens into the tint bath and raises it out of the bath based upon the timer setting. Darker tints will require longer tint times.



Typical mechanical lens holder