Making Glass Daguerreotypes

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WARNING

All daguerreian procedures involve materials and methods that pose potential risk of immediate injury, possible damage to your long term health and can pollute the environment. This is not an industrial hygiene training manual. Do not attempt any of the procedures in this paper if you have an inadequate grounding in industrial safety. You must also have access to and use proper safety equipment including but not limited to ventilation hoods, safety glasses, face shields, airway protection masks, chemical resistant gloves & clothing, chemical spill handling materials, eye/body washing apparatus and appropriate first aid supplies. It is best to work under conditions where help can be summoned quickly. The author of this paper is not responsible for any injury or loss resulting from following these instructions *regardless of their accuracy or lack thereof*.

Use entirely at your own risk.

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Introduction

This paper outlines a usable method of making silver surface Becquerel daguerreotypes on a glass substrate. Materials and methods are delineated, advantages and disadvantages of the approach are discussed and suggestions are made for future experimentation. The information is offered freely for use by persons interested in making glass daguerreotypes. It is a preliminary report of findings by a relatively inexperienced daguerreian practitioner and will doubtless be improved by comment and discussion from those with greater depth in the field.

Making daguerreotypes on glass is not a new process. Very early in my investigation of the particulars of producing daguerreotypes (April 2008), it occurred to me that a great deal of time and expense might be saved by utilizing front surface mirrors produced by chemical silvering on glass. The low cost of glass compared to copper, the simplicity of chemical silvering compared to electroplating or cladding, and the near perfect polished surface produced seemed like it would be ideal for the daguerreotype process. My pride of "discovery" was rather brief however. Shortly after coming up with the idea, I came across Jason Greenberg Motamedi 's lovely glass daguerreotype "failure" that he had posted on the Large Format Photography site (http://www.largeformatphotography.info/forum/showthread.php?t=27227&page=2) in July of 2007.

Jason discussed the difficulty he had run into during the fixing stage of the process, wherein the fixing agent had attacked the chemically deposited silver layer causing it to peel.

At about that same time Gregory Popovitch directed me to the discussion of glass plates that Irving Pobboravsky had made in his article "The Daguerreian Plate as Seen by the Contemporary Daguerreian Artist" in the section entitled "Alternative Fabrication Methods". This was originally published in the 1991 Daguerreian Annual, p114-121. (Now available in the "Making Modern Daguerreotypes" reprint produced by The Daguerreian Society and sold at http://daguerre.org/store.php). Irving discussed both vacuum deposition (sputtered) plates, as well as the chemical deposition type. He alludes to some successes with both types of plates, and gives a variety of hints as to methods to increase the chance of success. Details were somewhat limited as the material appears in an article with a larger context.

More recently I came across the account of the entirely successful glass based daguerreotype produced by Walter Johnson that was published in Vol.3 No.1 of the New Daguerreian Journal in September of 1974 (http://www.cdags.org/resources/ndj_03_01.pdf). This skillful portrait was taken by Walter on glass that had been silver coated using the sputtering process. The plate had been created by a colleague of his in the Ohio State Astronomy Department in response to Walter's continuing search for improved daguerreian materials and methods.

New Daguerreian Journal 23

Subject: Mr. Cris Duckworth, Photog: W.A. Johnson

THE DAGUERREOTYPE ON GLASS

Recent research at Ohio State University's Dept. of Photography and Cinema has produced a daguerreotype on a front surfaced mirror. With costs skyrocketing it became apparent that a less costly support material was needed to continue the classes in 19th century photographic processes. The front surface mirror has its faults, but at one tenth the cost of electro-plated materials is provides a reasonable solution to an expensive photographic process.

In private correspondence with Walter, he mentioned that the first plate he processed had failed because he also had encountered problems with the silver peeling at the fixing stage. The silver failure took place primarily at the edges of the plate. For the second effort Walter tells me that he sealed the edges of the plate with wax and created the success shown above. This information was of great interest, but since the apparatus for sputtering silver onto glass is quite expensive, I could not immediately follow that approach.

In the hope of getting additional information on the process of chemically silvering glass, I contacted Mike King of Angel Gilding in Oak Park, Illinois, USA. Mike is a professional chemist and co-owner of the Angel Gilding Co. (http://angelgilding.com). Angel Gilding sells materials and equipment for producing metal surface deposition on glass. Their customer base includes professional sign-makers, artists and others. Mike generously discussed the technical details of his process, particularly concerning the use of tin to increase the adhesion of silver to glass surfaces, as well as calculations of the thickness of silver layers created using chemical deposition.

Those who have been in the field longer than I doubtless know of other references to work on silvered glass in the daguerreian historical record. They may even have made such experiments on their own. As this method is explored and discussed by others, I imagine more such information will be brought to light. One purpose for writing this paper is to encourage others to share their knowledge of past efforts as well as details of their own research.

In spite of the reference materials I identified that are noted above, the fact remained that I was unable to obtain any highly detailed discussion of making glass based daguerreotypes. With the information that I had gleaned from my research though it seemed like success might be possible, and I decided to proceed with some practical experiments to see if I could come up with a workable method that could be shared with others in the hope that further refinements could be made. The primary challenge seemed to be the relative fragility of the silver layer produced by chemical deposition, most especially during the "wet" portions of daguerreian processing, but also during any buffing that might be required to take the silvered glass to the very high polish needed for a quality image.

(Addendum note: When I was almost finished writing this report, I ran across the material in Walter Johnson's New Daguerreian Journal Volume 1 Number 4 by O. Sherwood Poppe, that is a partial reprint of material from his 1955 MA Thesis material concerning the use of mirrored glass plates for daguerreotypes. This is a highly detailed report of method, and could no doubt be used as an alternative approach to the one outlined in this paper. Some important differences exist however - his cleaning and mirroring process is rather different and uses many more chemicals, he sensitizes using an iodine/bromine/carbon tetrachloride solution as opposed to a fuming box, and his fixer recipe is much stronger than the one outlined in this paper and does not include sodium sulfite

I also found David Burder's brief mention of having used silvered glass in his article "Making Daguerreotypes - My First 12 Months").

Silvering Glass

The first step in my own investigation was to create some silvered glass. Creation of mirrors by chemical deposition of silver onto glass is a process that has been known since at least 1835. While silvering can be accomplished by simply applying silver nitrate to glass, that process is relatively slow and inefficient. More refined methods generally employ a combination of chemicals consisting of a silver bearing solution such as Silver Nitrate, activators such as Ammonium, Potassium and/or Sodium Hydroxides that adjust pH, and a reducing agent, usually an aldehyde such as Dextrose or Formaldehyde. When combined correctly, these ingredients can produce a rapid plating of pure silver onto glass. This instruction set on the Amateur Telescope Makers web site by Michael J. Coslo is typical of what can be found online. (http://www.atmsite.org/contrib/Coslo/silver/) for those interested in do-it-yourself methods.

A simpler approach is also available using pre-mixed chemicals purchased from Angel Gilding. (Note: I have no commercial interest in this company). This company supplies thorough instructions, premixed chemical solutions in a variety of quantities, as well as equipment to aid in producing the highest quality finishes. As mentioned above it was from Angel Gilding that I also learned of the process of "tinning" glass to improve adhesion of the silver. The company supplies a stannous chloride solution that simplifies this process as well.

Although I initially purchased the Sheet Glass Mirroring kit from Angel Gilding for $175, my own experiments have led to a somewhat different set of equipment for producing daguerreian plates. This is primarily because I am working with much smaller pieces of glass than the Angel Gilding kit is designed for. My current mirroring kit consists of the following items:

1. A hand built acrylic tank with inside dimensions of 1.66" W x 8.0" L x 1.72" D (42x203x44 mm)
2. 125 ml Ready-to-use silver chemicals from Angel Gilding (A.G.)
   (tin for silver plus 3 silvering solutions - covers approx. 8 sq ft using meniscus method per A.G.)
3. 10 ml graduated cylinder from A.G.
4. 1 cup measure marked in fluid ounces from A.G.
5. Distilled water
6. 1.5 liter water spray bottle from A.G.
7. An 8x10 plastic photo developing tray
8. 2 - 10" pieces of 1" square clear acrylic tubing from A.G.
9. 2 - 5x7 plastic photo developing trays
10. A small ceramic or glass bowl
11. An 8"x8" piece of acrylic for supporting glass during cerium polishing
12. Micro-fiber cloth for cleaning/polishing glass
13. Glass cleaner from A.G.
14. Cerium Oxide from A.G.
15. A rubber bulb air duster
16. Small paper cups for mixing silvering chemicals
17. Graduated plastic medicine cup for measuring mixed Tin for Silver solution

18. A clock with a second hand
19. A simple hand built acrylic rack for standing mirror plates vertically while drying
20. Paper toweling
21. Hazardous waste disposal kit from A.G.

A note on the glass used for this project: My initial daguerreotype setup was based on silver clad copper in sixth plate size. As part of a general move to reduce costs while learning the medium I have recently completed equipment modifications to take "miniature" daguerreotypes using a 35 mm camera. As such my glass plates need only to be slightly larger than the 24x36 mm film opening in my camera. They also need to be thin enough to allow the camera to close without either damaging the camera or cracking the glass.

After some research I settled on using standard 1"x3" microscope slides for my substrate. These slides are typically 1 mm thick and quite inexpensive. ($6-7 USD per 72 count on Amazon.com - about 10¢ each). I cut these in slides in half by taping 10 slides together with blue masking tape, creating a block that I run through a small tile cutting saw that I have. The cut is not perfectly smooth as the diamond blade is rather old, but the J-Lar tape used to seal the finished daguerreotype covers the rough side. The resulting plates are 25.4 mm x ±37 mm, covering the camera opening nicely.

I also considered using the 35mm glass slide mounts produced by the Gepe company for standard slide film. The glass in these is slightly larger than the 1/2 microscope slides, perfectly edged, and is very thin. Unfortunately the most available versions are made with anti-newton ring glass which makes them unsuitable for mirroring or as cover glasses. The textured anti-newton surface is only on one side of the glass, so they could be used for mirroring on the plain side but you would still need a clear glass slide to make the cover. Gepe makes a plain glass slide, but I have only found them in 1000 packs in the USA for nearly $300 USD. You can also order a 20 pack direct from Gepe in Switzerland, but for me the postage is rather prohibitive. One possible advantage of the slide mounts is that the plastic carrier can be used as a "frame" to hold the daguerreotype and cover glass. Some will find the plastic outer frame lacking in aesthetics, but the inset aluminum inner frame makes a nice border if you like a modern look. I am likely to try these slide mounts as a substrate in the future - when my first 144 plates & covers run out.

I also discovered a wide variety of microscope cover slides available, including some fairly large sizes. These are rather thin however, and much more expensive in general, so I haven't tested any yet. Of course if you have a larger camera, I see no reason why larger front surface mirrors cannot be made and used successfully. Single strength window glass is inexpensive and available pre-cut or can be custom cut to any size. The general procedures outlined in this paper should scale up without much difficulty. After all, very large telescope mirrors have been made using this process that exceed the plate size capacity of any standard cameras. It is my intent to test larger plates in the future when I obtain a suitable camera.

Initial Testing with Mirrored Glass

When my mirroring kit arrived from A.G. I quickly made some test mirrors according to the procedures included in the box (exact current process is outlined in detail later in this paper). A first experiment involved putting a small quantity of Ilford Rapid-Fix (mixed to film strength) on a mirror surface. As expected the silver took on a frosted appearance almost immediately and the metal layer began to flake off within a minute or two. I found however by serial dilution of the fixer that I could significantly delay the effect. My reading had led me to understand that standard strength photo fixers are unnecessary for processing daguerreotypes. In photo film and paper the unphotolyzed silver iodides and/or bromides are imbedded in a gelatin matrix. To remove them from the gelatin it is common practice to use a fairly strong chemical solution. In the daguerreotype on the other hand, the compounds to be fixed are exposed on the surface of the plate in a layer only a modest number of nanometers thick. I reasoned that a very weak solution of fixer would still likely suffice to stop development and preserve the image. (I had also confirmed that pure distilled water caused no reaction in the silver surface after 24 hours of immersion).

My initial weak fixer test used pure anhydrous sodium thiosulfate mixed at a strength of 0.5 g per 50 ml distilled water. Unfortunately this first mixture was not a complete success. Although the silver layer did not come off the plate in a wholesale manner, at about three minutes I was still seeing random small points where the metal took on a frosted appearance - more than enough to mar any image on the plate. It was at this point that, prompted by a suggestion from Jon Lewis, I started re-reading Pobboravsky's treatise "Study of Iodized Daguerreotype Plates" (http://www.cdags.org/wp-content/uploads/Study_of_Iodized_Daguerreotype_Plates.pdf). In that paper he mentions the problem of free oxygen attacking pure silver particles during fixing and outlines the role of Sodium Sulfite in bringing that under control. It seemed germane to the problem at hand.

I mixed a new solution using the concentration outlined in the paper (0.5 g anhydrous sodium thiosulfate + 0.5 g Sodium Sulfite in 50 ml of distilled H_2O). I did not have the equipment to carry out the further step taken by Irving of subjecting the solution to a vacuum to remove all trapped gasses. In spite of skipping that step however, this solution proved to be successful. I was able to keep the plate immersed in the fixing solution for 15 minutes without any defects appearing in the silver. The plate was agitated gently but continuously the entire time.

After that test, I iodized a mirror plate to a golden yellow color over iodine crystals. Immersion in the weak fixer removed any visible evidence of that color after two minutes (first thirty seconds under red safelight). While not a precise quantitative confirmation, it does seem to indicate that the fixer is performing it's function even at that relatively weak strength. Thanks to Jon Lewis for suggesting this test.

Once I had a workable fixer, I also made some initial experiments with polishing. Although the mirror surface produced on glass by chemical deposition is extremely smooth, the chemicals themselves leave a slight haze on the silver that is resistant to simple water rinsing. (See figure 1). In order to get the pure silver exposed, some form of polishing is required. I tried a number of different polishes and polishers. The surface proved to be quite delicate but not impossible to clean and polish.

My initial attempt using Nuvite Nushine II S was a complete failure - simply touching the polish to the surface removed the silver layer immediately. I also tried a dry optical polishing paper - Opti-Wipe by Kim Tech. I had high hopes for this item, but it caused scratching whether dry or wet, regardless of how lightly I pressed the silver surface. Likewise I found no form of wet polishing with distilled water that was successful. I tried cotton balls and small pieces of new microfiber cloth (auto polishing material from Kragen Auto). When wet these removed the haze from the silver but also left rather noticeable scratches. I am at somewhat of a loss to explain why wet polishing did not work well. All my experiments involved light hand polishing. Although I use a random orbital polisher on metal plates, it was clearly overkill with the tiny size of my plates and the delicate silver surface.

What finally turned out to work well was simple dry polishing with jeweler's rouge using either a cotton ball or clean microfiber cloth as a carrier. Polishing was finished by using a cotton ball or microfiber cloth free of rouge to remove all traces of the rouge. The microfiber is marginally better at not leaving any tiny scratches, cotton balls are almost as good and somewhat cheaper. Using very light pressure and the minimum number of strokes to do the job I was left with a clean bright silver surface free of large scratches.

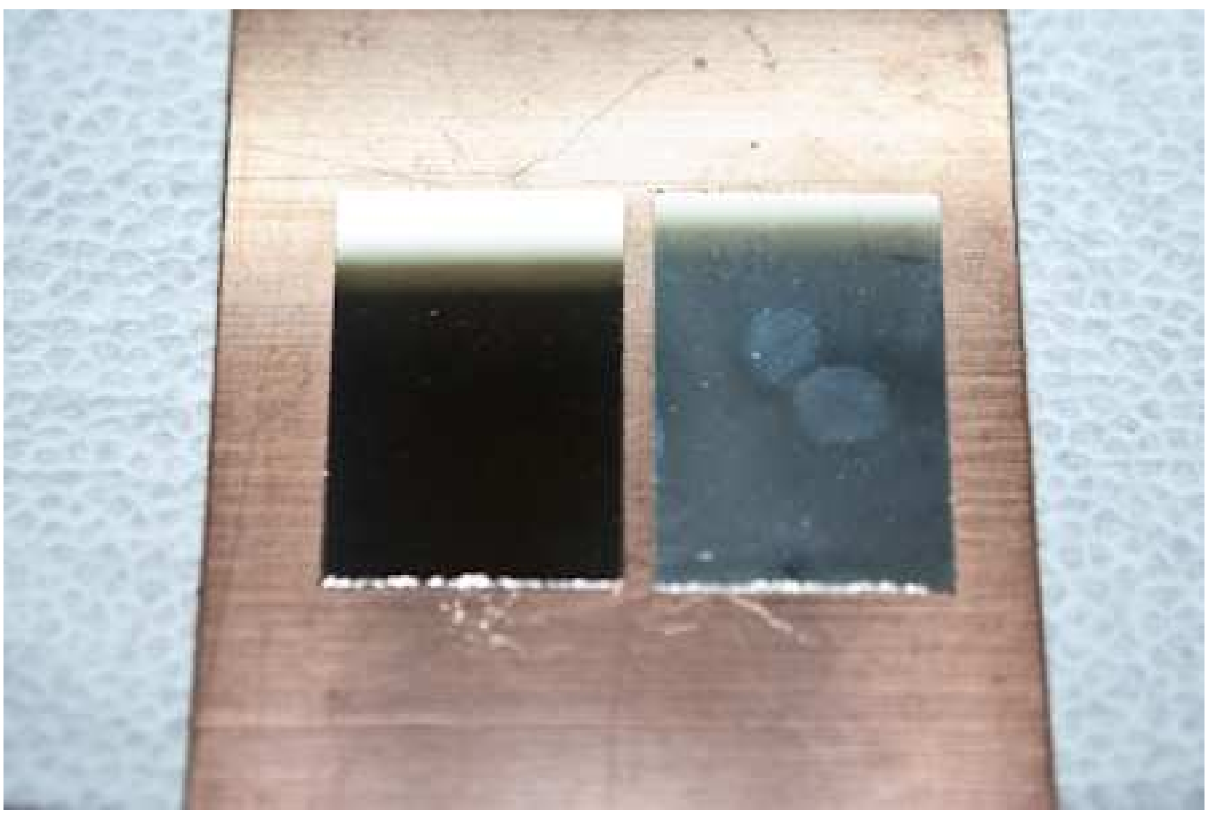

Fig. 1 - Polished and unpolished glass mirror plate

Current Procedure for Silvering Glass

My current procedure for silvering glass relies heavily on the instructional materials supplied by Angel Gilding. My main departure is that I silver my plates in a small custom made acrylic tank rather than leveling the plates and creating a meniscus of chemicals on the glass as A.G. suggests. The primary purpose of the meniscus method seems to be to conserve silvering chemicals - which is likely significant when silvering large plates of glass. My method lets me silver seven miniature plates at once and uses only 15 ml of chemicals to do so. It doesn't require as much hand-eye coordination either - which I find helpful. I also have slightly modified the cleaning procedure from that given by A.G.

Cleaning:

1) Put on nitrile gloves to prevent skin oils from getting on the glass plates during handling.

2) Fill two clean 5x7 photo processing trays about half full with hot tap water (roughly 120 deg F). Place one tray in the sink and one next to it.

3) Fill a small bowl (big enough to hold the seven plates) half full with room temperature distilled water.

4) Place the seven miniature plates in the tray in the sink.

5) Sprinkle a small amount (approx 1/8 teaspoon) of glass cleaner in the water of the tray containing the plates. I use the cleaner supplied by A.G. that they say is specially formulated to rinse off completely.

Note: All discussions I have found about silvering glass emphasize thorough cleaning. The slightest contaminant can prevent adhesion of the silver to the glass surface. Testing of cleanliness is determined by the water break method; in which water placed on the glass flows smoothly off the surface without any beading. In my initial attempt at mirroring I tried to simplify the process by only cleaning the plates thoroughly with Acetone. I thought this would work because microscope slides are advertised as "pre-cleaned". Although the glass passed the water break test, the mirroring still showed small defects on three out of seven plates. After that experience I switched to a method closer to the A.G. recommended procedure and obtained better results.

6) Using a new 2"x2" square of microfiber polishing cloth, gently rub every surface and edge of the glass with the hot water/cleaner solution. Use caution with sharp edges.

7) Rinse the newly cleaned plate thoroughly in a stream of hot water from the tap.

8) Place the cleaned plate in the second (plain water) tray of hot water.

9) Clean the remaining six plates in the same manner.

10) Thoroughly rinse out the tray containing the glass cleaner/water mixture and fill it half full with fresh hot tap water. Thoroughly rinse the 2x2 microfiber cloth out as well.

11) Place the 8x8 square of acrylic plastic in the sink. Put about a tablespoonful of hot water in the center of the plastic and sprinkle a small amount of cerium oxide into the water. The water will be pale pink.

12) Using the original 2"x2" piece of microfiber rub the cerium oxide on the side of the glass to be mirrored. Be sure to thoroughly cover all parts of the face of the glass (I engrave my plates with my initials and an identifying number so only one side is suitable for mirroring. If you don't do this it is probably best to cerium polish both surfaces in case you lose track of which side is which).

13) Under running hot tap water rinse the cerium oxide from the glass. Use your gloved fingers to gently rub the cerium oxide off as it clings to the glass and will not simply rinse away.

14) Place the rinsed glass plate in the clean hot water tray.

15) Polish and rinse the remaining six plates in the same manner.

16) Using a fresh 2x2 piece of microfiber cloth rub and rinse each plate one last time under running hot tap water. Perform the water break test on each piece and then place it in the bowl containing distilled water.

Silvering the Glass:

1) Place the silvering tank on the acrylic supports inside the 8x10 developing tray. This allows you to capture the rinse water at the end of the process for safe disposal while keeping the mirroring tank above the waste. I work in my fume hood as the mirroring solution liberates small amounts of ammonia, formaldehyde and other chemical vapors. (See figure 2).

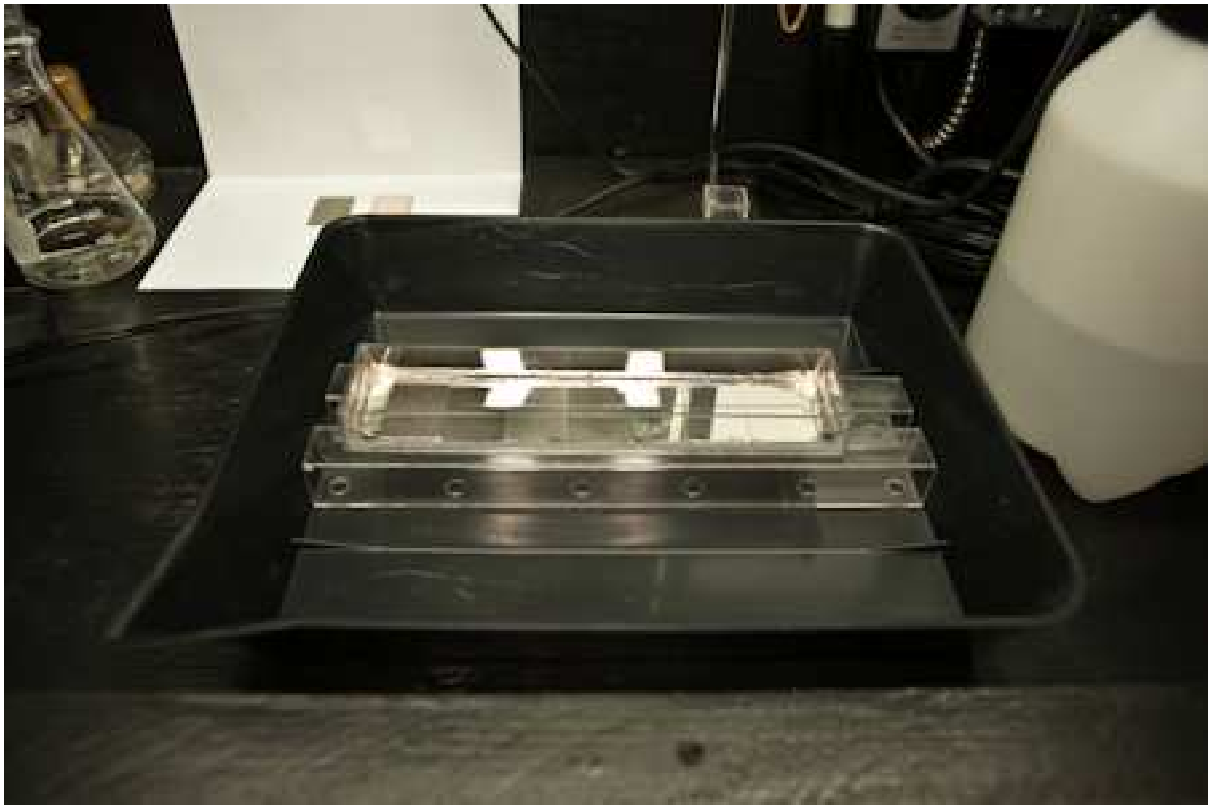

Fig 2 - Mirroring tank on acrylic supports in waste water tray

2) Put about 15 ml of distilled water in the tank and transfer the seven clean glass plates from the bowl of distilled water to the tank. The plates should never be allowed to dry as dust from the air might contaminate the glass surface.

3) Get out your silvering chemicals - tin for silver, and the three parts of the A.G. mirroring solution.

4) Get out 5 small paper cups. If you wish you can label them 1, 2, 3, and Mix 1 and Mix 2.

5) If you have de-gloved, put on a fresh pair. The silvering chemicals can cause skin damage and also will make indelible black stains on your skin.

6) Mix your tin for silver. 1 fluid ounce of distilled water to 1 ml of tin for silver solution. Pour 15 ml of the resulting solution into the medicine cup and set it near the mirroring tank setup. (Diluted tin for silver should not be stored, it only remains usable for 6-8 hours). Treat the leftover solution as hazardous waste. Do not pour it down the sink.

7) Measure and pour 5 ml of each of the three silvering chemicals into separate paper cups. Do not mix them together yet. Rinse your graduated cylinder with distilled water each time and pour the rinse solution into the 8x10 tray holding the mirroring tank for later toxic waste disposal.

8) Pour off the distilled water in the mirroring tank into the 8x10 tray. Surface tension will keep the seven plates in the tank as long as you are gentle.

9) Immediately pour the 15 ml of tin for silver into the tank. Agitate the tank gently for 30 seconds and then pour the tin for silver solution into the waste tray. Timing is very important here.

10) Immediately rinse out the mirroring tank with distilled water. You can spray directly onto the plates and then agitate for about a minute. Pour out the tank into the waste tray and repeat the rinse process again. You do not need to use a large volume of water, but be reasonably thorough. Before you pour off the second rinse water, mix the three mirroring chemicals (in order - 1,2,3) into the paper cup labeled Mix 1. Swirl the cup a few times to mix the solution. (Do not try mixing the three solutions together ahead of time, the reaction starts immediately and the solution will exhaust itself before you can use it).

11) Pour out the rinse water, and pour the silvering mixture into the tank. You are going to agitate the tank gently for five minutes. The silver surface will begin to appear within the first minute. The tank does not need continuous agitation and in between movement it is possible to measure out the chemicals for the second silvering. (You can measure it out in advance, but that takes a second set of three paper cups).

Note: during my initial experimentation I found that a single mirror layer seemed inadequate for making a usable plate. Although apparently well mirrored when looked at directly, if held up to light the silver layer could be seen through and was of uneven density. In discussion with Mike King of A.G. I became aware that it was possible to repeat the silvering to build a thicker layer. The tinning step is not repeated, one just pours off the old mirroring mixture and pours on new for another five minutes. Mike also shared some theoretical calculations with me concerning the thickness of the silver layer.

He wrote " A calculation based on 100% yield of silver plating and a plate density equal to that of standard elemental silver (10.49 g cm-3) gives a figure of 96 nm (roughly 10 Å for the traditionalists) for the plate produced by our process."

Most likely a 100% yield is not attained - however Irving Pobboravsky estimated the Silver Iodide layer thickness of the "golden yellow with reddish tinge" fuming stage at only 30 nm, therefore our double thickness mirroring would only have to have a 16% yield to be at minimum thickness. It seems reasonable to believe that a yield at that level is attained or even exceeded. Qualitatively the double silver layer is entirely opaque.

12) Mix the second batch of mirroring chemicals in the cup marked Mix 2. Swirl it a few times for good mixing.

13) Pour the exhausted silvering mixture from the tray back into the dirty paper cup it was mixed in (you are saving it for proper waste disposal). It is better to put it in the cup rather than the "waste tray" because otherwise it continues to plate out its remaining silver on your developing tray. The rinse waters are too weak to have that effect.

14) Gently agitate the silvering tray for five minutes.

15) Pour out the exhausted mirroring solution into the cup it was mixed in.

16) Spray distilled water directly on the plates until the plating tank is at least half full. Agitate the tray vigorously enough so that the plates jostle about a bit. This will ensure that the rinse water gets under the plates as well as over. You do not want any plate to slide across the mirrored surface of another however - that can cause scratching. Agitate the rinse water for about a minute. Repeat the spray and agitate rinsing process two more times. You want to rinse for a total of about five minutes. Pour any rinse water into the waste tray.

17) Use a thin pointed tool such as a pair of forceps to gently lift the mirrored plate from the bottom of the tank. Be careful not to touch the silvered face as it scratches very easily. Pick up the plate by the edges with your gloved fingers and stand it vertically with the base on a piece of paper toweling. Do not use a hot air source to speed drying - this bakes on the chemical residue and makes it impossible to remove later. Generally I have let my mirror plates stand overnight, but probably a half hour or so of drying is sufficient. Once thoroughly dry your plates are ready for polishing.

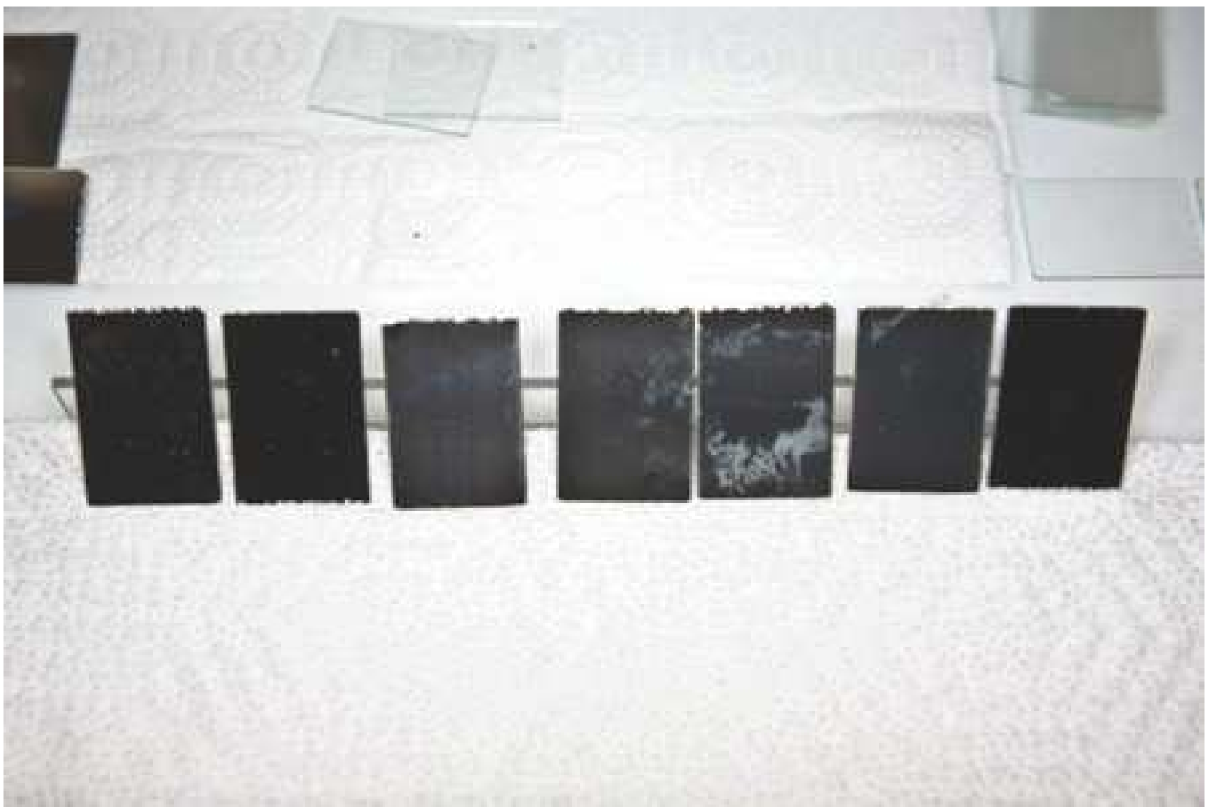

Fig 3 - Plates drying, note chemical residue

18) While you wait for the plates to dry, pour all your rinse water and exhausted mirroring chemicals into a marked gallon container such as a milk jug. You can turn it in later to your local HazMat collection point, or you can process it with the HazMat kit available from Angel Gilding.

Current Procedure for Polishing Silver on Glass

As outlined briefly above, the glass mirror plates need to be dry polished to remove the slight chemical residue that remains from the silvering process. The procedure is as follows:

1) Find a rigid substrate larger than the glass mirror plate that is small enough to turn by hand on your work bench. I use a sixth plate size piece of 21 gauge copper I had available. This is used to temporarily mount your plate for polishing. The mounting makes it easier to work with the tiny 35 mm plates and keeps you from picking up dust and contaminants from the workbench surface.

2) Thoroughly clean the support plate to remove any traces of dust, chemicals or leftover polishing compounds. I spray the copper plate with rubbing alcohol and rub it dry with a piece of paper towel. I then air dust the plate with a bulb type air puffer.

3) Set the support plate on the bench and place a small piece of double stick tape in the center. About 1/2" x 3/4" is more than sufficient. Tap the tape down gently with your finger tip. The tape will anchor your glass mirror plate to the support while you polish it. With too large a piece of tape you risk breaking the plate when you pry it off the support when done polishing.

4) Transfer one of your glass mirror plates from the drying rack onto the taped area of the support plate. Handle the plate only by the edges. This is best done gloved to prevent skin oils from ending up on the plate. Do not press the plate down, as even clean gloves sometimes have surface contaminants. Very gently air dust the plate with the puffer

Note: Because the silver layer is so soft, it is easily scratched. It is important to protect it from dust at all times. A single piece of dust can make a surprisingly large scratch. When I take the finished plates off the drying rack I usually store them under some kind of cover to keep airborne dust off. A folded piece of paper towel works well. Use a silver saver type piece of paper if you don't plan to use all the plates immediately. At some point I will make a plate box, but have not done so yet.

5) Take a clean, dust free cotton ball from its storage container (or a 2x2 microfiber cloth). Do not handle the portion of the cotton ball that will come into contact with the silver surface. Press it once gently into the surface of the glass plate to anchor it to the double sided tape. Leave the cotton ball resting on the plate.

6) Open your container of jeweler's rouge. I keep mine in a sheer nylon ankle stocking inside a Rubbermaid plastic food container (one of the "Premier" type made of polycarbonate with a softer gray plastic edge seal on the lid). I gently shake the stocking over the container 5-10 times, and then pick up the cotton ball and "wipe up" the rouge from the bottom of the food container. It really only takes a very small quantity of rouge. Don't set the stocking on the work bench, it will pick up contaminants. Return the stocking to the container and snap on the lid.

7) Gently rub the rouge coated cotton ball on the silver surface of the glass plate. It takes very little pressure - a light touch is critical. I rub fifty times in each of the four cardinal directions for a total of 200 strokes. It is easier to keep a consistent motion and pressure if you turn the support plate when you

change directions rather than reorienting your hand/arm. You can devise your own pattern, especially if you feel the orientation of the "polishing lines" to the picture is important. Don't be too concerned if there is still a bit of residue on the plate. The dry polishing without the rouge in step 9 will likely remove it.

8) Use the cotton ball to wipe up any rouge that has drifted onto the copper plate. Discard the cotton ball.

9) Take a fresh cotton ball from the storage container. Repeat the polishing action in step 7 but without using any rouge. This will remove all traces of rouge from the silver. Don't discard the cotton ball yet and don't set it down on anything dusty or dirty. If you can manage it just keep holding it while you pry off the glass plate from the holder.

10) Using sharp forceps or the tip of a razor knife, pry the glass plate off of the tape. Be gentle, it is easy to crack the plate, or suddenly launch it into the air when the tape lets go. If the tape does not remain adhered to the copper support, gently remove it from the back of the glass plate with the same instrument.

11) Using the cotton ball you are still holding, gently wipe away any traces of rouge - first from the edges of the plate and then from the back. Handle the plate only by the edges and do not touch the front silver surface. Discard the cotton ball.

12) Set the plate face up on a clean piece of paper towel.

13) Take a small (approx. 1" x 3/4") piece of regular Scotch "Magic" tape and form it into a "T" shape to act as a "handle" on the back of the plate. My best verbal description of this process is to make a "W" out of the tape and allow the two inner strokes of the "W" to stick together. This leaves you with a "T" shape on which the top of the "T" is sticky. Pick up the plate by the edges and stick the top of the "T" into the center of the back of the plate. This will leave a small handle sticking up for you to use when sensitizing the plate and when placing it into the camera. (See figure 5).

Note: In spite of all precautions you may still end up with one or more tiny scratches or defects in the silver surface. As with metal based plates it is an aesthetic decision about how large a defect you can tolerate. Obviously a "busy" picture with lots of mixed tones will hide more minor defects than a lone sapling silhouetted against the open sky. You will need to decide what works for you. Repetition helps too. I am already noticing that as my practice with the method increases, I am getting more defect free plates.

Fig 4 - Plate polishing setup

Sensitizing the Silver Surface

The sensitizing of silvered glass substrate plates for Becquerel daguerreotypes does not differ in any particular from the sensitization of copper substrate plates. In my case I use a very nice wooden sixth plate fuming box on long term loan to me from a daguerreian friend. It has an inner glass tray that has been ground to fit a sliding glass cover. It is charged with about 2 ounces of iodine crystals held between sheets of cotton batting. I have created a plastic insert to hold the miniature 35 mm plates I am currently using. (See figure 5).

The insert is made from two thin pieces of polycarbonate. The thicker (0.060") piece is cut to sixth plate size to fit the fuming box opening and then also has a rectangle cut into it with a razor knife to accommodate my 35 mm plates with about 1/32" relief all around. (to handle slight variations in plate size). A second thinner (0.026") polycarbonate rectangle, cut smaller than the sixth plate by about 1/2" in width and length has a rectangle cut in it slightly smaller than the 35 mm plate size. This second piece is glued (centered) to the bottom of the larger piece to provide a thin lip on which to rest the mirror plate during fuming.

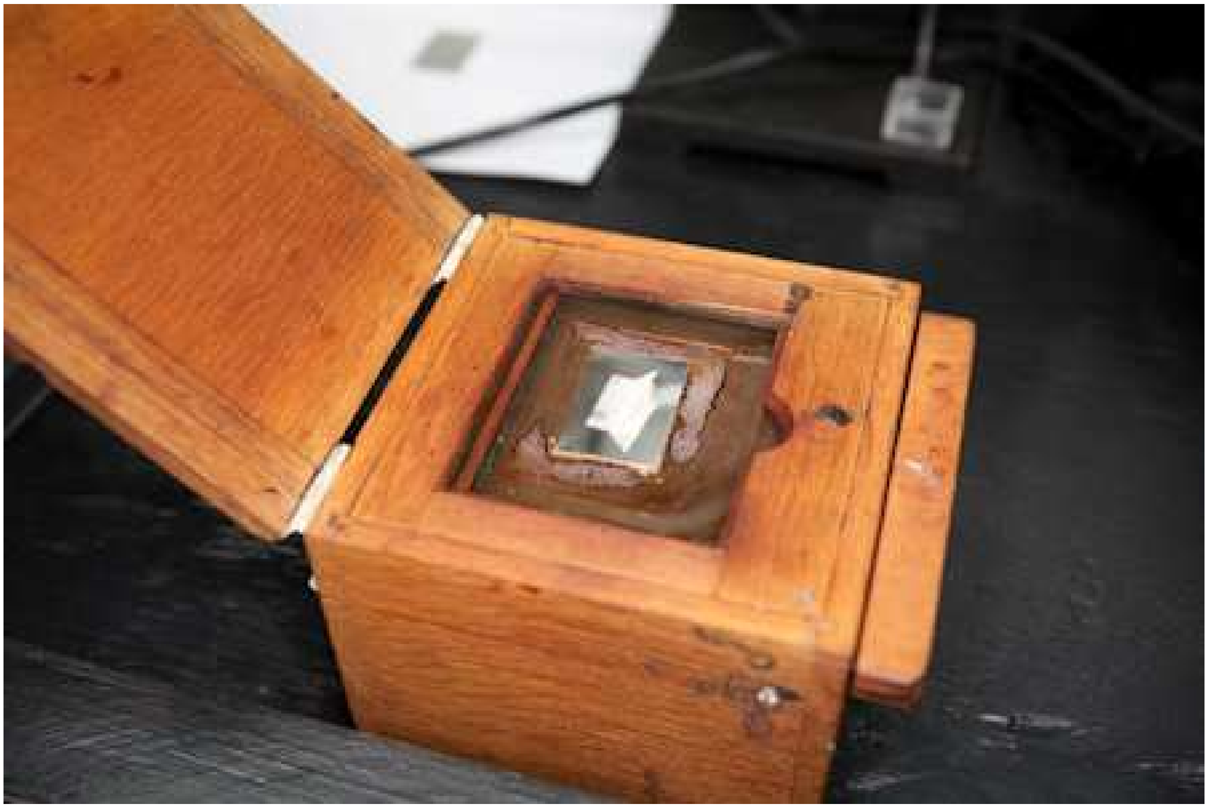

Fig. 5 - Iodine fuming box with polycarbonate adapter. Mirror plate inserted, tape "handle" attached.

I also use a plate color comparator to help with determining when the fuming process has progressed to the proper point. I worked out this method from suggestions given by a variety of persons because I had great difficulty seeing the color difference when simply looking at the plate directly. The comparator consists of a sheet of 8.5" x 11" white card stock folded at a 90° angle. Sitting about an inch from the fold I place a polished but unfumed plate. At timed intervals during the fuming process I take out the plate being sensitized and lay it down next to the unfumed plate. I then shine a simple bulb-type AA flashlight at both plates so that the reflections of the light hit the vertical portion of the index card in close proximity. This makes it very easy to see the color tone of the fumed plate. (See figure 6).

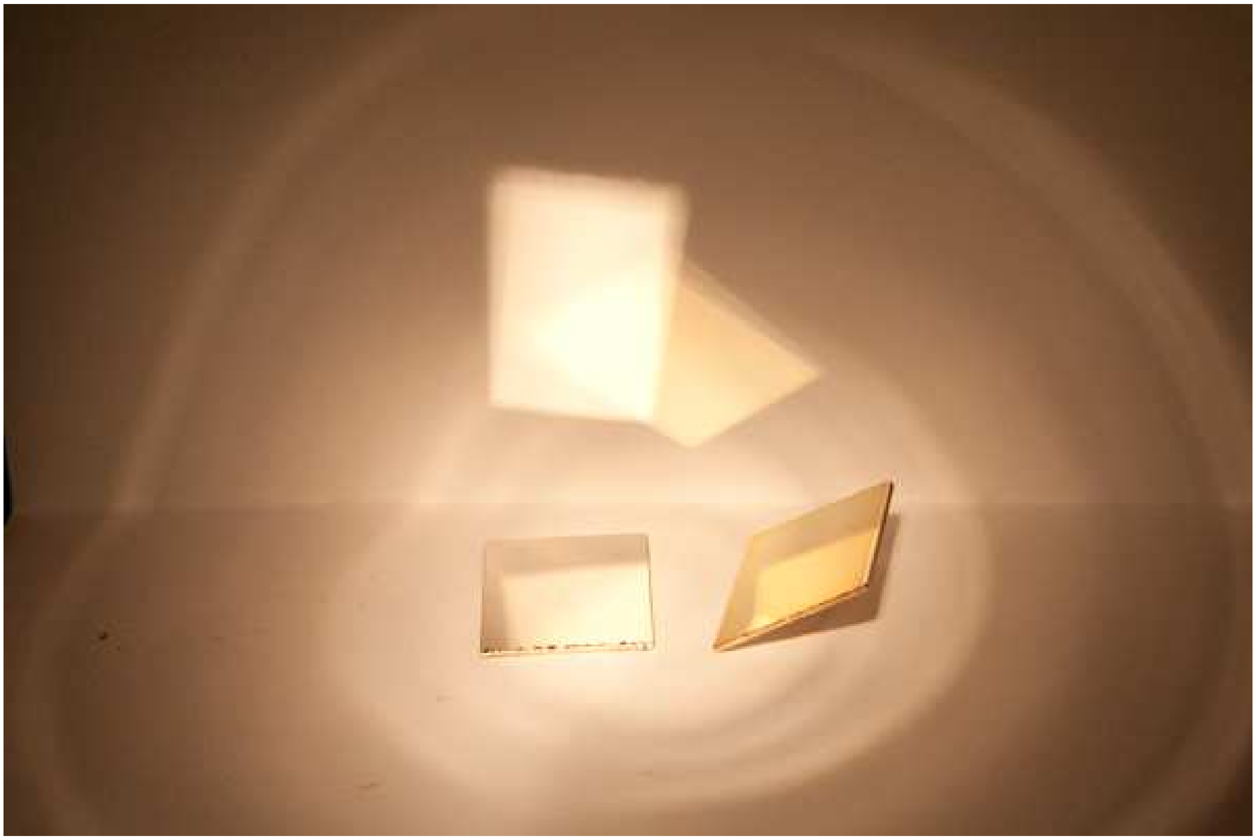

FIGURE 6 - Color Comparator

The glass mirror plate fuming process is as follows:

1) Turn on your fume hood.

2) Confirm that your fume hood is operating properly by measuring with an air flow meter.

3) Perform all your Iodine fuming inside the hood workspace. If you have any concern that fumes might escape the fume hood, don a respirator with an appropriate filter cartridge. Even if you are sure of your hood, a respirator mask is a good safety backup.

Note: There can be a tendency to believe that the iodine fumes used in the Becquerel process are relatively safe - especially when compared to the mercury and bromine vapor of mercurial daguerreotypes. Iodine also has a somewhat benign aura because many people have seen it as an ingredient in antiseptics used on the skin. Please don't let that lull you into complacency when working with iodine fumes. Breathing iodine fumes can cause permanent damage to your body. For further information Google "iodine MSDS" or go to the following link:
http://www.jtbaker.com/msds/englishhtml/i2680.htm

4) Cock the shutter on your camera. Open your camera and air dust the film chamber. Set the camera inside the fume hood off to one side with the back unlatched but mostly closed to keep out dust.

5) Remove your I_2 fuming box from its airtight storage container and set it in the center of your fume hood working area. Close the storage container and set it aside.

6) Using a non-contact IR thermometer, measure the temperature of the closed sliding glass cover on the iodine fuming box chamber. The warmer the box, the less fuming time is needed. The temperature on my fuming box usually falls between 60 and 70 °F. If the box is less than 60 °F I turn up the heat in the room for a while. After measuring, shut the top lid of the box to reduce fume escape.

7) Put the color comparator within easy reach and set a flashlight near to hand.

8) Ensure that a clock with a second hand is within easy view.

9) Turn on a red safelight and shut off the room lights. I have read that Becquerel daguerreotype plates are slow enough that a perfectly light-tight space is not required, merely one that is mostly dark and does not allow any direct light to fall on the plate. My workspace has a number of small light leaks that have not had any effect I can observe. None of them have direct line of sight to my working area.

10) Open the top lid of the fuming box. Place the glass mirror plate face down in the polycarbonate adapter. Make sure that it is seated correctly. Close the top lid of the fuming box.

11) Watching the clock, slide the glass cover off the iodine chamber and expose the plate to iodine fumes for five seconds. Close the glass slide.

12) Open the top lid of the fumer. Remove the glass plate using the scotch tape handle. Close the top lid.

13) Place the glass plate face up on the base of the color comparator close to the polished/non-fumed plate. Use the scotch tape handle and the edges of the plate only. The scotch tape handle will tip the plate slightly to one side.

14) Shine the flashlight at both plates simultaneously. You will see the light reflected on the vertical face of the comparator. The reflections will overlap somewhat because the fumed plate is tipped. You will easily see the difference between the two reflections as the fuming progresses.

15) If the plate is not yet a golden yellow color (or other color stage you choose) open the lid of the fuming box and return the plate to the polycarbonate plate holder. Make sure the plate is rotated 180° from its previous position. This helps produce even fuming. Fume the plate for another five seconds and then look at it again in the comparator. Repeat as needed.

16) Once the plate has taken on the correct hue, return it one more time to the fuming box and subject it to iodine fumes for 8 seconds. This will remove the effect of the flashlight illumination on the plate and will leave it in a fully sensitized state. Do not use the comparator process after this final fuming. (Thanks to Irving Pobboravsky for the particulars of this step).

17) Remove the plate from the fuming box and give it a few gentle puffs from the air duster.

18) Place the plate in the camera. My camera has been modified with a thin polycarbonate adapter to help align the plate correctly. Be sure that the plate is exactly positioned. Close the back very gently and latch it. Your camera may vary, but my Pentax ME has cracked several plates when I have accidentally placed even light additional pressure on that back after closing the camera. Obviously if you crack the plate you will need to start over - unless you really want a multi-piece daguerreotype. You are now ready to make an exposure.

Exposing the Daguerreotype

As with fuming, this step is essentially the same as exposure of metal substrate plates. I have not yet made enough daguerreotype exposures on glass (or any other substrate for that matter) to say a great deal on this topic. My best exposure thus far was a portrait of Sarah, my wife (#1011) that was fumed for 22 seconds to the first golden yellow, and exposed for 10 seconds at f 1.7 in a light intensity of EV 14.5 @ ISO 100 by incident reading. This resulted in a good range of tones and had only some very small blown highlights.

For comparison I did some linear and proportional interpolation of the information in Jonathan Danforth's very useful "Becquerel Daguerreotype Exposure Guidelines" to match my camera lens. (http://www.shinyphotos.com/content/dag_exposure_guideline.pdf). If I have made accurate assumptions about the math in his table, he would have computed the same exposure as taking roughly 5.6 seconds. That would indicate that my plates are either slower than his to some degree or I am still overexposing them. Even as a beginner I have come to understand that determining daguerreian exposure is as much an art as a science, but I can safely say there doesn't seem to be anything markedly different in the selection of exposure times for glass substrate daguerreotypes. Experimentation is key.

As mentioned earlier, I am currently making "miniatures" in a 35 mm camera to cut costs while I learn the process and to take advantage of the fast lens (f1.7) on a Pentax camera I already have in hand. Here is a picture of the plate holder in the camera.

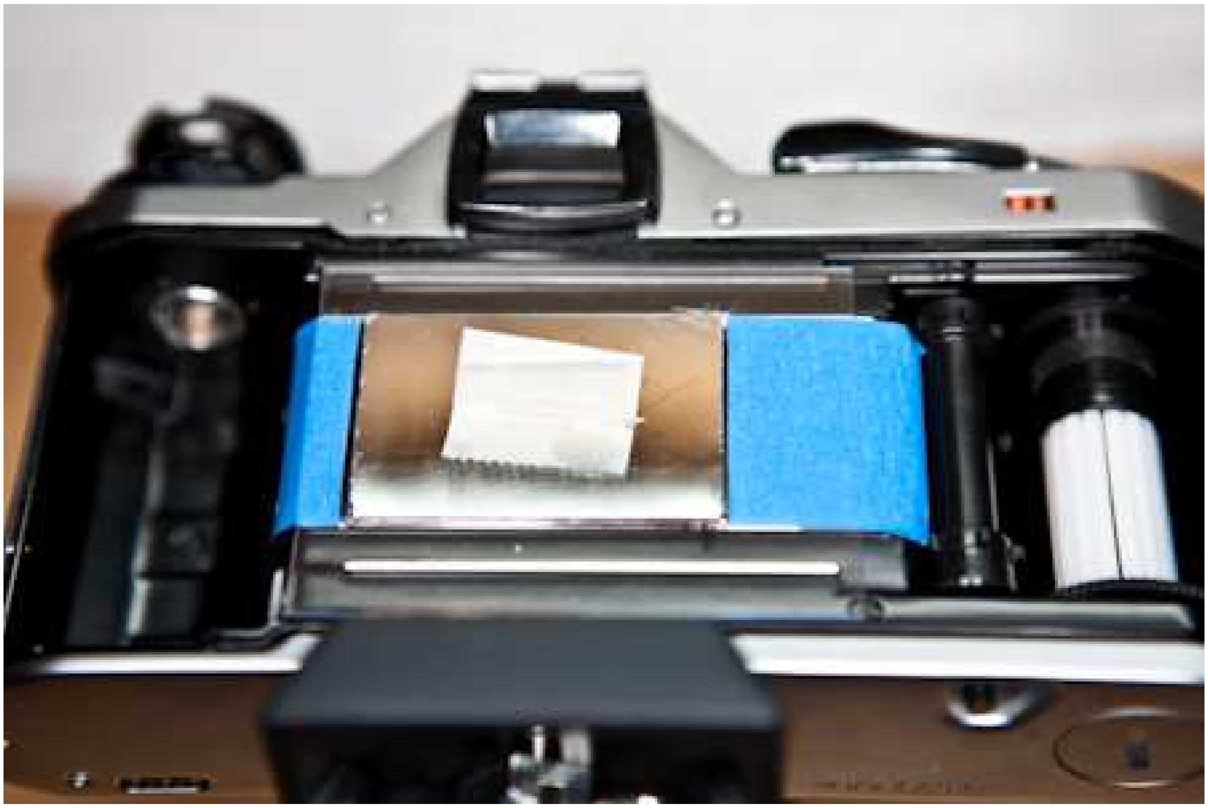

Fig. 7 - Camera with polycarbonate plate guide and plate

Developing the Daguerreotype

Becquerel daguerreotypes are developed by exposing the latent image on the plate to strong light from the red end of the spectrum. Development of glass substrate plates is identical. My development setup includes: a small household fan set to the slowest speed to prevent heat buildup on the plate, a halogen bulb in a simple clamp-type reflector fixture suspended above the fan to provide the light source, and a plate holder/developer made of black matte board and white index card stock with a piece of amberlith covering the opening above the plate. The plate holder is a copy in miniature of a design created by Alan Bekhuis. The lamp is a Philips 75 W/940 Lumen Halogen floodlight (Mfr #75PAR30L/NLP/FL 120 V) placed 7 inches above the fan surface and produces an EV of 14.7 at ISO 100. See figure 8.

Fig. 8 - Becquerel development setup

The basic procedure is as follows:

1) Turn on a red safelight and darken the room.

2) Open the camera slowly - if the tape "handle" is still on the back of the glass plate, it can sometimes adhere to the camera film loading door and drop off at an awkward moment. If the face of the plate strikes something, it can damage the coating and thus the latent image.

3) Pick up the plate by the tape handle

4) Open the two parts of the plate holder/developer, place the plate face up on the raised area of the base piece.

5) Cover the base (and plate) with the upper part that contains the amberlith window. Be careful not to touch the top of the glass plate with any portion of the holder/developer.

6) When the two parts of the holder/developer are aligned, place a couple of rubber bands around it to keep it closed. Be sure not to cover any portion of the amberlith window.

7) Place the entire assembly on the fan base down with the amberlith window exposed to the light.

8) Note the time. At present I am developing plates for two hours if the image shows within 8 minutes of starting the development and three hours if the image shows in the first 9-15 minutes. Other practitioners use different timings. According to more experienced practitioners, less time can result in more blue tones, too long a time can lead to fogging of the plate. Since my images are still somewhat blue I likely need to increase the development time. You can observe the development process to a certain extent looking through the amberlith window.

9) Once you have decided the plate is finished developing, turn off the light and fan and prepare to fix the plate.

Fixing the Daguerreotype

As noted above, one key factor in working with glass substrate daguerreotypes with a chemically deposited silver layer is to keep contact with the fixer to a minimum. The fixing mixture and times I have chosen reflect that fact. It remains to be seen whether my current methods are producing adequate fixing, or perhaps could even be reduced further in either concentration or time. My current process is as follows:

1) Mix fresh fixer for each plate. Proportions are 0.5 g Anhydrous Sodium Thiosulfate + 0.5 g Sodium Sulfite, in 50 ml of distilled water. I generally swirl the mixture in an Erlenmeyer flask 10 or 15 times and then let it sit at room temperature for 15-20 minutes to ensure that the chemicals fully dissolve.

2) Prepare the container in which you plan to fix the plate. It should be clean and sitting in something that will contain any spills.

Note: For fixing I presently am using the same acrylic tank that I mirror the plates in, sitting in an 8x10 developing tray. The long narrow tank allows me to set the unfixed plate in one end and then prop up the tank on a small piece of plastic. I put the fixer in the lower end of the tank and when ready I set the tank flat and the fixer flows quickly, smoothly and evenly over the plate. This helps reduce staining according to what I have read. I do plan to build a separate fixing tank soon however. The drawback of using the mirroring tank is that sometimes flecks of silver left in the tank from plating come loose and drift onto the plate. One has to be careful that they do not settle on the plate.

3) Prop up one end of the tank as noted above.

4) Place the glass daguerreotype in the high end of the tank, image side up.

5) Fill the lower end of the tank with the 50 ml of fixer, filtering it through a funnel containing a clean cotton ball.

6) Remove the plastic prop and allow the fixer to flow over the plate in one smooth motion.

7) Note the time.

8) Gently agitate the tank for nine minutes. Do not allow the surface of the plate to be exposed to the air as this seems to increase the risk of staining.

Note: I originally used a five minute fixing time but noticed brown stains on some plates that seemed to get darker on exposure to sunlight. I switched to 10 minutes for several plates but noticed occasional pinpoint defects in the silver layer toward the end of the fixing time. Nine minutes is the current compromise, but this may change as more plates are made.

9) Tip the tank into the waste tray until there is only enough fixer to just cover the daguerreotype plate.

10) Run distilled water into the tank from the opposite end (do not directly spray the plate).

11) Agitate the tank for five minutes.

12) Repeat the previous two steps twice more.

13) Drain the tank in one smooth motion.

14) If gilding is not to be undertaken, take the plate out of the tank and hold it vertically by the edges allowing the rinse water to drain to the bottom edge.

15) Touch the bottom edge of the plate gently to a piece of paper towel to pull away as much of the water as possible by capillary action.

16) Use a rubber bulb type air duster to forcefully chase remaining water drops off the plate. (Some practitioners recommend a hair blow dryer for this phase, but when I tried it the heat seemed to intensify any stains present on the plate).

Gilding the Daguerreotype

Gilding presents as many challenges to the practitioner using glass plates as the fixing step does. Gold Chloride, mixed in the common strength of 0.002% will strip the silver off the glass within about thirty seconds if applied to a dry plate, and can still sometimes cause reticulation of the silver when mixed with weak fixer.

After some experimentation using Larry Shutts cold gilding process, I did determine that using a 0.001% solution of gold chloride introduced into the standard weak fixer sitting as a meniscus on the plate, will produce a color change after 30 minutes. I have not attempted to heat plates for gilding. Here is a picture of the plate during gilding.

Fig 9 - Cold gilding a plate

The process used is as follows:

1) Level out a plastic developing tray using shims of any type. You can test for level by putting a blank plate down and forming a meniscus of water on it.

2) Prepare another small tray for rinsing by filling it half full with distilled water.

3) Place the developed plate on a flat support that does not extend past the edges of the plate. I used a 1/8" thick scrap of Plexiglas here. I set both on a small piece of paper towel to wick away any solution that came off the plate as my support was so low that capillary action could hold the fluid under the plate and interfere with the meniscus.

4) Cover the plate with weak fixer to form a meniscus. I used a 10 ml syringe to control the flow more easily. For these small plates, 2-3 ml of solution is sufficient.

5) Once the meniscus is fully formed, gently reflood the plate with weak Gold Chloride gilding solution (0.002%). A syringe is useful for this step also.

6) Start your clock and monitor the silver surface for degradation. Small areas of reticulation are generally ok as they will disappear once the plate is dried. They are more common on the edges than in the middle areas.

7) When your image has taken on the desired tone, tip the gilding solution quickly into the tray. Handle the plate by the edges using gloved hand.

8) Quickly immerse the plate in the rinse water tray and agitate it for five minutes or so. Drain out the water and repeat the rinse.

9) Lift the plate out of the rinse and turn it vertical to allow water to drain off.

10) Touch the bottom edge of the plate to a piece of paper towel.

11) Use your rubber bulb air duster to chase the remaining water drops off the edge of the plate.

12) Set plate vertically to dry.

At this point I do not have enough experience to say much more about gilding. Further experimentation is needed. The poorly exposed daguerreotype I used for this experiment is shown below as a before and after picture. The color change is more marked in the overexposed highlights and easier to see in the actual daguerreotype that in the scans below.

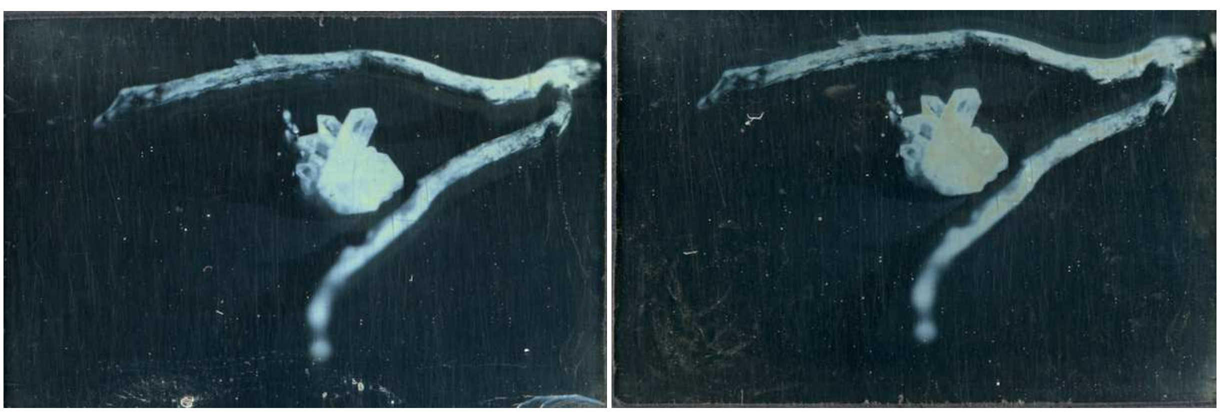

Plate 10 - Before and after cold gilding with weak solutions

Sealing the Daguerreotype

The sealing of any daguerreotype is required to prevent tarnish from forming on the silver surface and to keep dust and environmental contaminants off the image. The common practice is to use a glass cover the same size as the plate, a spacer of some kind to keep the cover from touching the image, and some form of archival tape to hold the package elements together. The package is then usually placed in a frame or case.

Glass daguerreotypes are no different in needing to be sealed, and as they are more fragile than metal substrate images, they need mechanical protection as well. My current sealing method uses a single strip of 1/2" J-Lar tape wrapped around the edge of the package. I let the tape overlap on the cover side by 1/16" and the remainder overlaps on the back. I use a strip of 1/16" width layout tape to form the spacer. The procedure is as follows.

1) Obtain a cover glass matched in size to the plate to be sealed.

2) Clean the cover glass carefully with a microfiber cloth and rubbing alcohol to remove all traces of dust and fingerprints. Do not handle the cover with the bare fingers once the cover is cleaned (I use post-it type notes to handle the glass of my mini plates. They pick up dust and allow me to easily manipulate the glass without touching it).

3) Using 1/16" black plastic layout tape create a "frame" around the edges of the cover glass. (Note this tape has not been tested for its' archival qualities as far as I am aware. I am using it because I have not yet developed a method for creating a miniature metal spacer).

4) Lay a piece on each of the long edges and trim the excess flush with the edge using a razor knife.

5) Tape the short edges and trim flush to the tape on the long edges using the razor knife. The tape is very thin, but it will keep the cover glass from touching the daguerreotype surface.

6) On a cutting mat fasten down a 1/2" x 6" piece of J-Lar tape with two pieces of regular tape of any kind. The sticky side of the J-Lar faces up.

7) Gently place the cover glass on the daguerreotype plate and place the package so that a long edge touches the J-Lar. Set the edge down about 1/2 inch from the tape holding the J-Lar to the mat. I use a line on my cutting mat to keep a consistent 1/16" of J-Lar on the cover glass side of the package.

8) Use a razor knife to free one end of the J-Lar from the hold-down tape.

9) Pick up the free 1/2" inch of J-Lar and fasten it to the short side of the package. It will cover about half of the one short side.

10) Carefully "rotate" the package 90 degrees and stick the untaped short side to the J-Lar. Maintain the 1/16" of free tape on the cover side.

11) Rotate the package through another 90 degrees and stick the second long side to the J-Lar.

12) Rotate the package through the final 90 degrees and stick the J-Lar to the halfway taped remaining short side of the package. Use the razor knife to cut the J-Lar free from the remaining regular tape hold down so that a small overlap of J-Lar is created on the short side. Be sure that the overhanging tape on the cover glass side has a consistent 1/16" width and exactly mates with the beginning of the J-Lar first laid down.

13) You will be left with your package with a single strip of J-Lar wrapped all the way around the four sides, sealing the edge. Some people likely wrap their tape freehand, but I find it easier to be precise with the method I describe.

14) Carefully press the 1/16" strip of J-Lar down onto the cover glass starting in the middle of the long sides.

15) Press down the short sides in the same manner and form a miter at the corners

16) Carefully press down the J-Lar tape on the back sides. Start with the long sides and allow the tape to stick to the short sides as if you were wrapping a gift box.

17) Press down the short sides to the back of the package. There will be enough adhesive still exposed to hold them down.

18) Your package is now sealed and ready to be mounted in a frame or case as you choose.

Examples of Glass Daguerreotypes

Here are some sample daguerreotypes taken with the method outlined above. The first version below is roughly life size, the second shows the plate enlarged. None of the daguerreotypes shown is gilded.

Nutcrackers

Stag

Sarah

Pros and Cons of the Glass Daguerreotype

Glass daguerreotype plates are not a replacement for plates with a more traditional metal substrate. They do represent an interesting alternative to the original materials and offer an additional option to the interested practitioner. They may be particularly useful for persons who just want to "try out" making a few daguerreotypes to help them decide if they wish to invest the time and expense involved in using the full traditional process.

The primary benefits are as follows:

1) Less expensive plate materials

High quality glass is easily available most anywhere, and the silvering chemicals are fairly inexpensive as well. I estimate that a finished 4x6 plate - including a pre-cut, edge polished glass substrate, cleaning, silvering and polishing - costs about $3.72 USD. If you cut your own glass it could be even cheaper. My impression in reading in various sources would indicate that a comparable electroplated metal plate would be running $30-50 and a clad plate considerably more.

2) Much less time spent polishing

There is simply no comparison here to metal. To finish polish one of my miniature 35mm plates takes about five minutes. Larger plates would certainly take somewhat longer but likely not that much. If a way can be found to eliminate or remove the slight chemical residue from the mirroring process, polishing might be eliminated entirely. Metal plates require a significant investment of time regardless of the method used.

3) Very consistent level of polish

Although there is still some question in my mind whether the lightly rouge polished surface of a glass plate is as perfect as the metal plate polished by a master daguerreian, starting with the exquisitely uniform surface of modern float glass gives you a very serious leg up on having a uniform surface. One thing that I did notice was that fuming and exposure times were very consistent, an indication of the uniformity of the polish.

4) Potentially easy to create large plate sizes

Although I have only worked in miniature, the Angel Gilding site displays numerous examples of very large pieces of glass that have been beautifully silvered using their methods. I see no reason why whole plate sizes cannot be easily attained, and no real barrier to even larger sizes if someone finds them desirable. It does remain to be seen if any of the challenges of the wet process handling of mirrored glass present any unique difficulties that do not show up in miniature plates.

5) No expensive machinery required

Some operators polish metal plates entirely by hand, but most use either motorized polishing wheels, or random orbital sanders. In the glass plate process, neither is needed, a definite cost savings.

6) Materials required are very easy to obtain.

Most operators find significant barriers in obtaining electroplated or clad copper plates. The equipment to produce them by yourself is prohibitive in cost. Glass on the other hand is as close as the local frame shop or hardware store, and the silvering chemicals can be purchased online, or made from basic chemical stock from a chemistry supply.

The drawbacks include:

1) Archival quality is unknown

I believe this remains a most serious challenge to the use of glass as a substrate material. Clearly the glass/silver bond is weak, and it is unknown at this point how long it will last. Antique mirrors do exist, but many show the ravages of time. The difference in the coefficient of expansion between glass and silver is much higher than that between silver and copper. This may contribute to an inevitable degradation of the silver layer.

Beyond the glass/metal bond, there is also the consideration that glass is subject to breakage. Certainly we have many examples of glass negatives that have been lost to breakage on their journey from history to the present day.

In the long run, glass may be more useful as a learning medium for beginners than as a typical method for the deeply engaged artist. Only much more experimentation, and time itself will clarify that issue.

2) Difficulties with gilding

Gilding is important both esthetically and as a method of making the daguerreotype image more durable. Although not all daguerreotypes are gilded, if glass does not prove capable of sustaining a typical degree of gilding, it will be seen as a drawback by many practitioners.

3) Glass plates are fragile

See above reference to archival quality. A certain delicacy of touch will be required of those making daguerreotypes on glass. To the long list of factors that can ruin a daguerreotype, shattering would have to be added. Some practitioners may feel that the current list (even with metal substrates) is already too long.

4) Current plates produced in this experiment do not seem to have attained the level of surface perfection attained by experienced metal plate practitioners.

More experimentation is needed to determine if this is simply the lack of expertise of the experimenter, or inherent in the glass plate method itself.

5) The images produced may differ in characteristics or quality from metal substrate daguerreotypes.

Some may rightfully argue that a glass substrate daguerreotype is not truly a daguerreotype at all. They certainly do not conform to the historical process. It remains to be seen if there are significant observable differences. Side by side comparison of the highest quality images in either medium will be of great interest, especially when carried out by experienced daguerreians.

Further Experimentation

This experiment constitutes only a very brief foray into glass plate daguerreotypy and was carried out by an inexperienced daguerreian practitioner. Numerous questions remain to be answered. Areas meriting further investigation include:

1) Is it possible to remove the chemical haze left by the mirroring process without doing any polishing at all?

It is difficult to polish the haze off of the silver surface without marking it to some degree. It may be possible to chemically remove the haze without any polishing at all. This would be ideal. Experiments have been made with Acetone and with both Ethyl and Isopropyl alcohol without success. Further investigations are in progress. The opinions of a trained chemist would be very useful here.

2) How well do glass plates perform when sensitized with both iodine and bromine?

Is the silver layer thick enough? Does the bromine damage the silver glass bond in some way that iodine does not?

3) How well do glass plates perform when developed with mercury?

What challenges to the plate are created by hot mercury vapor? Does the development proceed in the same way as with metal plates?

4) Can we create some "accelerated aging" tests to begin to determine the archival character of silver mirrored glass plates?

Until more information about the archival quality of glass plate daguerreotypes can be determined, it is unlikely they will be taken too seriously as an art medium. Those with expertise in the archival characteristic of materials will need to weigh in on what meaningful tests could be performed.

5) Experienced practitioners need to make daguerreotypes on glass and compare them with the best efforts on metal substrates and write about the similarities and differences seen.

Qualitative differences will need to be determined by experienced eyes.

6) Can successful gilding be carried out and what are the specifics of the best methods?

Those with experience with gilding need to experiment with various methods and compare the results obtained in metal substrate images.

7) Are there any sealing/packaging methods that are specific to glass plates?

The best ways to package and preserve the images will need to be determined. It remains to be seen if specific challenges will be encountered in sealing glass substrate images and whether any special methods need to be developed.

8) The weak fixer process still seems to occasionally produce a reticulated surface on the silver layer. Is it possible to further reduce the strength of the fixing solution?

Once in a while the surface of the silver takes on a frosted appearance here and there during fixing. Although it usually goes away during rinsing, I can't help but wonder if it has caused some permanent damage to the silver that might make it deteriorate faster. Further experimentation, or perhaps someone with greater expertise in stoichiometry might determine that even further reductions in fixer strength might still successfully remove the unphotolyzed surface layers. (Interestingly the Poppe article suggested that the reticulation problem may be temperature related).

Conclusion

Certainly additional experiments can be imagined. Hopefully others will take on the challenge of working them through. The method presented in this paper does allow the creation of good quality Becquerel daguerreotype images on glass substrate first surface silver mirrors created by chemical deposition. It remains to be seen how much further the technique can be carried. I invite others to try and report their experiences to the daguerreian community at large.

A Note on a name for this process: There is no established name for a daguerreotypes done on a glass substrate (at least as far as I am aware). I am on shaky ground here as I am not a photo historian, but I believe Verreotype has already been used historically as an alternate name for the Ambrotype as have both Glass Daguerreotype and Daguerreotypes on Glass. At present I am calling them Daguerreotypes on Glass as it seems the most descriptive. If they turn out to be more than just a rare curiosity, perhaps a new name can be coined to differentiate them from the traditional mode. In any event, practitioners working on glass should make it very clear to any collectors of their works that a non-traditional method has been used. To do otherwise would be unethical.

Acknowledgements

No person operates in a relational vacuum. More particularly anyone who attempts to advance the arts or sciences stands on the shoulders of those who have come before. A number of people have directly or indirectly helped me with the processes involved in this paper. In alpha order by first name they are: Alan Chidgey-Bekhuis, Gregory Popovitch, Irving Pobboravsky, Jason Greenberg Motamedi, Jon Lewis, Jonathan Danforth, Larry Shutts, Mike King and Walter Johnson. I am grateful for their assistance. In addition I would also like to thank the entire membership of the CDags.org forum for the many hints and insights that they have given me in the course of the discussions there.

Recent information concerning glass daguerreotypes

When I completed the first draft of this paper, I sent it to a number of people for review and comment including Walter Johnson and Irving Pobboravsky. The ensuing correspondence uncovered additional information concerning glass daguerreotypes and also resulted in an introduction from Walter to Chris Duckworth, the subject of Walter's portrait on page 4. It turns out that Chris, a professional historian, made daguerreotypes on both glass and metal in the 1970's and still owns the portrait that Walter made. I include here a number of quotes from the correspondence with all three men as it pertains to daguerreotypes on glass, and some additional comments of my own.

Since the portrait of Chris Duckworth is currently the oldest example of a glass daguerreotype that I am aware of, I was interested in any and all information about that portrait. Walter Johnson had mentioned in earlier correspondence (noted previously) that the portrait had been produced on silver sputtered glass and that he had some problems with silver peeling from the glass during fixing.

When I asked him for any further details that he recalled, he contacted Chris Duckworth who still has the portrait and made a current scan of the piece. Walter forwarded the scan to me and it is reproduced below.

In truth my initial reaction on seeing the scan was to think "Well that's the end of glass daguerreotypes as an artistic medium!"

I continued the correspondence with both Walter and Chris however to see if I could determine what "had happened" to the portrait. I asked Walter how the image had been sealed and he stated the following:

"When I had given the image to Chris it was with an acid-free matt and cover glass, but I have no idea of how he stored it since then".

Chris replied extensively to my query about the history and present condition of the portrait. He said:

"... During this time, which mostly took place over the spring and summer of 1973, I frequently spoke with Walter. One of us, probably him, first mentioned the possibility of using silvered glass plates. Walter had a plate made using, I believe, the common chemical process for coating (NB - Walter reports the plate as sputtered). I happened to arrive at his office when he first received it. The image that you see was the result.

The image was not protected with AuCl. Walter matted it with common matte board and placed it, under glass, in a wooden photographic contact-printing frame. He put some black photographers tape along the seams, but the unit was not well sealed, certainly not hermetically. Walter took the photograph that appeared in New Daguerreian Journal, and I'm not certain how he did it as I was not present. He may have used polarized lighting because, even at the time, the reproduction looked much better than the original dag. On the other hand, the recent image that I produced was made by simply placing the dag, in its matte, on a flatbed scanner and scanning a full-histogram image in color. Because the image was not on the scanner glass, it is slightly out of focus, and the scanner's direct lighting certainly leaves much to be desired. I am certain that photographing it with polarized light would yield a far more attractive image as well as one that would serve as a better comparison to Walter's original shot. Over the years, the dag has deteriorated somewhat, though not as much as one might think by simply looking at these two images. The silver has not separated from the glass, but a number of bright, silver-like crystals on the surface probably have increased in size, and some tarnishing has taken place. Given the environment, that is by no means surprising.

An analysis of the surface of plate employing microscopic and chemical analysis might be interesting, but, frankly, this is more than I care to undertake. I suspect one would find that we neither fixed nor washed the plate sufficiently and that residual chemicals are responsible for the "crystals" and other deterioration. Moreover, the framed images has sat on a shelf in my library for thirty-five years."

Chris's response leads me to believe that making daguerreotypes on glass is still worth additional investigation but that practitioners need to be aware that there are questions that remain unanswered about the longevity of the images.

Furthermore, comparisons of the images with more traditional forms will need to be made. The following quote from Irving Pobboravsky is germane:

"It was O. Sherwood Poppe's article in the PSA Technical Quarterly, May 1956 pp. 75-79 that sparked my daguerreian journey. We corresponded in '61-'62 and he loaned some of his images on glass and literature he recorded on microfilm. The images were weak, flat and gray and his comment was that they had degraded since they were made some 5-6 years ago."

In addition to the correspondence with Walter, Chris and Irv, I sent the draft paper to Mike and Sarah King of Angel Gilding. Mike sent a couple of email replies outlining a suggested alternative procedure for mirroring glass that might produce a silver surface that does not require any polishing. I quote both of his emails in their entirety below they are of great interest. Both emails are © Mike King 2010.

Mike King - 2/25/10

Andy, here are my thoughts on the silver haze issue:

The silver pouring process was devised for pouring chemicals onto a flat glass surface and allowing them to develop as a mirror over a period of minutes. In doing this, it is important to "rock" the glass about once a minute to prevent large areas of inhomogeneity. That is, without the rocking, ripples tend to form in the silver mirror, visible from both the front and back surfaces of the mirror.

Even with the rocking, the back of the mirror (the "third surface") tends to be hazy versus the front (the "second surface") which is usually perfectly smooth. I believe the reason for this is that the glass surface is itself smooth while the air interface on the other side is not. This means that convection currents arise, causing the silver to deposit unevenly.

The purpose of the sensitizer is to provide a metallic surface for the initial layer of silver atoms to deposit and they do so very evenly because the glass is smooth. As the silver layer builds up, however, there is a tendency for convection currents in the liquid and the air above the liquid to move the atoms around before they find a location to stick and this results in a haze.

In other words, I do not believe the haze you are seeing is a contaminant or residual chemical but a non-smooth silver surface. When you polish it as you describe, you are literally pushing the surface layer of atoms around to form a more even surface - a crystal in fact. The face of this crystal is quite smooth although still not quite as good as the one next to the glass.

With our drip silver technique, we have a different set of silvering chemicals that deposit much faster, although still giving a true silver mirror. The idea is that you apply the chemicals in a pair of streams that combine to form silver which then deposits on the surface, usually within a couple of seconds. By moving the stream around you can distribute the silver as you wish, making some areas thicker than others if you *wish or just "repairing" areas as you go. Our experience of doing this is that this leads to much smoother results on the back surface than the pouring method. The same chemicals can also be sprayed using a single two-nozzle spray gun or just a pair of hand-held spray bottles, the liquids being deposited in a fine mist which makes fine particles of silver and a more continuous surface over a large area than the drip approach.*

Mike

Mike King - 3/2/10

Andy,

On the issue of submerging versus pouring, our pouring chemicals work either way - the only difference is at the edges. The shape of the liquid surface tends to make the concentration lower towards the edge and one of the functions of the rocking process is to compensate for this by redistributing the chemicals. If using a tank, you would also want to move the liquid relative to the surface (moving one or the other) so as not to favor parts of the surface over others.

The spray approach is used on any surface, whether horizontal, vertical or anywhere in between. It is somewhat easier to do horizontally as the liquid stays at the application site for longer but it is applied as very fine, light droplets which tend to stay where they are put anyway.

My calculations based on the amount of silver in the pouring solution, the surface area and the density of elemental silver leads to a figure of about 50 nm (5% of 1 micron) for a typical silver mirror. Electroplating does indeed make thicker plates but that is because it is a continuous process of building up atoms at the surface of either the substrate or the already-deposited silver. The concentration that would be required to make a much thicker plate in one pass of the electroless process would result in too fast of a deposition rate and consequent sloughing off of the metal. In multiple passes, each plate is weaker than the prior plate and so a point comes when the whole thing just peels away. Two passes seems to works very well, giving you a realistic maximum of about 1/10 of a micron.

All of that said, you could combine electroless with electroplating which is the way that nickel plating of non-conductive surfaces, for example, is done. An initial silver plate would be applied with the pouring method and this is then used as an electrode in a silver-plating bath. With a copper plate of course you do not need the initial poured plate. At the same time, the electroless plating process was designed for such non-conductive surfaces that do not interfere with the chemistry. Spraying or pouring on metals does not work as the metal interferes with the silver chemistry.

When we look at spraying, the generally recommended technique is to "waft" the spray over the surface. The amount of silver in each pass is so little that continuous movement tends to even the plate thickness. In industrial spraying applications, a regular, continuous relative movement of the spray and *substrate ensures consistency. When plating sheets, for example, they run them at a constant speed under a fixed set of spray guns. I would point out that the drip technique which we provide does not give very even surfaces as the amount of silver delivered in each drop is much more than the fine mist from a spray gun and one is generally more concerned with getting all of the surface coated than the evenness of the plate. Dilution of the liquid combined with more dripping would probably not give a better result as the chemistry changes.*

As for wastage, as I said, the amount of silver in each droplet is very small so the loss over the edges is not great. Of course small pieces of substrate have relatively longer edges so the wastage is greater so you may want to spray large areas and then cut them up. This is the approach we prefer take when we have a choice as edge effects are then eliminated.

The third surface when sprayed tends to be smoother and more reflective than when poured as the silver deposits faster and has less time to be disturbed by convection currents or waste products. Our customers that do "front-surface mirroring" where the surface you see while mirroring is the one you want to see in the finished product, have successfully reproduced chrome-plated types of effects with our spray products. In their case, they generally cover the silver with a transparent protective coat of lacquer which in your case you would not do but I would think it would work for you.

Mike

Which takes us to the present moment. Making glass daguerreotypes is practical when done correctly and has certain attractions. Various questions clearly remain. Individual practitioners will determine the next steps and the future of this particular approach to the daguerreotype. Please contact me at andy@thedaguerreotypist.com or join the discussion at the cdags.org forum if you would like to discuss glass daguerreotypes further.

Andy Stockton
04/04/2010