HARD COATING TYPES USED for OPHTHALMIC Lenses

Thermal Coatings—

- Thermal coatings are cured with heat at between 60° C. to 100° C.
- They are cured for 1 to 4 hours depending on the lens substrate material
- They are typically NON–TINTABLE
- They go on the surface thin, about 3 microns
- They usually have a high abrasion resistance
- They oftentimes need an adhesion primer
- They usually can be stripped off the lens surface
- They contain solvents
- **They can be dipped coated or spin coated**
HARD COATING TYPES USED for OPHTHALMIC Lenses

UV Curable Coatings— (100% Solids) –

- 100% Solids Coatings are NOT solids, they merely contain no solvents
- They can be Tintable or Non-Tintable
- They are easy to ship because they are not restricted since they have no solvents
- Tintable types absorb the tint into the coating
- Tintable coatings usually are about 6 microns
- They may have a high abrasion but usually they do not compare with thermal coatings
- They are usually spin coated for ease of application and for equipment cost savings

UV Curable - Solvent Based

- Solvent Based Coatings contain solvents
- They can be Tintable or Non-Tintable
- Tintable types absorb the tint into the coating
- Tintable coatings usually are about 4.5 microns
- They do not usually have a high abrasion
- They do have typically have good adhesion
- They are usually spin coated for ease of application and for equipment cost savings
HARD COATING APPLICATION

DIP COATING vs. SPIN COATING

Main Dip Coating Advantages:

1. Same coating goes on front and back of lens which;
   - makes it easier to have an AR recipe that has the same color reflectance
   - the lenses will have the same abrasion resistance on front and back
   - coating adhesion to the lens and to the AR will be more consistent
2. Higher throughput with larger automated dip coaters than with a spin coater such as the MR3 or HRC coater – 192 lenses/hr vs. 120 lenses/hr at full capacity
3. Lower cost per lens without amortizing equipment expense into the cost

Main Dip Coating Disadvantages:

1. Expensive equipment and tooling up front for dip coating
2. Specialty room is needed for coating and curing
3. Lower yields than with spin coaters – 92% vs. 98%
4. Coating thickness variance between the top of the lens and the bottom of the lens is significant
5. Tank maintenance for solvents and cleaners very cumbersome
6. Cleaning of lens holders require additional equipment
7. Takes up to 4 hours to cure the lenses
8. Can’t apply coating on all lenses and brands
HARD COATING APPLICATION
DIP COATING vs. SPIN COATING

Main Spin Coating Advantages:

1. Excellent thickness control center to edge with spin coating
2. Can use either Thermal or UV curable coatings
3. Easy to operate and to maintain the machine
4. Better first pass yields
5. Lower up front cost for equipment
6. Any lens and any brand of lens can be coated

Main Spin Coating Disadvantages:

1. Lower throughput than with dip coating
2. Could have a different coating on the front and on the back of lenses if only coating the back of the lens
3. Must stay on top of most current spin coaters as they are easy to misadjust times, speeds and curing cycles
BACKSIDE COATING – GET THE BEST RESULTS

Successful Hard Coating

1. LENS PREPARATION
2. LENS SURFACING
3. LENS WASH UP
4. COATING THE LENSES
5. TINTING COATED LENSES
6. INSPECTION OF LENSES
7. AR APPLICATION (as it pertains to hard coatings)
8. EQUIPMENT TYPES
9. MAINTENANCE OF EQUIPMENT
10. TROUBLESHOOTING
1. LENS PREPARATION AND PROTECTION:

- Semi Finished Lens Inspection -
  - The front side of all SF blanks should be inspected prior to processing to ensure that they are free of defects

- Protect the Lens front Surface –
  - The front surface of all SF lenses should be protected before surfacing by using a surfacing tape or a protective film to ensure that the factory front side surface remains free of defects to during processing

- Stock Lenses –
  - Inspect all stock lenses for defects, imbedded particulates and excessive edge flashing prior to coating. CR-39™ lenses are especially prone to edge flashing

- Lens Cleaning –
  - Prepare stock lenses to be coated by washing them with soap and water and scrubbing them with a sponge prior to coating
  - Avoid sharp edges on plus lenses by washing from the inside out to lens edge with a sponge
  - DO NOT blow dry lenses as they will pick up static electricity and debris will stick to the lens surface
2. LENS SURFACING

- **Blocking lenses** –
  - The use of alloy, wax or thermal plastics are fine as long as the wash up step, after polishing is diligent, especially making sure to carefully and thoroughly clean the edges of the lenses to avoid any residue contamination in the coating process.

- **Generating lenses** –
  - Using a cut to polish process it is imperative that the generated curve and the lap are a perfect match to each other to avoid poorly polished lenses that will not coat well.
  - Using a cut to fine process is also acceptable but make sure that the curves on the generators are checked continuously for accuracy since fining will change the lens curve easily and swirls will occur.

- **Fining Lenses** –
  - It is always best to final fine lenses with the finest grit pad that your process can bear, depending on your generated surface quality.
  - Use a proven fining process with good quality pads ending with as small a micron pad possible to ensure that the backside surface is free of defects such as swirls, pits or scratches which can not be covered by the coating.

- **Polishing Lenses** –
  - Always polish lenses using the best polish you can find and for the longest time that your process can tolerate. A savings here will cost you in coating.
  - Inspect lenses, on the block, using a 40 watt clear incandescent bulb.
3. WASHING THE LENSES

- Remove the surfacing tape or surfacing film carefully from the lens, preferably automatically, to avoid scratching of the lens surfaces.
- The use of recirculating water for wash up is NOT recommended unless it is filtered with a 5 micron filter before recycling. Additionally, scum can build in water that is old and it will hinder the wash up process, so replace often.
- It is preferable to wash lenses in a non silicone soap such as Joy Liquid and scrubbing the lenses with a sponge to remove built up polish, blocking wax or imbedded debris like, fining particles, tape or polish.
- The use of ultrasonic cleaners with proper cleaning detergents is highly recommended especially if using wax as a blocking medium.
- Ultrasonics will help in removing imbedded particulates that may cause defective coatings but be sure to use cleaners that are compatible with your coating and lens substrate material.
- When washing stock lenses, inspect the lenses carefully for defects before and after wash up for excessive edge flashing, particularly on CR-39™ lenses.
- The use of jewelry at wash up is not advised as scratches will occur on lenses.
- DO NOT USE A HIGH PRESSURE BLOW OFF OR COMPRESSED AIR TO DRY WASHED LENSES. Static electricity will be created by high pressure and the compressed air may contain oils or dirty water that can damage coatings.
- Inspect the lenses carefully before coating to ensure that the lenses are free from defects.
Successful Hard Coating

- **PRE COATING PROCESS:**
  - Inspect all lenses before coating
  - Prepare machine so it is ready for production
  - Check the coating level to ensure good pump flow
  - Check the coating height of the machine
  - Check the coating filter for air bubbles
  - Check the wash water level and filter
  - Verify that the suction cup is clean, dry and pliable
  - Verify application and spinoff spin speeds

- **COATING PROCESS:**
  - Prepare trays to be coated
  - Rinse concave side of the lens with water and clean cloth prior to placing in suction cup. If using alcohol to pre rinse the lenses, ensure that the wash cycle is running well
  - Place trays sequentially so the lenses correspond with the trays for put back
  - Inspect lenses as they come off the machine for defects due to coating failures
  - The use of a PAL engraving mark finder works well for inspecting for surface defects

- **MAINTAIN QUALITY BY MAINTAINING EQUIPMENT:**
  - Perform all recommended maintenance procedures on a timely basis
  - Check for lens coating quality by using an arc lamp to detect coating flaws
Different Spin Hard Coatings
Optimizing the Tinting Process

Make Tinting a Breeze by using the following tips:

- Wash the lenses in soap and clean water using a sponge
- Never use recirculating water for cleaning
- Prevent streaking, splotchiness and pin holes during tinting by using a pre tint cleaner
- Prepare the surface with an easy to use wetting agent surfactant
- Always have the actual dye in the dye pot at 205° F +/- 5 degrees
- Change your dark color dyes weekly
- Will not harm any substrate material
- Never use DI water in the dye pots. Dye pots are not intended for DI water use
INSPECTING THE LENS

- HARD COATING INSPECTION:
  - Define your standards based on your customers wishes
  - Always Inspect lenses to the same standard by having a STANDARD document and a passibility (my own new word) chart with zones
  - Be aware of cut out zones and if a lens is being shipped uncut or cut and edged
  - In line inspect lenses using a black background and a 40 watt fluorescent lamp at inspection
  - The Use of a PAL engraving mark finder for hard coating inspections works really well to see runs and ripples

- AR COATING INSPECTION:
  - Use a 20 watt Halogen bulb to check for coating crazing or cracks
  - Use a 40 watt fluorescent lamp with black background for pits or marks

- MAINTAIN YOUR QUALITY BY MAINTAINING YOUR EQUIPMENT:
  - Structure a sound and detailed maintenance program to avoid having problems in the future
  - Create a start up check list similar to what pilots do before they fly
Testing for AR Compatibility

The AR Technical Committee of THE VISION COUNCIL has several tests that they recommend for testing AR adhesion to hard coatings and to substrates. The following tests are fundamental in verifying AR compatibility.

- Cross Hatch
- Cycle Humidity
- Oven Test
- DI Water Soak
- Salt Water Boil Test

- ALL THE ABOVE TESTS CAN BE PERFORMED IN HOUSE OR BY NSL LABORATORIES OR COLTS LABORATORIES

NOTE: ALL LENSES TO BE AR COATED SHOULD BE HARD COATED AS WELL.
EQUIPMENT TYPES

SMALL COATING UNITS

EZ Coat

Mini II
EQUIPMENT TYPES
MEDIUM COATING UNITS

MR3

HRC

G-3
EQUIPMENT TYPES
LARGE PRODUCTION COATERS

G-4

CALMATION
Maintenance of Equipment

- Replacement of coating filter
- Use of water filter
- Type of Water used
- Replacement of bulb and reflectors
- Measurement of RPM
- Timing of Cure Cycle
- Replacement of Capacitors
- Keeping the Water Drain Clean
- Replace the water tip nozzle
- Keep incoming air clean and dry
- Clean out coating bowl each shift with clean dry towel
- Disinfection of clean water tank with Clorox should be performed monthly to avoid bacterial contamination
- THE REPLACEMENT OF COATING PUMPS
Coating Pumps

- The Graylor coating pump is a good pump but not intended for the rigors of hard coating. It seems that they are always failing and that can be attributed to the fact that they are not meant for the chemicals, they are made for fish tanks.
- Using a chemical coating pump makes more sense like the CD (Continuous Displacement) pump or the HP (High-Performance) pump that are now available.
- Any pump used should be able to withstand the continual on and off of the electronics and the robustness of chemical resistance.
Coating Pumps

GOOD

BETTER

BEST
KEEP THE PROCESS UNDER CONTROL

- Regularly measure and adjust all the process variables as needed
- Speeds, Cure Times, and Lamp Energy must be monitored frequently to ensure proper coating process control
- The machine operator should NOT be the one responsible for monitoring the process
- Keep a LOG of all data by date and when changes are made
- Preventative maintenance saves money and increases production output and yields
Maintenance Needs and Frequency
High Production Labs

- Water Nozzle Tip – Replace every 3 months
- Coating Filter – Replace every month
- Wash Filter – Replace every month
- UV Lamp (hours of use) – When energy gets below 1.0 joule or at 1000 hours
- Lamp Reflectors – Replace with each bulb change
- Wash Tank Water – Replace the water every 5 days and clean tank every two weeks. DO NOT use “charged” DI water for spin lens cleaning
- Coating Bowl – Clean once a week with dry clean cloth
- Wash Bowl Drain – Keep clear of debris and stoppage
UV Energy Measuring Device
Radiometer for UV Energy Measurement
TROUBLE SHOOTING COMMON DEFECTS

Coatings **do not** create pits, or specs. This is one of the biggest misconceptions regarding UV cured backside spin coatings in labs around the world. Here is a list of the most common causes of pits and other defects that are commonly blamed on the coating.

A. Bacteria in the wash system.
B. Small particles from parts in the wash system that are deteriorating due to constant exposure to water which is a solvent.
C. Poor water supply. Using water from a system that isn’t functioning correctly or hasn’t been maintained.
D. Incorrect spindle speeds. Can cause coating to apply too thick, or not dry a lens completely.
E. Contaminated compressed air supply.
F. Air in the coating system due to a bad fitting, or bad coating pump.
G. Water in the coating. Old deflectors, or improper dry nozzle adjustment are the biggest cause of water being brought over to the coating system. If water remains on the lens or spindle, it will spin off into the coating.
H. Weak UV bulb.
I. Defective capacitors.
J. Incorrect cure cycle time.
K. Dirty cure ring.
L. Poor surfacing.
M. Problem with digital Free-Form generator.
Common Defects and Nomenclatures

- Wagon wheel effect – Poor coating dispense
- Poor tinting - air bubbles attached to lens
- Coating Voids – Not enough coating on the lens or not enough spin off speed to get coating to edge
- Comets on Lens – due to debris on lens surface prior to coating
- Splotchy Tints – due to poor tint preparation
- Uneven Tints – Could be caused by uneven curing or different amount of coating in center as to the edge. Poor maintenance of machine
- Coating Swirls - Poor surfacing of lenses. Coating can’t cover everything
- Water Droplets – Lens not dried after washing causing the coating to cover over the water droplet and then the water droplet pops and there is a divot on the lens
- Coating Defects – Debris falls on lens surface after coating but before curing so its on top of the coating
- Coating Pits – debris on lens before coating and coating covers the particle. The debris is under the coating
- Coating Ripples – Orange peel effect due to coating not spreading evenly throughout the lens surface
- Coating Particles (specs) – My favorite one because it’s the one I always hear about and it means that we don’t know what the defect is so we’ll bunch it all in one word
Wagon Wheel Effect
due to excessive pressure by the coating pump
Air Bubbles on Tint
due to poor tinting preparation
Coating Voids

due to not enough coating applied
Comets on Lens

due to debris on lens surface before coating
Splotchy Tint

due to poor coating flow due to surfactants not mixed well
Uneven Tint
due to uneven cured lens due to lamp
Coating Particles
due to debris on lens surface
Coating Swirls
due to bad coating flow from pump
Water Droplets

due to droplets transferring from wash station to coat station
Coating Defects
due to dirt on the lens surface
### Features

- Special bonding chemical formulation and unique UV/Thermal hybrid chemistry
- Proprietary manufacturing procedures combines the best quality raw materials and an unsurpassed, inline quality control process through inspection
- Special Purification and filtration process
- UV curable coating
- High Abrasion and Scratch resistance
- Excellent adhesion to AR
- QUICK (QT) Tint coating
- VOC Free
- Compatible with standard UV curing systems & bulbs
- Compatible with standard spin coaters
- Highest quality coating available on the market
- Low viscosity
- Excellent coating stability

### Benefits

- Superb adhesion to all substrates including CR-39, Polycarbonate, Trivex, Spectralite, 1.55, and High Index
- Optimized Coating with HCLT (Hybrid Cross Linking Technology™) during lab production ensures the best coating adhesion, abrasion, yields and tintability
- Improved coating performance with less impurities and better filtration
- Fast curing coating
- UVMAX has unsurpassed coating durability
- Specifically formulated to adhere to all AR coatings
- Quick tinting formula produces 15% in 15 min.
- No volatile solvents for safe shipping and handling
- No changes needed for optimum curing
- No hassles in switching coatings
- Improved yields at reduced costs
- Improved life for inexpensive coating pumps
- Viscosity remains steady