FSICT Application Training

Anti-Fog Coatings

FSICT Application Training Presentation

Coating Technologies

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Fundamentals of Anti-Fog Coating

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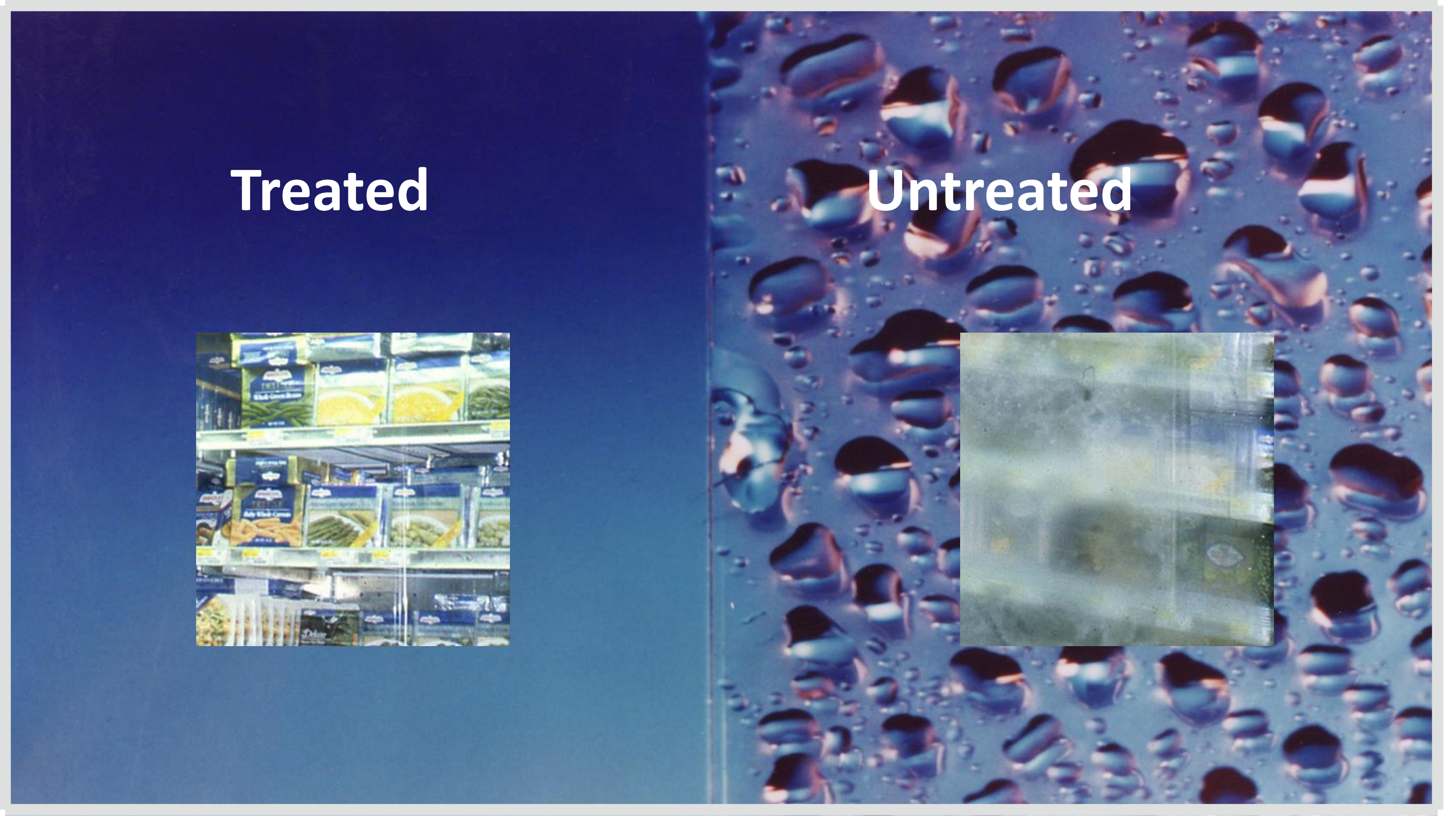
Anti-Fog Coatings



Treated and Untreated Freezer Doors

Fundamentals of Anti-Fog Coating

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Process, Application, Maintenance, Performance

1. Fundamentals of an Anti-Fog Coating
2. AF Coating Process
3. AF Coating Application Techniques
4. AF Coating Selection Process
    1. Substrate Types
    2. Functional Properties
    3. Application Techniques
    4. Market Applications
5. Solution Maintenance
6. AF Coating Performance Properties
    - Abrasion Resistance
    - Adhesion
    - Tintability
    - Impact Resistance

Fundamentals of Anti-Fog Coating

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Anti-Fog Coatings Value Proposition

Improve the performance of a material

- Provides a durable surface protection
  - Abrasion, scratch and mar resistance
  - Resistance to environment exposure (UV, humidity)
  - Chemical resistance
- Adds functionality
  - Optical properties
  - Surface properties
- Adds value!
  - Product differentiation

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Anti-Fog Coating Process

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Visgard Premium Anti-Fog Film

Installation Videos

- AUTOMOTIVE Windows: https://www.youtube.com/embed/orRe7yoV46s
- BATHROOM Mirrors:
- https://www.youtube.com/embed/UwbIoqw6YFM
- FREEZER Doors:
- https://www.youtube.com/embed/TcNVJYOTQv8

Anti-Fog Coating Process

Substrate, Adhesion, Temperature

- Substrate Compatibility
- Chemical Resistance
  - Coating cannot "attack" the part
- Adhesion
- Coating must stick to the part
- Temperature Resistance
- Thermal Resistance
- Thermal & UV-Cure
- Must keep temperature below Tg of part

Anti-Fog Coating Process

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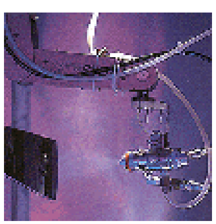
Conditions & Constraints



- May be limited by application technique
- Dip, flow, spray
- May be limited by application equipment in use
- Design, including design throughput
- May be limited by amount of available curing time
- Will depend on whether primer is needed
    - Primer/AF coating vs. AF coating
- Will depend on part configuration
- Size
- Shape complexity
- Single-sided coating vs. Double-sided coating

Anti-Fog Coating Process

Performance Features

- Durability
- Abrasion, mar and scratch resistance
- Environmental stability
- Exposure to
  - UV light
  - Moisture
  - Chemicals
- Stability to secondary processes
- Tinting
- Mechanical strength
- Impact resistance
- Functionality
- Optional enhancements
  - Tinting
  - Anti-Fogging
  - UV filtering

Solution Maintenance

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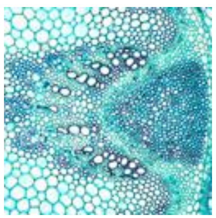
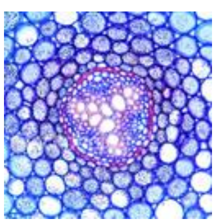
Coating Solution Maintenance – In Use

Percent Solids, Solvent Ratios & Viscosity





Why are they Important?

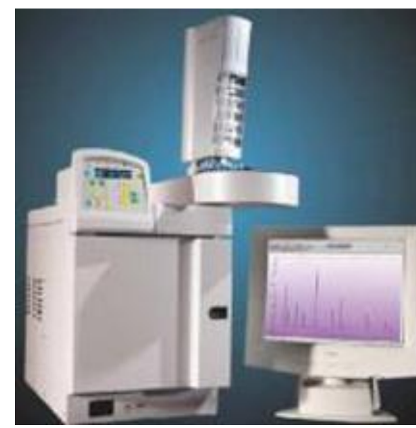
- Determine coating thickness
- Proper process control
- Cosmetics
- Adhesion
- Cured coating performance
- Shelf-life
- Pot-life

Solvent Measurement

Property Importance

Why are they Important?

- Measures non-active ingredients
- Important for process control
  - Dry time
  - Cosmetics
  - Solutions stability
  - Pot-life
  - Adhesion
- Measured via gas chromatography
- Separates and quantifies components of volatility and amount
- Reference: SDC TM-111A



Solids Measurement

Properties Affected

Why are they Important?

- Measures active ingredients in coating
- Moisture balance methods recommended (FSI TM100)
  - Weight of liquid coating measured
  - Volatile materials driven off
  - Weight of remaining solids measured
  - Percent solids to total solution weight calculated
- Solids measurement affects coating
  - Thickness
  - Cosmetics
  - Pot-life
  - Viscosity

Viscosity Measurement

Control Purpose

Why are they Important?

- A measure of material's resistance to flow
- Important for controlling thickness; process control and cosmetics
- Rational viscometer yields the most accurate and reproducible data
- Others (Ford and Zahn cup) not useful for low viscosity materials
- Reference: FSI TM200 (ASTM D1638, D1824, D2849 (8.02)

Coating Maintenance

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Protocol Check List

- Check solids concentration regularly
- Check solvent composition
- Add appropriate solvent mix to maintain solids target
- Add fresh coating to maintain tank levels
- Add flow modifier if necessary
- Monitor room temperature and humidity
- Log all parameters in lab journal

Application/Processing

Coating Parameters

- Air temperature
- Humidity
- Air filtration
- Withdrawal speed
- Thickness
- Cure
- Filtration
- Recirculation
- Age
- Maintenance protocol

Environmental Factors

Affects of Temperature, Humidity, Filtration

Air Temperature

- Affects solvent evaporation rates
- Affects cosmetics of coating
  - If temperature is too high, horizontal lines or orange peel may result

Humidity

- Affects how quickly coating dries
- High humidity may cause haze on lens due to water condensation

Air Filtration

- Poor air filtration may cause particulate contamination
- Particulates can cause coating imperfections

Process Controls – Part I

Coating & Lens Temperature

Coating Temperature

- Affects stability of solution (solvent loss)
- Affects solvent evaporation rates
  - Affects cosmetics of coating

Lens Temperature

- Affects solvent evaporation rates
- Affects cosmetics of coating
  - May affect adhesion

Process Controls – Part II

Coating Thickness

Withdrawal Speed

- Faster withdrawal rate, thicker coating

Viscosity

- Higher viscosity, thicker coating

Solids

- Higher solids, thicker coating

Part Orientation

- Part shape or part racking may affect coating thickness
- Affects solvent evaporation rates

Tank Circulation

- Affects coating thickness
- Affects ability to filter coating

Coating Thickness

- Affects abrasion and impact resistance

Process Controls – Part III

Coating Cure Rate Parameters

Pre-cure

- To enable handling and inspection, thermal or IR lamp

Oven temperature

- Higher temperature, better cure (125° C – 130°C)

Cure time

- Correct cure time, better cure (@1 hr)

Air flow in oven

- Better air flow, better cure
- Part racking/spacing may affect air flow

Cure

- Affects adhesion, abrasion, impact and chemical resistance

Coating Maintenance

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Filtration, Flow, Age

Solution Maintenance

- Many effects as discussed earlier

Coating filtration

- Proper filtration necessary to minimize particles

Coating flow into the tank

- Flow direction into coating may affect cosmetics

Coating age

- As coating ages, performance may change
- Aging depends on number of lenses coated per day/week/month

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Anti-Fog Coating Performance Properties

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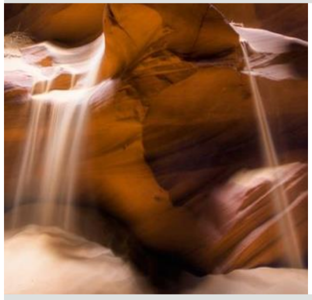
Anti-Fog Performance Properties



Properties & Testing

Abrasion resistance a function of

- Curing
- Coating thickness

Adhesion a function of

- Curing

For best abrasion resistance

- Thick application of AF coating needed on all substrates
- Curing temperature should be highest possible for substrate material

Anti-Fog Performance Properties

Other Considerations
Thickness, Curing & Match

High coating thickness can cause cosmetic defects on parts

- Dips, waves, sages

Insufficient curing can cause adhesion problems

- Temperature too low
- Duration too short

Finding the right balance in coating application

- Adhesion
- Thickness
- Curing conditions
- Matching a particular AF coating to a substrate application

Anti-Fog Performance Properties

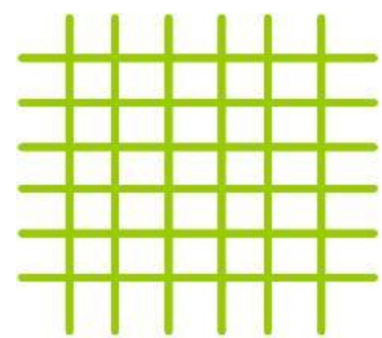
Testing Durability

- Abrasion Resistance
- Adhesion
- Anti-Fogging
- Impart Resistance
- Tintability
- Outdoor Durability

Testing

Crosshatch Adhesion

- Crosshatch pattern cut into lens surface
- Specified grade of adhesive tape placed firmly on crosshatched area and pulled off at 90º angle to surface
- Test area inspected to determine coating adhesion level rated as 0-100%
- Crosshatch adhesion used to measure
  - Initial adhesion



Abrasion Resistance Summary

General Market Trends
& Test Methods

Each method measures a different component of abrasion resistance

- Bayer used for Ophthalmic and high-end Sunglasses
- Steel Wool used by Ophthalmic and Sunglass but mainly for Safety

Other Methods

- Taber
- Falling sand
- Micro-scratch and micro-indentation

Best results obtained using a combination of measurement techniques

Tintable Coating System

Migrating Dyes into Coating

Allows dye dispersed/dissolved in water-solvent mixture to migrate into coating

- Measured by reduction in light transmittance through lens (%LT) – measured on a Colorimeter
- Normally dye-solution is heated to about 97º C and lens submerged into solution until desired level of %LT achieved
- On a Non-Tintable substrate (PC)
  - Dye absorbed into the coating system
- On a Tintable substrate (PA, CR-39, MR-6, MR-7, MR-8)
  - Dye may penetrate into substrate materials

Tintable Coating System

Tinting Substrate Materials

In some cases it may be desirable to tint substrate materials

- May be prior to coating system application, does not require use of tintable coating.
    - Dye resident in tinted lens may be drawn into coating solution during coating application process
        - Reduces color in lens (increases %LT) and contaminates coating system with dye material.
- Tint lens by adding dye or resin during lens manufacturing process, does not require use of tintable coating.
- "Tinting Rate", time it takes to achieve target %LT depends on types of dyes used, make-up of dye-solution and tinting process.

Anti-Fog Performance Properties

Hydrophobic & Hydrophilic Measurement

Anti-fogging – measures ability of coating system to stay transparent when exposed to water or mist.

- Works by water spreading or absorbing.
- Water spreading (hydrophobic – “fear of water”)
- Droplets in coating spread across surface, results in transparent film of water
  - Does not saturate, will sheet water as mist comes in contact with coating
- Water absorbing (hydrophilic – “water loving”)
- Droplets drawn into coating surface, acts as a sponge
  - Eventually saturates, causing droplets to form on coating
  - Saturated coating surface easily damaged by scratching – can include loss of Adhesion

Anti-Fog Performance Properties

Other Considerations

Both types of anti-fogging coatings require open coating matrix

- Reduces coating system abrasion and chemical resistance

Anti-fogging tested using several techniques

- Steam exposure test
- "Coffee Cup" test
- Water soak test
- Freezer test

Two types of anti-fogging coatings perform differently in these tests

- There is no perfect anti-fogging product

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Anti-Fog Coating Selection Process
Visgard® Dual Coating 121-35-SP

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Visgard®Dual Anti-Fog Coating

Formable
Anti-Fog Coating 121-35-SP

- Visgard coating offers unmatched optical application features incorporating permanent resistance to fogging, scratching and chemical attack.
- Coating for use on PC, CR-39®, nylon and certain other clear plastics without primers.
- Suggested applications: lenses, visors, windows and mirrors
- Primer available for glass applications
- Unique combination of attributes allows products to be coated once with a single solution rather than coating one side to protect against scratching and the other side for fog resistance.
- Elastic and non-brittle polyurethane coatings do not degrade the impact strength of molded parts.

Visgard Dual Anti-Fog Coating

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Scratch-Resistant
Anti-Fog Coating 12135-SP

- Visgard will not crack when flexed and coated, parts can be thermoformed to small radius bends without loss of performance.
- Coating appears colorless on treated parts, blue added to enhance brightness.
- **Scratch resistance** equal to many commercial anti-scratch finishes.
- **Anti-fog** properties retained after repeated washings and years of use.
- Most other anti-fog coatings lose their active ingredient or become saturated and fail after washing only once.

Visgard Dual Anti-Fog Coating

Chemical-Resistant
Anti-Fog Coating 121-35-SP

- Visgard consists of cross-linked hydrophilic polymers that cause condensed moisture to spread invisibly rather than forming droplets which appear as fog.
- **Anti-static** properties are an added benefit; however, magnitude varies with humidity.
- Very good **Chemical resistance**
- Additional coating features include:
  - Supplied ready to use, solution remains fluid and usable for many months
  - Will not solidify or increase in viscosity without heat
  - Specifically design for dip coating, also suitable for flow, roll and spray coat applications.

Visgard Dual Anti-Fog Coating

Physical Characteristics

DESCRIPTION	ATTRIBUTES
Appearance*	Light blue to blue-green
Viscosity (Brookfield)	10 – 50 cps
Solids Content (by weight)	25%
Solvent(s)	Diacetone Alcohol
Density	.98 g/cc
Refractive Index	1.532

*Coating appears colorless on treated parts, blue added to enhance brightness.

Visgard Dual Anti-Fog Coating

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Handling and Use
Coating Viscosity & Thickness

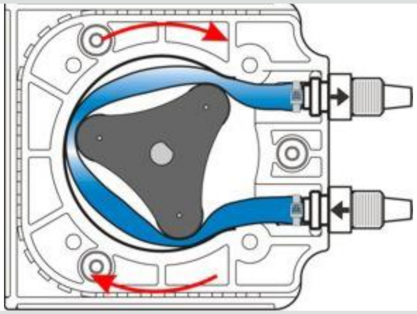
- For best results dip withdrawal speeds 5.0 - 12.0 inches per min. (13 to 30 cm/in.) in a clean-room environment.
- Solution viscosity range 10 - 50 cps desirable; good coatings can be produced over wider viscosity range by adjusting percent solids, dip speed, air dry time and solution temperature.
- Target coating thickness 5 - 6 microns dry.
- Abrasion resistance and anti-fog performance increase with coating thickness.
- Drip tabs recommended to minimize accumulation at bottom of each part, a sufficiently slow withdrawal rate usually prevents visible pooling.

Visgard Dual Anti-Fog Coating

Handling and Use
Withdrawal, Temperature & Humidity

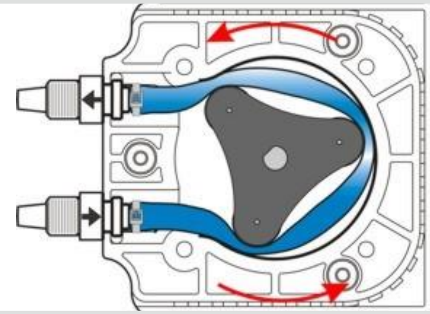
- Withdrawal and hold parts for 30-60 seconds in position allowing bottom of each part to barely touch solution, draining off excess material. Tilt parts at 30-45° angle so coating accumulation at bottom runs off lens corners, safely out of visual area.
- Coat parts with difficult geometries at low solids (15%) with fast withdrawal speeds so excess coating drains off quickly before drying begins.
- If Visgard solutions are chilled; ensure temperature of coated parts are not below dew point temperate in coating area. Otherwise moisture may condense causing low abnormalities and possibly precipitating dissolved polymers.
- Viscosity will not change significantly over time, monitor percent solids periodically and adjusted to maintain suitable viscosity (see "Dilution" and solids content).
- Humidity levels above 65% may cause light haze to form on Visgard coated surface immediately after cure. This dissipates within 1 - 2 hours at lower humidity and performance properties will be completely normal. Haze can be removed with a dry cloth.

Visgard Dual Anti-Fog Coating



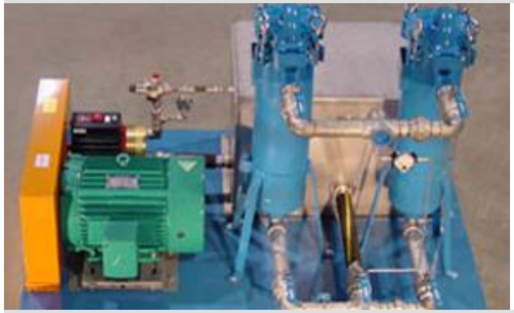
Caution

Compatibility & Equipment



- Silicone hard coatings incompatible with Visgard and impair anti-fog performance even at low concentrations.
- Thoroughly clean and free all equipment from other coating residues before evaluating Visgard in production systems.
- Peristaltic pump is best for initial tests because there is no actual contact of Visgard with pump chamber or mechanical parts.
- Visgard is incompatible with PVC tubing due to plasticizer extraction.
- Use only LDPE or PU tubing.
- Circulate diacetone alcohol (DAA) through pump, hoses, and filter for 8-12 hours to remove possible contaminants before start-up or change over.

Visgard Dual Anti-Fog Coating



Dilution & Filtration

Dilution

- Visgard 12135 is ready to use as is, no dilution required.
- Make-up solvent is 1-methoxy-2-propanol to maintain solids.

Filtration

- Filter solutions through a 0.5 micron filter cartridge for several hours before coating operations begin, and continuously throughout coating process.
- When operations stop, drain Visgard from system and store in sealed container at 20-30°C (60-86°F).
- Circulate DAA through system and drain before replacing Visgard if shut down extends more than 24 hours.
- If shutdown is overnight only, continue pumping and do not allow Visgard to flow in contact with humid air.
- All connections must be air-tight and system designed to prevent turbulent flow, which can cause bubbles.

Visgard Dual Anti-Fog Coating

Curing Tips

- Best cure obtained heating one hour at 125°C (257°F).
- Check actual surface temperature with temperature indicating labels.
- Visgard 12135-SP will not cure hard at temperatures below 110°C (230°F), under-cured coating feels tacky and has poor abrasion resistance.
- Harden under-cured coatings by baking again at proper temperature as long as this is done within a 2-3 day window.
- Severe over-curing may cause discoloration.
- Surface haze may develop under ambient humilities, or if cure time is extended. This disappears upon standing for several hours at lower humidity.
- Molded parts with high levels of stress are susceptible to solvent attack.

Visgard Dual Anti-Fog Coating

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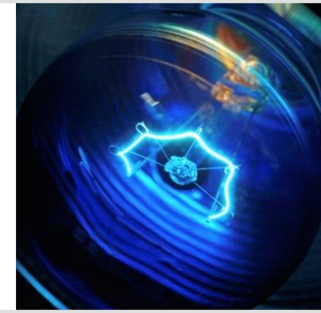
Curing Precautions



- Stress crazing can affect optical clarity and reduce impact strength, it is essential to fully test molded parts before offered for commercial use.
- If stress crazing is severe, annealing parts for two (2) hours at 140°C (266°F) before coating reduces stress.
- After annealing, let parts gradually cool to room temperature before coating.
- Coated parts can be pre-dried 15 min. at 100°C to flash off solvents, followed by normal cure cycles.
- Coatings may be pre-cured 10 min. at 100 - 110°C (212-230°F) to reduce surface tackiness, followed by full cure, but this is not necessary.
- If necessary, pre-cured coatings can be stripped for re-coating by immersing parts in DAA or Dowanol PM.
- Fully cured coatings are very difficult to remove.

Visgard Dual Anti-Fog Coating

Chemical Resistance

Visgard Coatings

- Resist exposure to most alcohols, ethers and aliphatic hydrocarbons, including gasoline and jet fuel.
- Withstand commercial glass and lens cleaners, even those containing ammonia.
- Avoid exposing to strong acids.
- Not intended to resist aggressive solvents such as methyl ethyl ketone and toluene.

Visgard Dual Anti-Fog Coating

Shelf-Life & Packaging

Shelf-Life

- Six (6) months from date of shipment if stored in tightly sealed containers in a cool dry place – longer if refrigerated.
- Keep away from sources of ignition.
- Consult MSDS for shipping, disposal and health hazard information.

Packaging

- Use high density polyethylene (HDPE) bags rather than low density bags, preferably sealed to exclude moisture.
- Do not package in an area where humidity is above 70%.

Visgard Dual Anti-Fog Coating

Tinting

- Cured Visgard coatings accept commercial ophthalmic dyes at room temperature without sacrificing anti-fog properties.
- Usually only 1-5 min. dip time required, gradient tints are easily produced by controlled withdrawal.
- Adding 5% methyl or ethyl alcohol to aqueous dye bath promotes uniform dyeing.
- Important to test colorfastness and ultimate effect of coating properties for each individual color.
- Very deep hues (<40% visible light transmission) more likely to reduce scratch resistance and anti-fog performance.

Visgard Dual Anti-Fog Coating

Clean Up

- Wash equipment with isopropanol, diacetone alcohol or methyl ethyl ketone before coating cures.
- Fully cured coatings may be difficult to remove.
- Dispose of waste in accordance with Federal, State and Local Regulations.

Visgard Dual Anti-Fog Coating

Coating Technologies

Typical Properties

Description	Visgard µ @8 Thickness	Visgard µ @4 Thickness	Most other Hardcoats/Anti-fogs
Anti-Fog	Pass ASTM F659	Pass ASTM F659	Fail ASTM F659
Taber Abrasion*	10% ΔHaze	18% ΔHaze	4-8% Δ Haze
Falling Sand Abrasion	Diffusion of Light = 1.5	Diffusion of Light = 7	Diffusion of Light = 6 to 28
Bayer Abrasion	5% ΔHaze (R=4)	15% ΔHaze (R=1.5)	20-30% ΔHaze (R= 0.6 to 1.0)

* 100 cycles at 500g load with CS10F wheels. Only cyclohexane and a soft clean-room wipe is to be used to remove. Taber residue from the abraded surfaces of Visgard test plaques. Using another solvent will result in erroneous haze measurements.

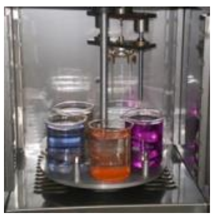
Anti-Fog Application Techniques

Environmental Considerations

- Must have environmental controls
- Cleanliness – clean room class 1000 or lower conditions
- Temperature and humidity
- Parts & Cleaning – “Garbage in, garbage out”
- Detergent cleaning – may be multiple steps
- Water Rinsing – ideally with multiple steps using de-ionized water (DI)
- Drying – to remove water droplets
- Coating Application
- Including primer
- Drying/Solvent evaporation – required for primer & AF coating
- Primer – ambient conditions or by heating (to speed-up process)
- AF coating – may involve pre-curing
  - Almost tack-free to prevent dirt from sticking to parts
- Curing – to achieve final performance properties

Anti-Fog Application Techniques

Dip Coating Process



Parts dipped and withdrawn from tank filled with coating solution

- Parts are coated on both sides
- Coating thickness controlled by part withdrawal rate
  - Fast withdrawal for thick coating
  - Slow withdrawal for thin coating

Coating tank design

- Overflow type with continuous filtration of coating

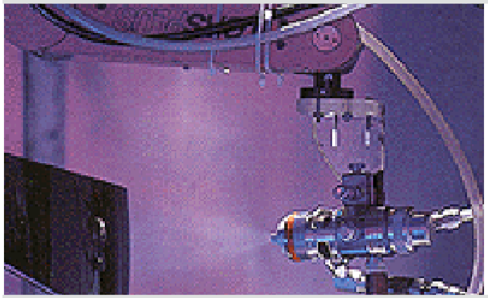
Anti-Fog Application Techniques

Flow Coating Process

Flow Coating

- Steady flow of coating applied to vertically hanging part by a hose manually moved from bottom to top and across top of part.
- Parts coated on each side separately
- Coating thickness controlled by making adjustments to coating solids, viscosity and solvent composition
  - Coating thickness varies from top to bottom of part
  - Top will be thinner than bottom (Wedge Effect)
- Equipment designed to allow collection/filtration and re-use of excess coating flow-off

Anti-Fog Application Techniques



Spray Coating Process

Spray Coating Process

- Coating atomized under pressure and delivered onto part in a spray
- Parts coated on each side separately
- Coating thickness controlled and varied by
  - Making adjustments to coating solids, viscosity and solvent composition
  - Speed and overlap of spray nozzle relative to part
- Coating re-use is not possible

Coating Technologies

Anti-Fog Coating Selection Process

Vistex® Aqueous Coating 105-20 (Parts A&B)

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Vistex® Aqueous Anti-Fog Coating

105-20 Two parts (A & B)

- Vistex Aqueous Anti-Fog coating renders surface permanently fog-free.
- Intended for use on molded PC lenses, windows, mirrors, etc. **(see “substrates”).**
- Two components (A & B) must be combined, and coated article must be baked to initiate curing.
- Cross-linked hydrophilic polymer composition causes condensed water droplets to spread evenly.
- Highly durable when wet, coating will not saturate and fail under very humid conditions, as will many other anti-fog materials.
- Anti-fog properties retained even after repeated washing with commercial glass and lens cleaners.

Vistex Aqueous Anti-Fog Coating

105-20 Two parts (A & B)

- Cured coating offers excellent clarity, will not **discolor with exposure to sunlight.**
- Outstanding **chemical resistance**.
- Vistex unaffected by, and protects substrates from, brief exposure to most solvents (see “Chemical Resistance)”.
- Coated sheets may be drape formed, embossed or heat pressed.
- Scratch resistance slightly better than untreated plastics – superficial scratches that occur when dry permanently heal when exposed to moisture.

Vistex 105-20 Two-Part Coating

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Physical Characteristics

DESCRIPTION	PART A	PART B
Appearance	Colorless to pale amber	Clear to slightly hazy
Viscosity (Brookfield)	75-150 cps	10-25 cps
Solids Content (by weight)	13%	27%
Solvent	Water/N-methyl	Pyrrolidone
Density	1.030 g/ml (8.6 lbs/gal)	1.081 g/ml (9.0 lbs/gal)

Vistex Aqueous Anti-Fog Coating

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105-20 Mixing Ratio

- Mix 10 parts "A" with 1 part "B", stirring thoroughly with low speed mixer to prevent air entrapment. It's best to mix and dilute 12 to 24 hours prior to use.

SUGGESTED STARTING FORMULATION	% NV = 10%
Vistex (Part A)	100
Curing Agent	10
Vistex (Part B)	Viscosity = 50 cps
IPA	30
Water	14

Vistex Aqueous Anti-Fog Coating

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105-20 Mixing

- For most applications, mixed anti-fog solution should be diluted to reduce solids content to 10% from initial 14%.
- Mixture of isopropanol (IPA) and water particularly effective as alcohol releases trapped air, retards development of foam and promotes uniform wetting of low energy surfaces.
- ***Commercial de-foamers must be avoided***.
- Weigh ingredients in separate clean containers first, then add dilution solvents to Vistex mixture, and **not** the reverse.
- Vistex compositions have limited tolerance for IPA and other non-aqueous solvents.
- For most formulations, total concentration should not exceed 30% by weight. Anything above 30%, solution may become cloudy as sensitive materials begin to precipitate, depending on amount of water in formulation.
- Vistex solutions can be diluted with large amounts of solvent mix containing 67% IPA and 33% distilled or de-ionized water.

Vistex Aqueous Anti-Fog Coating

105-20 Mixing

- Curing agent (Part B) may become turbid or material may settle at temperatures below 55°F (13°C).
- Always allow solutions to warm to room temperature before use.
- If either component is frozen, it will be fully usable after all solid material re-dissolves to a clear solution.
- Other useful solvents include methyl; ethyl ketone (MEK), isobutanol, normal butanol and tertiary butanol.
- Water and MEK most effective at reducing viscosity.
- MEK affords best combination of viscosity reduction, wetting and foam prevention.
- MEK may also attack sensitive substrates if used in concentrations over 10%.
- Adding IPA to a given formulation will not appreciably affect viscosity, butyl alcohols actually increase viscosity.

Vistex Aqueous Anti-Fog Coating

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Application & Cure Requirements
Thickness

- Recommended dry coating thickness 0.15 -0.30 mils (4 to 8 microns).
- Thinner coatings less resistant to abrasion and may have reduced anti-fog properties.
- Theoretical coverage ranges from 750-1,600 sf per gallon (18 to 39M^2 per ltr.)
- Individual lenses best coated at 9 -10% solids.
- For larger parts, an 8 - 9% concentration may be necessary to provide low viscosity and prevent excessive buildup toward bottom of coated article.
- Coatings thicker than .05 mils (12.5 microns) take longer to cure and may not develop full hardness.

Vistex® Aqueous Anti-Fog Coating

Application & Cure Requirements
Temperature

- Baking should begin as quickly as possible after coating application; while coating is still wet.
- Coated parts should be allowed to drain for 20 min. or less before oven curing.
- Air-dry times of 30 min. or more may interfere with complete cure, especially if ambient humidity is above 70%RH.
- High humidity may also contribute to haze, notable at top of coated parts.

Vistex Aqueous Anti-Fog Coating

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Proper Curing Essential to Coating Performance

- Use of temperature indicating labels strongly recommended.
- Minimum surface temperature of 257°F (125°C) necessary for proper curing to take place. Complete curing requires:

Time	Temperature
30 to 40 min.	266°F (130°C)
1 to 2 min.	302°F (150°C)

- Cure time depends on a number of factors, including mass of coated article and efficiency of oven.
- Yellow discoloration indicates over-cured coating and exposure time should be reduced.

Vistex Aqueous Anti-Fog Coating

Proper Curing Essential to Coating Performance

- Coated parts may be dried for 10 min. at a low temperature (e.g. 140°F, 60°C) and subsequently cured at higher temperatures. This is particularly useful for lenses which are highly stressed.
- Time interval for complete cure must not exceed 3 - 5 hours.
- Degree of cure can be evaluated by scrubbing 25 times with a fine (white) Scotch Bright® pad and water.
- Coating should not smear or abrade from surface.
- If more than a few scratches show, coating is either under-cured or is too thin (>3 microns).
- Thin coatings usually have an iridescent (rainbow) appearance and may seem to be under-cured when they are actually fully cured.

Vistex Aqueous Anti-Fog Coating

Application Methods

- Suitable for flow, dip and roller application techniques.
- For spraying, dilute to 5 or 6% NV. High dilution ratio offset by flash evaporation from atomized droplets.
- Small amounts of butanol or diacetone alcohol prevents humidity blush and slows evaporation so droplets have a chance to flow together.
- At 6% N.W., do not exceed 30% organic total solvent.
- White or hazy precipitate indicates system does not have enough water to keep all materials in solution.

Vistex Aqueous Anti-Fog Coating

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Application Formulations

Suggested Formula at 5.5% Solids:	
105-20 Part-A	100
105-20 Part-B	10
Isopropanol	75
Propylene glycol methyl ether	15
Distilled water	18

- Be careful to prevent contamination by grease, oils and other lubricants, especially silicones. Solvents other than those mentioned on previous page must be carefully tested for their effect on anti-fog permanence and degree of cure.

Vistex Aqueous Anti-Fog Coating

Preferred Substrates
Polycarbonate (PC)

- Excellent wetting, flow and adhesion obtained with use of primers or additives.
- Some substrates such as glass, metal and metalized plastics may require pre-treatment with primer to promote adhesion.
- Coated articles must be free of surface contamination (e.g. from oils, mold releases and masking residues).
- Plastics other than PC can be coated as long as material can tolerate baking temperatures of 266°F (130°C) or higher.
- Coating and curing operations may reduce impact resistance of PC and other plastics. While effect is minor, it is essential to include comparative tests in any evaluation program.
- Coated articles may be subsequently drape formed or hot pressed. Coating cracks if elongation exceeds 25-30%, as in vacuum forming operations, and anti-fog is lost.
- Coating tolerates brief exposures to temperatures over 350°F (175°C) and exhibits long-term stability at 140°F (60°C).
- Contact FSI Coating Technologies for coating acrylics and other plastics with lower heat tolerance.

Vistex Aqueous Anti-Fog Coating

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Maintenance and Care

- Properly cured Vistex coatings usually outlast coated item.
- Excellent resistance to oil based stains.
- Water-soluble stains may penetrate coating if left in contact with it for an extended period of time.
- Grease and oils contaminate surface and impair anti-fog effectiveness, remove with strong grease cutting detergent such as Top Job®, Fantastik® or Formula 409®.
- Clean coated articles regularly to prevent accumulation of oily deposits. **Avoid using abrasive cleaners or pads.**
- It is normal for coating to pass through a tacky phase as it dries.
- To clean, wipe with a wet cloth or paper towel and allow to dry**. DO NOT TRY TO RUB TO DRYNESS.** This will leave smudges and will necessitate cleaning again.

Vistex Aqueous Anti-Fog Coating

Scratch & Chemical Resistance

- Vistex scratch resistance superior to untreated PC, however not designed to perform like silicone or acrylic hard coats.
- Superficial scratches caused by fingernails, harsh fabrics or other abrasive materials, such as Velcro®, can be permanently healed by wiping with damp cloth or by breathing on scratched coated surface.
- Coating will not crack, peel or flake as it ages.
- Unaffected by brief exposure to methanol, ethanol, isopropanol, acetone, methyl ethyl ketone, diacetone alcohol, toluene, hexane, gasoline, glycol esters, ethyl acetate and ammonium hydroxide solutions.
- Avoid exposure to strong acids and alkalis.
- Water and lower alcohols soften coating and make it more susceptible to gouging by hard objects. After drying, normal hardness returns.

Vistex Aqueous Anti-Fog Coating

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Clean up & Removal

- Clean equipment with soap and water or a water and isopropanol solution.
- Removal of dried coatings may require a strong polar solvent such as N-methyl pyrrolidone or diacetone alcohol.
- When fully cured, it may be impossible to remove coating except by mechanical abrasion.

Vistex Aqueous Anti-Fog Coating

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Shelf-Life

- Vistex solutions remain usable for 1 year or longer, if the two parts are kept separate.
- A light, fluffy precipitate may develop on standing in Part A, this can produce slight haze or particular contamination in cured coatings. Usually this does not become apparent for several months. If it does appear, re-dissolve precipitate by warming briefly to about 150°F (65°C).
- After mixing Parts A and B, the shelf life will range from 6-12 months depending on amount of dilution.
- Shelf-life can be extended by refrigeration, do not allow material to freeze.
- **Test old solutions before use. <u>Any mixture that has become milky or contains white insoluble precipitate must be discarded.</u>**

Vistex Aqueous Anti-Fog Coating

Handling & Safety Precautions

- Avoid contact with skin and eyes.
- Do not take internally.
- Observe proper industrial hygiene, including splash goggles and impervious gloves.
- Provide adequate ventilation.
- Avoid contact with strong acids or alkalis.
- Dispose of solution and clean-up wash water in accordance with local, state and federal regulations.
- This product is not a hazardous waste under RCRA guidelines.

Summary

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36 Years of Product Innovation
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High Performance Anti-Fog Coatings

Innovative Product Solutions

- Enhance products
  - Surface protection from fog, impact, abrasion, scratch and chemical attack
  - Resistance to environment exposure (UV, humidity)
  - Improve image without compromising optical clarity
  - Durability, functionality and product differentiation
- Product benefits
  - Long shelf-life
  - Tintable, flexible, formable
  - Suitable for multiple substrates and application methods

Performance with Chemistry™

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36 Years of Innovation

Global Leader in Anti-Fog Coating Systems