

Spray Silvering Instructions

Introduction

Spray Silvering uses an air compressor and specially designed spray guns to apply silvering chemicals to glass and other substrates. It is similar to spraying paint with a compressed air gun but there are extra steps and components needed to prepare, mirror, rinse and dry a glass sheet for mirroring.

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Spray Silvering Instructions

Overall Sequence of Operations

1. Clean and polish the glass
2. Sensitize the glass with the Tin for Silver
3. Mirror the glass with the silver chemicals
4. Back the silver with galvanic copper
5. Air-dry the coppered surface
6. Paint the copper with backing paint
7. Clean off spills from the front face of the glass

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Glass Tray and Rack

The silvering process works the same way whether the glass is vertical or horizontal. We think that you get a more uniform result and use silver more efficiently when the glass is horizontal.

Spray silvering is a very wet process. You will need to construct a tray to catch the run-off and a rack to hold the glass while you work. Since every shop is different, we offer these suggestions:

- Your work area must be large enough to let you maneuver the glass safely
- The tray and rack must be level, sturdy and waterproof (see http://angelgilding.com/media/documents/Build_A_Mirror_Bench.pdf)
- The rack must hold the glass at least 2" above the tray to avoid splash back
- The tray must drain into a separate container to capture and treat the run-off (see http://angelgilding.com/media/documents/Waste_Treatment.pdf)
- Spraying produces a chemical mist. Your shop needs an active ventilation system and you need a respirator designed to trap mirroring chemicals (see <http://angelgilding.com/A3525.html>)

Compressed-Air Equipment

Air Compressor

For spray silvering, you need an air compressor that can deliver at least 6 to 8 CFM (cubic feet per minute) at 40 to 60 PSI (pounds per square inch). The HP (horse power) of the compressor is much less important than its delivery rate. The larger the tank (measured in gallons), the less often the compressor will cycle off and on. Buy the largest compressor you can afford; it will last longer and you will be able to use it later for other things, such as sandblasting. All of our spray silvering equipment is designed to withstand a maximum pressure output of 150 PSI.

Regulator

You need a regulator to monitor and control the air pressure from your compressor. Some compressors have a built-in regulator and some do not. Some stand-alone regulators include a water trap. You need a water trap for sandblasting; you do not need one for spray silvering. You need to install the regulator between the air compressor and the manifold.

Air Hoses

If you have a stand-alone regulator, you need to connect it to the air compressor with an air hose. The length of the hose and the size of the connections depend on your compressor and your regulator. You will need another air hose with a 1/4" NPT male end to connect the regulator to the Spray Silver Manifold. Your set-up will be more flexible and easier to repair if

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you use “quick-connect” connectors throughout. All hoses must be designed to withstand the maximum pressure your compressor can supply. Our hoses are designed to withstand a pressure of up to 150 PSI. (See Appendix for more information on NPT threads and “quick-connect” connectors)

Manifold

The manifold is a rigid brass assembly that allows the compressor to drive multiple devices at once. Each outlet has a separate turnoff valve. The ¼” NPT male end on the hose connects to the ¼” NPT female end on the air hoses that connect to the spray guns. Because each outlet has a separate turn-off, you do not need to use “quick-connect” connectors to connect the gun hoses to the manifold.

Spray Guns

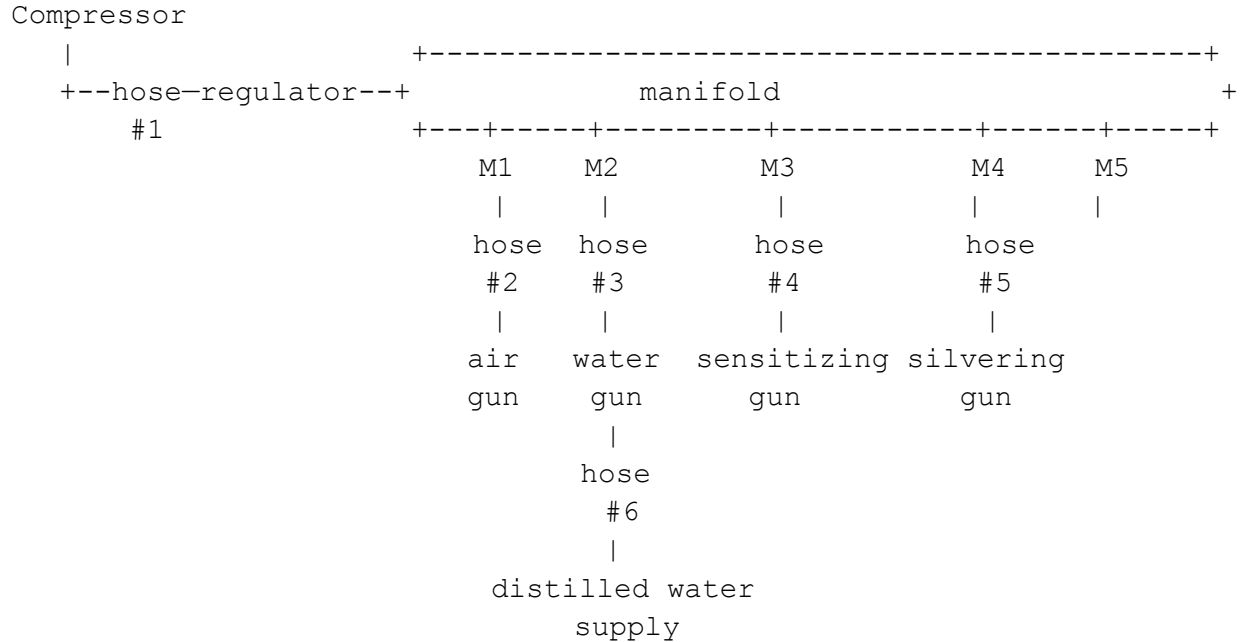
These are hand-held air-driven devices (stainless steel in the case of the silvering chemicals) that deliver liquid or air from the supply bottle to the glass. For spray silvering, you need four (4) separate guns:

- Silvering gun (dual-nozzle) for the silvering chemicals
- Sensitizer gun for Tin for Silver
- Distilled water gun for rinsing
- Air gun to force dry the finished mirror

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Compressed Air Train

The following schematic shows how to connect all these components together.



Air Gun

The air gun is used to blow-dry the mirror after you silver it and before you paint it.

Water Gun

The water gun is used to rinse the glass with distilled water between each step in the process. You must use distilled or de-ionized water for mirroring. The water gun has a barbed connector and a plastic hose that feeds into a distilled water container. The container must allow air to flow in as the gun draws the water out.

Sensitizing Gun

This is used to deliver the sensitizer (diluted Tin for Silver). You must sensitize the glass before you silver it. The diluted Tin for Silver is held in a one quart (1 liter) bottle underneath the gun. The gun and the metal parts of the HDPE bottle are made of stainless steel to resist attack from the tin chemical. The angle of the bottle relative to the gun can be adjusted when you attach the bottle.

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Silvering Gun

The silvering gun is basically two guns joined together with one handle and one trigger. The gun lets you keep the activated silver and the silver reducer separate until you mix them together on the glass.

Our silvering gun has a stainless steel body to resist attack from the silver chemicals. It has a ¼" NPT male inlet to attach to the female-ended hose. Each side has a separate screw head and feed tube to attach to a separate 1-quart HDPE bottle – one bottle for Activated Silver and one for Silver Reducer.

The jets from the two guns come together at a point about 1 foot in front of the gun. To get a smooth layer of silver, hold the gun at least 3 feet away from the glass so that they merge before they hit the glass. You do not need or want to “force” the silver onto the glass.

Adjusting the Silvering Gun

Before you use the guns, be sure that each side is delivering the same rate of flow. Use distilled water for this test, not silvering chemicals or tap water. Measure 500 mL of distilled water into each bottle and attach the bottles to the gun. Point the gun into a sink or tub, squeeze the trigger and hold for about 30 seconds. Remove the bottles from the guns and set them flat on your bench. The bottles should have lost the same amount of water. If the level is not the same, adjust the knobs on the end of each gun and repeat the test until the guns are spraying equally. The silvering process will not work if the guns are out of balance.

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Filling the Silver Bottles

The left bottle should be filled with Silver Reducer while the right bottle should contain Activated Silver. These are made up by diluting the concentrated silver solutions in your kit. This is done as follows:

- Wash the left bottle with distilled water and empty it.
- Measure **40 ml** of Concentrated Spray Silver Reducer into the bottle. Add **960 ml** of distilled water. Attach it to the gun.
- Wash the right bottle with distilled water and empty it.
- Measure **40 ml** of Concentrated Spray Silver Solution into this bottle. Add **920 ml** of distilled water.
- Add **40 ml** of Concentrated Spray Silver Activator to the diluted silver solution (1000 ml total). Attach the bottle to the right side of the silvering gun.

SAFETY NOTE:

You must **never** mix Concentrated Spray Silver Solution with Concentrated Spray Silver Activator without adding water. Concentrated Spray Silver Solution and Concentrated Spray Silver Activator together can form an unpredictable, explosive mixture called fulminating silver. When you add Spray Silver Reducer, as you do when you are silvering, the mix cannot form fulminating silver so waste chemicals are not dangerous. The mix does not form fulminating silver when it is diluted. See <http://angelgilding.com/ChemicalSafety.html> for details.

Mix up only as much diluted silvering chemicals as you can use in one day.

Tips on Cleaning the Glass

Mirroring is very sensitive to dirt, grease, particles and chemicals. It is essential that the glass be perfectly clean. Clean the glass with a polishing compound (cerium oxide) and a powerful detergent that does not leave a residue (such as <http://angelgilding.com/A2517.html>).

The best test for cleanliness is the water-bead test. When you have washed off the polishing compound with hot tap water and a sponge, flood the surface with more tap water until it drips off of the edges. Let it sit for about 15 seconds and visually check that no beads of water or dry spots can be seen. If these occur, they are typically at the edges or corners. If the water does not form a straight bead along the edges, polish that area with the felt polisher, sponge off the polishing compound and do the flood test again. It may take several times to get this done. Make sure that the contamination is not from particles of polishing or cleaning compound. If the glass is not perfectly clean, you will not be able to get a perfect silver deposit. You will get

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bare spots, dark areas and ragged edges. If this happens, you need to remove the silver and re-clean the glass before you re-silver it. Be sure to rinse the glass thoroughly with distilled or de-ionized water before you sensitize it.

Sensitizing the Glass

Our sensitizer (Tin for Silver) comes in concentrated form to increase its shelf life. You will need to dilute it before use. Diluted Tin for Silver has a shelf life of only 6 to 8 hours. Mix up only as much as you can use in one day.

- Wash the sensitizer bottle with distilled water and empty it.
- The mixing ratio for Tin for Silver is 30:1. To make 480 ml (1/2 quart) of diluted Tin for Silver, pour 15 ml of Tin for Silver Concentrate into the sensitizer bottle and add 450 ml of distilled or de-ionized water. For spray silvering you will use 30 to 45 ml of diluted Tin for Silver to sensitize 1 square foot (0.1 sq m) of glass.
- Pour the mix into the sensitizer bottle. Attach the bottle to the sensitizer gun.

After cleaning and rinsing the glass with distilled water, spray a generous amount of sensitizing solution all over the glass, making sure all areas are covered evenly. One quart (1 liter) of diluted Tin for Silver covers about 28 square feet (2.6 square meters) of glass.

When you have covered the entire surface, wait for about 30 seconds for the sensitizer to work then rinse it off with the water spray. The “tinning” or “sensitizing” layer is invisible but very important. Use a generous amount of water to remove the sensitizer pushing it over the edge into the collecting tray. The invisible sensitizing chemical attaches firmly to the glass – you can not rinse it off. If you do not rinse the sensitizer enough, the silver will not deposit properly.

Silver Mirroring

Now at last we come to the actual mirroring. Using the same technique as the sensitizer, spray the silver solutions onto the glass, holding the gun about 2 feet (0.6 meters) away from the surface of the glass. Because you have to stand back do this, there will be some overspray of chemicals so be sure to protect the area around the glass with plastic sheeting. You should also be careful with the fumes that come from the spray. If you will be doing a lot of spraying, you should wear a respirator and the room should have a ventilation system.

Keep waft-spraying for about 30 seconds until you see a white area cover the glass. This means that the silver is depositing properly. If it doesn't seem to be working, you may be standing too close. As you continue to spray, you will see a yellowish flood on the surface which is one of the waste products. If you are not sure if there is enough silver on the glass, stop spraying, let the surface liquid settle down and check if you can see through the glass. If you can, the silver is not

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thick enough. It helps if you have a white base to the mirroring table to reflect the supporting rack though the glass. If some areas need touching up, spray them again, avoiding concentrated spraying at just one point. The finished mirror should be opaque or nearly opaque.

Silver Rinsing

After you have silvered the glass, use the distilled water spray gun to push all the waste liquid over the edge of the glass. Finish up by starting at one corner and pushing the liquid ahead of the spray area until no colored or cloudy liquid remains on the surface and all of the runoff is clear.

Galvanic Copper

We provide a concentrated solution which you will dilute into a hand-held trigger spray bottle. Measure 250 mL of concentrate into the 1-quart spray bottle, fill with distilled water and screw on the top.

To use, first sprinkle a light even layer of iron powder from the sifter onto the wet, freshly-silvered surface. Next spray the copper solution over the mirror, using the spray to push around the iron if it forms clumps or built-up areas. Within a few seconds a red copper layer will form and should cover the entire silvered area. When complete, rinse the glass thoroughly, making sure that all of the brown-black particles of iron are removed and the surface is copper.

See http://angelgilding.com/media/documents/Galvanic_Copper_Instructions.pdf for details.

Air Drying

To dry the mirror, use the air gun and the same “push” technique you used to rinse the glass. Make sure you do not flick waste water from the mirroring tray back onto the glass. If you do, just rinse it off with water spray and dry again.

If you do not want to wait for natural evaporative drying, you may gently warm the glass with a heat gun or hair-dryer to thoroughly dry it, being careful not to point the heat at one spot.

Painting

When you are sure the glass is perfectly dry on both sides, apply the backing paint liberally with a brush or roller, making sure all of the red copper is covered with paint. The paint should dry hard in a couple of hours.

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Front Face Cleaning

Paint spots and silvering chemicals often creep over the edge onto the front face of the mirror. When the backing paint is completely dry, you can remove it with a new single edge razor blade or a little pumice on a wet paper towel. Be careful not to scratch the glass.

Silver drips or spots can be removed with a paste of pumice and Silver Remover. Be careful not to let the Silver Remover attack the mirror back. Give the glass a final polish with commercial glass cleaner and a dry, clean towel.

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One-Time Setup Checklist

1. Do this once before using the equipment for the first time
2. Refer to the schematic "Compressed Air Train" above
3. Set the regulator on your compressor to deliver **40 psi** (pounds per square inch)
4. Attach the compressor hose to the manifold
5. Attach four (4) air hoses to the manifold
6. Attach the four (4) guns – air gun, water gun, sensitizer gun and silvering gun – to the other end of the hoses
7. Attach one end of the siphon hose to the barbed connection on the water gun
8. Insert the other end into a distilled water bottle
9. Turn on the compressor and let the tank fill with air
10. Test the water gun to be sure it is operating properly
11. Label one quart bottle "Tin for Silver"
12. Fill the bottle half way with distilled water
13. Attach the bottle to the sensitizer gun
14. Spray water from the sensitizer gun to test all the connections and clean the bottle and the gun
15. Empty the quart bottle and blow all remaining water out of the gun
16. Use a felt pen to write "S" on one side of the silvering gun and "R" on the other side
17. Label one quart bottle "Silver" and the other quart bottle "Reducer"
18. Fill the bottles equally with distilled water
19. Attach the bottles to the correct side of the silvering gun
20. Spray water from the gun to test all the connections and to clean the bottles and the gun
21. Adjust the guns to deliver equal amounts of liquid (see above)
22. Empty the quart bottles and blow all remaining water out of the gun

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Silvering Setup Checklist

1. Do this before every silvering session
2. Measure out 450 ml Distilled Water
3. Pour it into the "Tin for Silver" bottle
4. Measure out 15 ml of Concentrated Tin for Silver.
5. Pour it into the "Tin for Silver" bottle
6. Rock the bottle to mix Tin for Silver
7. Re-attach the Tin for Silver bottle to the sensitizer gun
8. NOTE: Diluted Tin for Silver has a shelf life of about 6 hours. Mix up fresh Tin for Silver every day.
9. Measure out 920 ml Distilled Water and pour it into the "Silver" bottle
10. Measure out 40 ml Concentrated Spray Silver Solution
11. Pour it into the "Silver" bottle
12. Measure out 40 ml Concentrated Spray Silver Activator
13. Pour it into the same "Silver" bottle
14. Rock the bottle to mix the Activated Silver solution
15. Attach the "Silver" bottle to the "S" side of the gun
16. Measure out 960 ml distilled water and pour it into the "Reducer" bottle
17. Measure out 40 ml Concentrated Spray Silver Reducer
18. Pour it into the "Reducer" bottle
19. Rock the bottle to mix the silver reducer solution
20. Attach the bottle to the "R" side of the gun

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Silvering Checklist

Clean and Polish the Glass

1. Wear gloves at all times to keep finger prints off the glass and the chemicals off your fingers
2. Use a clean sponge to clean the glass thoroughly with Concentrated Glass Cleaner and hot water, paying special attention to the edges
3. Rinse the glass with hot tap water
4. Sprinkle a little cerium oxide on the glass
5. Use our Maple Felt Polisher and hot water to polish the glass
6. Use a dedicated sponge and hot tap water to physically remove the cerium oxide
7. Inspect the glass to be sure that the water does not bead up anywhere
8. Place the glass on your rack in your mirroring tray
9. Spray-rinse the glass thoroughly with the distilled water in the water gun
10. Do not touch the glass until the silvering is complete

Sensitize the Glass with the Tin for Silver

11. Use the Sensitizer gun to spray the glass all over with Tin for Silver
12. Wait about 30 seconds for the sensitizing to take effect
13. Spray-rinse the glass thoroughly with the water gun (you will not be able to rinse off the sensitizer)

Mirror the Glass with the Silver Chemicals

14. Use the Silvering gun to spray the glass with the silvering chemicals
15. Wait about 30 seconds for the silver to develop
16. Repeat these two steps until you cannot see through the glass
17. Spray-rinse the finished silver with distilled water

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Back the Silver with Galvanic Copper

18. Sprinkle a very light, even layer of iron powder all over the wet silver
19. Spray the silver with diluted Galvanic Copper solution in the trigger spray bottle
20. Use the force of the spray to move the iron powder to areas where the copper is not fully deposited on the silver
21. Use the distilled water spray gun to remove all traces of iron powder

Air-dry the Coppered Surface

22. Use the air hose to dry the coppered silvered glass
23. Stand the glass on edge in a dry location to allow the face of the glass to dry completely

Paint the Copper with Backing Paint

24. Paint the coppered silver with mirror backing paint using a brush, roller or paint spray gun. For extra protection, paint the mirror with Mirror Undercoat before you apply the backing paint.
25. Allow the paint to cure completely before installing the mirror.

Clean off Spills from the Front Face of the Glass

26. It is normal for some silvering chemicals to deposit on the face (the reflective side) of the mirror. Use a paste of Silver Remover and pumice to clean any stubborn spots.
27. Finish cleaning the face with a commercial glass cleaner sprayed onto a soft rag.

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Appendix 1 – National Pipe Thread

To ensure these all connect without leaks, there is a standard called NPT (National Pipe Thread) which specifies exactly how large the connectors are, the number of threads per inch, the diameter and so on. Spray silvering usually uses ¼" NPT connectors which have the following specification:

- One end of the connector has a male screw thread with a taper of 1/16" per inch
- The other end has a female screw thread which has a parallel thread
- The threads are spaced at 18 per inch so the pitch is 1.41122 mm
- The male end must be wrapped in Teflon or similar tape so that as the joint is tightened, the tape fills in the gaps between the two sets of threads
- The outer diameter of the thread is 13.72 mm, the crests of the threads having a diameter of 13.87 mm
- The joint should be tightened about 3 turns by hand and then 4-5 using a wrench and not repeatedly tightened and un-tightened (or over-tightened)

Because compressors usually remain fixed while spraying equipment is put away when not in use, the hose that connects the compressor to the spraying setup usually has quick-connect rotating couplings (also known as a Milton coupling). These attach by pulling back on the ring at the end of the fixed side of the connection, pushing in the hose end and releasing the ring. All other connections are permanent, taped and tightened.