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# Reconstruction of European Daguerreotype and Ambrotype Cover Glasses

**Jens Gold**

*Presented at the 2013 AIC & ICOM-CC Photographs Conservation Joint Meeting in Wellington, New Zealand.*

## Abstract


Conservation work on daguerreotypes and ambrotypes is not new to most photograph conservators, and not for the conservation department at Preus Museum. The challenges of this work are well known in the field of photography conservation. The major difficulty for the conservator and the conservation interns during this project was the very high amount of extensively damaged, broken or complete missing cover glasses. The original cover glasses (or the existing fragments) of this time period were mostly decorated/reverse painted in the manner of *Hinterglasmalerei* (German term for glass hand-painted from behind) and *verré églomisé* (French term for reverse decorated, gilded, painted glass; coined in the 18th century). Occasionally, the cover glasses were also decorated with metallic gold lines. Restoring or reconstruction of such cover glasses in a high and satisfactory quality is, even with good skills and using helping tools like handmade masks, very time-consuming. This is maybe fine when dealing with one or two objects over a working year, but not with the amount of cover glasses as in this larger project. An extensive search, both in historic photo literature and contemporary conservation literature, did not lead to a description or a straight-forward method to make or reconstruct a European type cover glass for daguerreotype or ambrotype images. The consultation of conservator colleagues or articles from conservation literature/journals gave surprisingly little information. There was remarkably slight information on straight-forward reconstruction methods or paint application techniques! Because of this, the conservator of the Preus museum together with intern Tereza Cikrytová from the school of paper conservation at the University of Pardubice - Czech Republic, began searching for available procedures that could help to develop such a technique. Thus, the goal of our project was to develop a method for reconstruction European daguerreotype and ambrotype cover glasses, making them look very close to the original. Major objectives was also to find a method that would be safe for the original photographic material, not too time consuming to use, useable for conservators in all types of institutions or in private practice, relatively easy to handle and economic in terms of time and financial resources.

## Background

In 2010-11 Norwegian museum and archival institutions launched the project "fotografiets barneår", which means "the childhood of photography". This project aims to register, document and conserve the parts of national photographic heritage produced in the first ten to twenty years of photography. In connection with this, many different photographic works came to the conservation department in Preus Museum, and among them were many European daguerreotypes and ambrotypes with damaged or missing cover glasses.
The project "fotografiets barneår" additionally intends to document daguerreotypes and ambrotypes, not only nationally, but also internationally together with other nations in the Daguerreobase project (initiated by the conservation department of *Nederlands Fotomuseum*), organized for Norway by the National Library of Norway in Oslo.


Fig. 1. *Brud fra Lærdal i Sogn* by Marcus Selmer, Bergen – Norway, 1855

The Norwegian photographic heritage on daguerreotypes and ambrotypes consists of about 700 objects. Because of the international trade connections and the fact that Norway has always been a sea nation, all kinds of daguerreotype mounting/housing designs are possible to find. However, the major part of the Norwegian daguerreotypes and ambrotypes are housed in European daguerreotype/ambrotype frames (see figure 1).

## Typical damages observed on Norwegian daguerreotypes and ambrotypes

The most common damages observed on the daguerreotypes and ambrotypes, coming to the conservation department at Preus Museum are no different to what exists in many other collections:

- Broken seal of the daguerreotype/ambrotype package
- Damage and dirt caused by insects and dust
- Loose plates in the package
- Scratches on the plates and cover glasses
- Broken cover glasses (fig. 2 & 3)
- Glass corrosion in different stages


Figs. 2 and 3. Objects with broken cover glasses.

- Glass corrosion products on image surfaces
- Delamination of varnishes on the cover glass and ambrotype background
- Corrosion and delamination of image materials, in different stages
- Missing cover glass (fig. 4 & 5)
- Missing housing parts
- Complete absence of housing



Figs. 4 and 5. Objects missing cover glasses.

## Methods to Make Replacements of 19th Century European Daguerreotype and Ambrotype Cover Glasses

*Historic Literature and Previous Research*

As mentioned, historic literature and periodicals on production of daguerreotypes and ambrotypes gave no or very little helpful information on the making and reconstruction of 19th century European cover glasses paint-decorated from behind (Hinterglasmalerei). Major focus in the early photographic literature was almost exclusively on the photographic processes. Exceptions were advertisements concerning design of housings or only very short notes in the photo literature of that time-period (Coucher & Le Gray 1851, Eder & Kuchinka1927, Bland & Long 1856, Humphrey 1853-54).

When studying articles from conservation literature/journals little information on reconstruction or paint application techniques were found, apart from a few recent articles and publications:

- Susie Clark: Conservation of wet collodion positives, *Studies in Conservation*, 1998, page 231–241
- Hanako Murata: Investigation of Historical and Modern Conservation Daguerreotype Housings, ARP 2003
- Lene Grinde: Conservation of Stereo Daguerreotypes, ARP 2005
- Caroline Barcella: The Conservation Project of the Manila Daguerreotypes, ARP 2009.

These publications gave essential information concerning analysis and information regarding historic pigments and binders used on housings, and also on contemporary conservation materials (pigments, binders, glass), photographic activity tests on materials used at the time-period and also on modern alternatives, deterioration issues about historic housing materials and their contemporary alternatives. Especially helpful was three publications of research projects at the Mellon Advanced Residency Program in Photograph Conservation (ARP): The work of, respectively, Murata (2003), Grinde (2005) and Barcella (2009). They not only describe many of the used materials in the 19th Century period using analyses like FTIR, but they also describe contemporary alternatives putting several of these materials through the Photographic Activity Test (PAT). This gave us a great tool and starting point for what kind of materials we should go for in a reconstruction project of daguerreotype cover glasses.

## Typical Materials Used to Make 19th Century Cover Glasses

*The Glass*

From the beginning of the 19th century, with the availability of cheap soda production and improvements in the glass production technology, glass became a cheap mass product. Typical for the period was to produce flat glass sheets with the "cylinder technique". A bottle-like cylinder was blown of a glassmaker, the top end button of this bottle was removed and the cylinder was opened (cut) on one side. During a heating process, the cylinder was opened up and flattened on a surface to become a glass sheet (Corning Museum of Glass / Cylinder of Window Glass http://www.youtube.com/watch?v=hx2JO1QcZjY). This was the common type of glass used for windows, frame making and for daguerreotype and ambrotype cover glasses. Practically all flat glass for these purposes was made of the soda lime glass type. Depending on variations in the production (impurities and contents of the raw material) the glass color could vary from almost colorless to shades of light green, green yellow or blue green (easily to observe from the edge of the glass sheet). The thickness of the used glass sheet could vary from about 2 – 4 mm depending on the format of the daguerreotype or ambrotype, or due to unknown reasons. Though glass was an industrial product, still a great deal of handwork was involved (Koesling 1997, The New Encyclopedia Britannica 1974). That might be the reason why these glass sheets often hold imperfections such as a little wavy uneven surface character, tiny encapsulated air bubbles or solid small particles.

*19th Century Binders, Pigments and Other Materials Used on Reverse Painted Cover Glasses*

Laboratory analyses (Clark 1998, Grinde 2005, Barcella 2009) indicate that a wide range of pigments and binder substances have been used to paint-decorate daguerreotype and ambrotype cover glasses. Almost everything available in the period, which proved to work for painting on glass, was used. Little workshops and manufactures produced series of handmade housing systems for photographic studios (Clark, verbal information, 2012). Thus, there is no surprise to find many variations in design, materials and techniques. Some typical binders at the time-period would be Shellac, Dammar, Sandarac, Bitumen, Asphalt, Canada balsam, Casein glue, Oil of turpentine and Linseed oil. Common pigments were for example Carbon black, Lamp black, Bone black, red iron oxide pigment, chalk or plaster and many more. The golden lines were decorated with the help of brass powder (Clark 1998, Grinde 2005) or by the use of metallic gold (Barcella 2009). Recipes for these paints can be found in the historic literature or in Grindes work as mentioned earlier.

*Contemporary Materials for Making 19th Century-Style Cover Glasses*

On an early stage in this project, we decided to use materials for the cover glass replicas that would fulfill following requirements:

- harmless to photographic materials
- resemble 19th century look "perfectly"
- varnishes should adhere very good to glass also over time (if possible, they should not be sensitive to moisture)

- varnishes should not interact with other paints neither during application nor in a long term perspective

It is likely that most 19th century binder materials would not have passed a PAT. From a wide variety of possible binders, a few that had the necessary properties and that had passed PAT earlier, were chosen (Grinde 2005). The only exception was Shellac, which does not pass PAT, but proved to have very good performance in the paint application process of thin lines. However, when using shellac it was isolated behind layers of B-72 binder after applying the last paint layer.

## Practical Tests and Evaluation of Materials Used in the Project

*Binders in the Test Series*

To begin with, several binders like Shellac, Dammar, Bitumen, Canada balsam, Paraloid B-72 (acrylic resin), Plextol D 498 (acrylic resin in aqueous emulsion), Lascaux (acrylic paint in aqueous emulsion with different pigments) were tried and examined. It turned out that most suitable, in terms of adhesion to glass and ability to blend with different pigments, was Paraloid B-72, Lascaux acrylic paint in aqueous emulsion and shellac. Plextol D 498 worked well as a binder but built many small air bubbles during mixing with pigment and application.

*Pigments in the Test Series*

From a wide variety of pigments used in the 19th century, a few were picked out - the ones that, together with a suitable binder, closely resembled the quality of the colors seen on 19th century cover glasses. In addition, modern pigment resources were included in the search for suitable reconstruction materials. The table below shows pigments that, together with binders like shellac, acrylic binder in aqueous solution or B-72 acrylic binder in Toluene, proved to have suitable properties.

| **Pigments Used** | | |
|---|---|---|
| ***Black*** | ***Gold*** | ***Other*** |
| Bone black (Kremer 47100)<br>Ivory black (Kremer 12000)<br>Spinel black (Kremer 47400) | Mica pigments / Pearl Luster / pearlescent pigments in different shades of gold<br>Kremer Pigments 50000 – 50990 and Deffner &Johann, Germany Best. Nr. 1785900<br>Metallic gold powder / Altgold / Malergold (Deffner & Johann, Germany, Best. Nr. 3256000) | Different pigments in acrylic aqueous emulsion of *Lascaux Artists' Acrylic Colors* Art. Nr. 3920: oxide black, ultramarine deep blue, titanium white, cobalt blue, emerald green, carmine red, permanent yellow medium, yellow ochre, English red |

To find a good combination of binders, pigments and practical combinations of these, several tests were made. To recreate the gold lines, Mica based pigments or metallic gold powders were mixed with different binders. The same were done with pigments of carbon black, ivory black and spinel black to resemble the deep black background for the gold lines. The mixtures were applied to small glass sheets to examine their properties, - visually, application-wise (different brushes, masking tapes and other tools), and their ability for adhesion (Fig. 6). In addition, mixtures of Lascaux paint (see table above; acrylic resin in aqueous emulsion with different pigments) was applied to glass sheets for testing of the same properties. After selecting the pigment / binder combinations (see table above), the next step was to find a good combination between the materials used for the gold lines and the background color. This was done by cross-testing on sheets of glass (Fig. 7) checking the interaction of the different varnishes concerning eventual properties regarding dissolving or softening of the previous applied layer of varnish. Here it became obvious which combination was good and which were not recommendable. The test showed that the safest combination is a water-soluble acrylic binder like Plextol D 498 (Kremer 76000) or Lascaux Artists' acrylic colors with a solvent- based binder like Paraloid B-72 or shellac. However, combinations of shellac-based varnishes with Paraloid B-72 in Toluene works in many circumstances well since Paraloid B-72 is not so easy to dissolve once it has hardened/dried.

Fig. 6. Gold pigment tests.

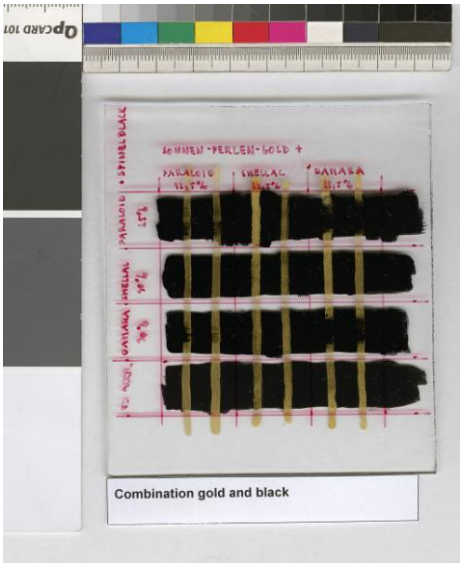

Fig. 7. Gold and black cross-testing.

The set of binders, which behaved satisfying in several combinations with each other, in the test are:

- **Gold lines:** Paraloid B-72 (25 % solution in Toluene), Dammar (30 % solution in Toluene), Shellac (30 % solution in Ethanol)
- **Black background:** Paraloid B-72 (25 % solution in Toluene), Dammar (30 % solution in Toluene), Shellac (30 % solution in Ethanol)
- **Various colored background:** Lascaux Artists' acrylic colors Art. Nr. 3920 / acrylic paint mixture in aqueous emulsion

For the final work the combination Paraloid B72 with Shellac or Lascaux Artists' acrylic colors Art. Nr. 3920 was preferred.

*Glass Alternatives for a Cover Glass Replica*

Two different glass types are most suitable for producing cover glass replicas today. Both are available as common float glass or in the old-fashioned cylinder-made version.

The modern soda lime glass, sold as window or frame-maker glass, is the contemporary version of the old traditional soda lime glass. It is available in a wide variety of thicknesses and optical properties. This type of glass is unfortunately hard to find in a neutral color as is the case also with the 19th century soda lime glass, but it exists from almost neutral color to shades of light green, green yellow or blue green. The neutral type may be very hard to find. Soda lime glass is, under good environmental conditions, a moderately stable material. However, this type of glass usually develops glass corrosion over time. The glass is easy to work with and very cheap.

A more modern glass type, also used in this project, is the borosilicate float glass. There is no difference in surface characteristics between modern soda lime glass and borosilicate glass since both types are produced in both of the mentioned shapes. However, compared to soda lime glass, this glass contains, besides a higher content of silica, also boron oxide and phosphor oxide and other special ingredients. This composition makes borosilicate glass a chemically and physically very stable material compared to traditional soda lime glass. Borosilicate glass is more resistant to mechanical damages (like scratching), heat and temperature changes (little expansion coefficient) and a great variety of chemicals, high humidity and other environmental factors (Koesling 1997, Murata 2003). Since borosilicate glass is somewhat resistant to scratching, it is a little bit harder to cut. Today it is available in a great variety of thicknesses and to an affordable price (http://www.schott.com/architecture/english/products/index.html). Other significant advantages are the color of the glass, it's almost exclusively neutral. The mechanical stability prevents it to a degree from damages. However, the major advantage is the chemical stability: borosilicate glass is not prone to glass corrosion.

| **Glass alternatives** | | |
|---|---|---|
| **Glass type** | **Advantages** | **Disadvantages** |
| Antique window glass<br>(soda-lime glass) | authentic look (?)<br>easy to cut<br>inexpensive | prone to glass corrosion<br>breaks easier than modern glass<br>often hard to find the right type/look<br>hard to find neutral colored |
| Modern window glass<br>(soda-lime float glass)<br><br>2 mm frame maker glass | easy to cut and work with<br>inexpensive<br>easy to get | suffers glass corrosion<br>breaks easier than borosilicate<br>often no neutral color (green/blue tint) |
| Borosilicate glass<br>(float glass)<br><br>Schott Borofloat<br>2 or 2.75 mm (+/- 0.2 mm) | no optical difference to traditional float glass<br>neutral color<br>extreme high resistance to corrosion<br>good resistance against mechanical damage | often special order<br>harder to cut |

Yet another option would of course be the use of antique glass. But since this is not only hard to find, but also breaks much easier than modern glass, it is obvious that there are not many good reasons to use this glass type today.

*Cleaning the Glass*

After cutting, the glass sheets are abraded with a type 300 sanding paper to remove sharp edges. After that, the glass sheets are washed under running water to remove all particles from the sanding in order to prevent scratches. Now the glass is ready for thorough cleaning of the surface to remove all residue of oily or fatty substances and products of glass corrosion.

There are many types and ways of cleaning glass surfaces. The table in the text shows some of the common ones in the 19th century. They are still quite effective and many are still in use. For our purpose we chose the method with rottenstone. It is a cheap and effective method that have been in use also for cleaning glass sheets used to make wet collodion negatives and positives, and also to polish daguerreotype plates.

For this method the glass sheet is placed on a suitable support (for example some clean smooth cotton fabric, foam sheet etc.). Very fine rottenstone powder is then, with some water and ethanol, applied to the glass surface. With a moist cotton or microfiber tissue and moderate pressure, the rottenstone is then applied, using a circular agitation pattern, to the glass surface. This process should go on for several minutes to make sure that all possible dirt and glass corrosion products are removed from the surface. After cleaning both sides, the glass sheet is washed under running water. To make sure that all oily substances are gone, and to speed up the drying process, the glass sheet is washed again with a 50 % ethanol/water solution. The final drying is done by using a clean cotton tissue.

| **Glass Cleaning Methods** | |
|---|---|
| **Polishing / cleaning substance** | **Type of cleaning** |
| Jeweler's rouge / red rouge<br>[Iron(III) oxide] (Kleffel 1863, Eder 1927) | Mechanical |
| Optician's rouge / ceria<br>(Kleffel 1863, Eder 1927, Clark 2012)<br>[Cerium(IV) oxide] | Mechanical |
| Pumice, Tripoli, rottenstone, limestone,<br>(Robert & Sobieszek 1854, Kleffel 1863, Eder 1927, Osterman 2000) [Mineral: mix of silica & calcium carbonate] | Mechanical |
| Acid cleaning<br>(Kleffel 1863, Eder 1927), [Nitric acid] | Chemical<br>*Very aggressive, not recommended* |

## The Reconstruction of the 19th Century Cover Glass Design

Examinations of various cover glasses show that there are variations in paint applications even with similar designs. Brush strokes and the possible use of some kind of mask can be observed or assumed (Fig. 8 & 9) (Grinde 2005). As already mentioned, the literature reveals little about paint application methods. Because of that, a few methods have been tested like free hand painting (known from glass ware and porcelain painting), paint decorating with the help of handmade masks and paint application with the help of computer-generated machine-cut masking film.

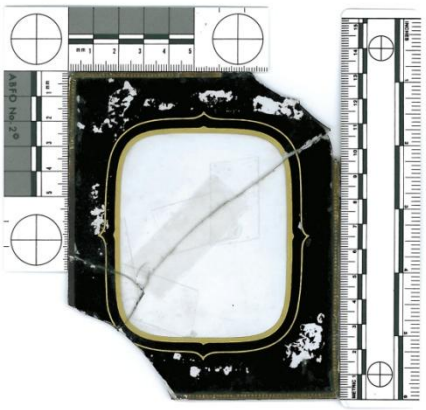

Fig. 8. Overall photograph of a 19th century cover glass

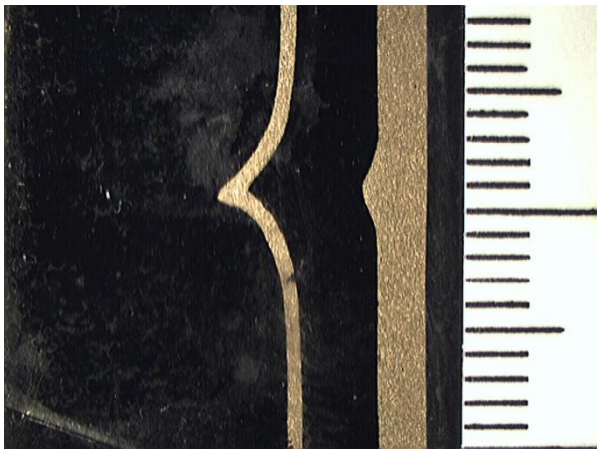

Fig. 9. Detail indicating the possible use of a mask to aid in design application.

*Free Hand Painting*

Painting the decoration by hand without masking help has been tested and was a successful way to apply paint in terms of the quality of the work (Fig. 10). The method is very time-consuming and it demands very good skill to do this in a reasonable time. Porcelain painters who have developed routine and skill over many years might be able to do paint decorations like this on a daguerreotype cover glass in a few minutes. A conservator, which paints maybe one or two decorations a year, will probably have difficulties to do the same thing in such a short amount of time. The test proved noticeably that there ought to be a more efficient way of doing this.

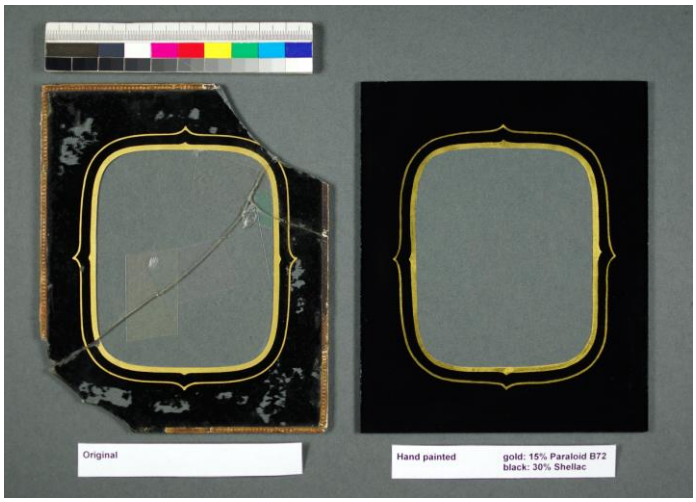


Fig. 10. Hand-applied decoration.

*Decorating with the Help of Handmade Masks*

Another method tested, is paint decoration with the help of handmade masks or masking film cutouts. For this method, self-adhesive masking film is attached to the glass sheet to be decorated. The desired design is drawn on with a pen and then cut out with a sharp cutter or scalpel. Afterwards, the masking film areas for the first paint layer are removed. The now open glass surface is carefully cleaned from tape residue before the desired paint is applied. This method works well although the cutting of the masking film is very time-consuming and not always flawless. A small mistake and the whole cutting-out process needs to be repeated. Another difficulty is the (usually) very thin lines in the decorations. The use of this method does not provide the typical look of the original fragments. No surprise really, since smooth, even brush marks on many of the originals indicate that masks like these probably were not used. This test also indicated that there ought to be a more efficient and practical way of doing this work.

*Decorating with the Help of Plotter Generated Self-Adhesive Masks*

By studying modern technologies for the application of complicated graphic designs on all kinds of surfaces, one technology seemed quite suitable for the work that needed to be done in our project. Computer/plotter generated self-adhesive masking film is a universal tool for many applications in advertisement, motorsports tuning, wide-ranging paint decoration and many other applications. A great variety of decoration and masking films for all kinds of purposes are available. The author came across this technology some years ago when visiting a graphic art studio that created advertisement materials for all kinds of purposes and costumers. While working on this project it became apparent that this product, as it is quite wide spread, easy, cheap and available almost over the whole world, would be good also to recommend also to other colleagues.

A short description of how this tool was used in the daguerreotype/ambrotype cover glass project may help to illustrate the working principle.

**Step 1:** Fragments of a broken cover glass or a handmade sketch are scanned together with a centimeter scale (see fig.9). Original fragments or a handmade sketch are used to keep a human touch in the final product. The image is then transformed to a graphic image to make the mask. Missing parts of the fragments image are replaced. The image of the final décor is placed in the right proportion with the help of graphic software (fig. 11). Important proportions are the general size of the original but also the thickness of the lines and "brushstrokes". Asymmetric properties of the original and original dimensions are copied as far as possible 1:1 in the final plotter image. The final image is copied several times to make several masks in one step on one foil sheet.

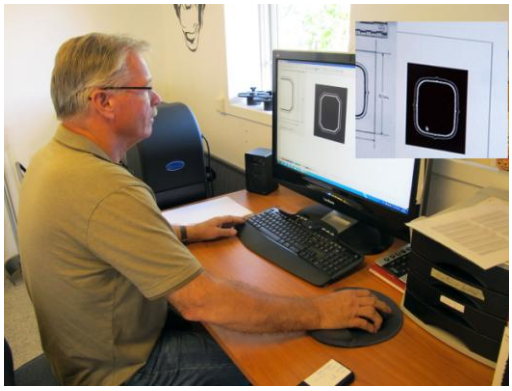

Fig. 11. Digitally recreating missing components of the original cover glass.

**Step 2:** The décor image is conversed to a special plotter/cutter, which is cutting the final image in the masking film with the help of very small cutter blades (fig. 12). After that, the masking film is arranged on a working table where particular parts of the cutout are removed (fig. 13) after which the masking film is covered with transfer film. The removal of cut-out areas can also be done later if desired.

Fig. 12. The plotter/cutter.

**Step 3:** After cutting the masking film pieces to the cover glass sizes, the material is ready for use. The previously cleaned cover glass sheet should be placed on a smooth and flat surface, maybe fixed with a little piece of double-sided tape. It is practical to have a dark background since this makes it easier to see dust and air bubbles on the glass sheet or the film. When transferring the film to the glass surface, first detach about $^{1}/_{10}$ of the thick waxy mask carrier paper so that only one narrow side of the tacky masking film gets in touch with the glass, making it easier to position the mask fittingly edge to edge on the glass sheet. After setting the masking film correctly, the rest of the carrier paper is removed carefully and the film is pushed down with the help of a wide spatula from one end of the glass sheet to the other (fig. 14). It is critical to do this in an even and smooth way to avoid big air bubbles between film and glass surface. However, should it happen that some bigger air bubbles appear it is possible to remove them by sticking a sharp needle in the foil/bubble.

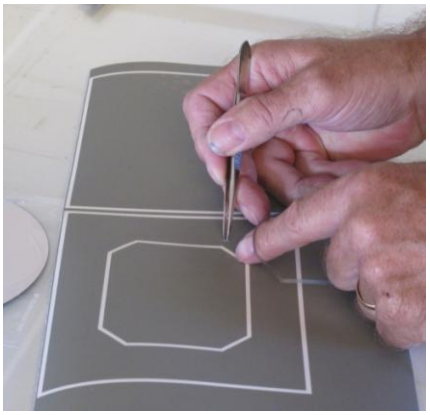

Fig. 13. Removing parts of the cut-out mask by hand.

**Step 4:** After the film is fixed to the glass, the transfer paper can be removed (fig. 15). This is done by carefully lifting one edge of it and slowly removing it from edge to edge.

Fig. 14. The mask is placed onto the glass sheet.

**Step 5:** If not done right, after the printing/plotting, the desired area of the masking film can be removed also now (fig. 16). Some masking films leave a little bit of adhesive residue on the glass surface. This should be cleaned off, since it may disturb the paint application. Often a cotton swab moistened slightly with distilled water is enough for this job. In addition, it is sometimes advisable to use gentle pressure to push the edges of the cutouts in the masking film down to the glass surface. A very good tool for that is a little Teflon spatula (fig. 17).

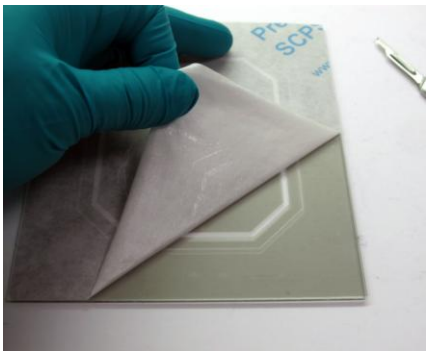

Fig. 15. The transfer paper is removed from the glass.

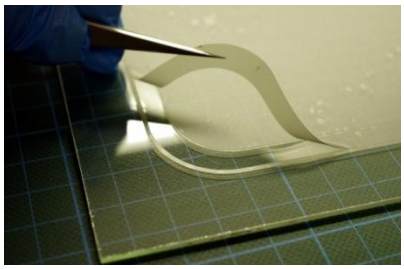

Fig. 16. Removing the desired area of the masking film.

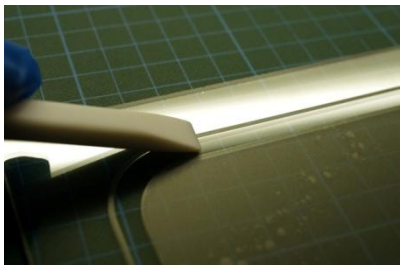

Fig. 17. Applying gentle pressure with a Teflon spatula.

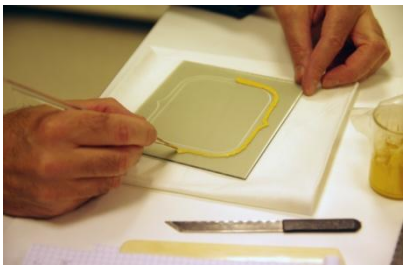

Fig. 18. Applying the initial varnish – the gold lines.

**Step 6.** The prepared varnish for the first step, the gold lines, can now be applied to the open glass surface (fig. 18).

**Step 7.** After a short drying time, the masking film that covers the background area is removed carefully from edge to edge (fig. 19). It is important not to wait too long with this step since otherwise parts of the just applied décor may also be removed and thereby destroyed. Sometimes a little cut in the paint edge can be helpful to start the removal of the masking film.

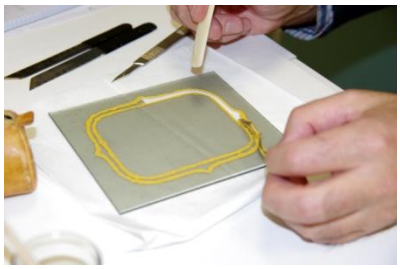

Fig. 19. The masking film is removed from the background.

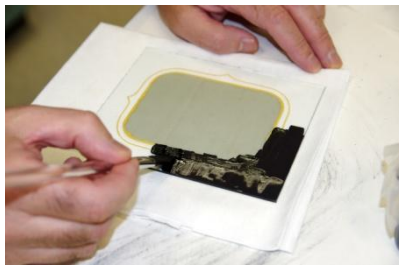

Fig. 20. The background color is evenly applied.

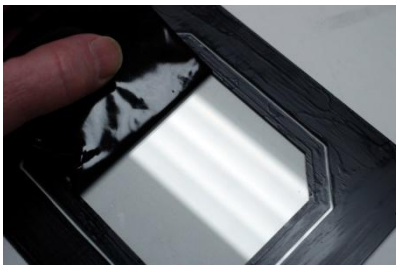

Fig. 21. The central part of the mask is removed.

**Step 8.** The now open glass area is checked and may be cleaned of any adhesive residues.

**Step 9.** The background color is evenly applied to the glass surface (fig. 20).

**Step 10.** The last part of the masking film, left in the center area for the opening in the cover glass, is removed carefully (fig. 21). Also here it is important not to wait too long after the paint application. Otherwise problems of paint coming off where it should not, may occur.

**Step 11.** After the paint has dried, the opening of the cover glass can be cleaned. The cover glass is now ready for use in the rehousing of a daguerreotype or ambrotype (fig. 22).

Fig. 22. A new cover glass used in the rehousing of a daguerreotype.

## A Technique for Gilding Mirror-Like Metallic Gold Lines

Some daguerreotype or ambrotype cover glasses have decorative mirror-like metallic gold lines (figs. 23 & 24). These lines are in their look often similar to metallic gold lines known from china or glassware. There are several ways, also known in the 19th century, of applying such lines. The table below shows three of them. The one method, which works well and can be done easily in small conservation studios, is the application of gold leaf. For this method, 1 g gelatin is dissolved in 125 cm distilled water of 60 °C (Rottländer 2000, Schönburg, 2001). (In the project photo gelatin type Restoration 1, Nr. 40321 from GMW-Gabi Kleindorfer in Germany, was used and performed very well.) The solution should be very clean and possibly filtered before use. To create the thin metallic lines with the masking film system, it is wise to start with the background paint application. Then remove the masking film pieces for the lines and apply the gold leaf in the open areas overlapping to the already applied background paint.

Figs. 23 & 24. A mirror-like gilded surface in different lighting conditions.

Fresh gelatin solution is brushed on the glass area which is supposed to be gilded (fig. 25). The small gold leaf pieces are then applied to this surface with a gilders brush (fig. 26)'. (The gold leaf used in the project was Dukaten-Doppel-Poliergold 23 $^{1}/_{2}$ kt from Arkivprodukter AS - Norway and Orange-Doppelgold 22 kt from Deffner & Johann - Germany). Some instructions recommend pressing the gold leaf down after application by the use of soft leather or paper. For the use of making small gold lines, this step has not proven to be very practical because some gold tend to stick to the leather. When the water has evaporated, the gold adheres very well to the glass surface (fig. 27). Some gilding instructions recommend also gilding twice to fill in imperfections like small areas without gold.

Fig. 25. Gelatin is brush-applied to the area to be gilded.

Fig. 26. Small pieces of gold leaf are applied with a gilder's brush.

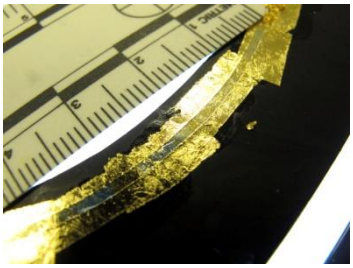

Fig 27. The gold is well adhered to the glass surface.

Finally, to protect the very thin gold layer and also to correct possible imperfections in the gold (little holes) it is possible to cover the dried gold layer with a layer of yellow varnish. In this project, water based acrylic paint, shellac based paint or B-72 based paint was used for this purpose (fig.28).

Fig. 28. The gilding is covered with a layer of yellow varnish.

Recommended literature about gilding:

- *Practical Gilding*, Peter MacTaggart and Ann MacTaggart, 2007.
- *Historische Beschichtungstechniken*, Kurt Schönburg, 2011.
- *Historische Techniken des Malers*, Hans Rottländer, 2000.
- *Vergolden / Das Arbeiten mit Blattgold*, Hans Keller, 1992/2009.

| **Gilding Technique** | |
|---|---|
| **Technique** | **Application Method** |
| Industrial metal preparations on ceramics and glass (Heraeus: http://www.heraeus-ceramiccolours.com) | Brush or spraying, setting by heat (glaze-firing), by about 750 or 850-1250 °C (difficult, expensive) |
| Classic gold- and silver leaf application behind glass (Hinterglasvergoldung) behind the glass gilding | Adhesion with a gelatin solution (safe, easy, inexpensive) |
| Chemical application of gold (Liebig 1856) | Chemical reduction of gold onto glass surface (poor adhesion, difficult) |

**Evaluation of the Technique**

*Glass Types*

Two types of glass have been used in the project. Both of them worked well for the glass decoration job. However, in the long run the Borosilicate glass will probably be the better choice, mainly because of its high permanence and resistance to glass corrosion and its neutral color. The price should be no issue anymore since prices have fallen significantly in the resent years and glass sheets for daguerreotypes and ambrotypes are mostly very small in size.

*Gold Leaf: Types and Application Techniques*

The use of gold leaf may not be the ultimate way to produce metallic gold lines. Never the less it is almost ideal since it is relatively easy to do after some training, very permanent and inexpensive. The author also found that with some improvement, the quality of the lines became so good that they almost are comparable to industrial applications, which use high amounts of heat and expensive equipment. However, some observations made during this project indicate that several techniques have been in use originally to make mirror-like metallic gold lines and

that the use of gold leaf seems to be one of them. On some original cover-glasses the reflection of light in gold lines are not always perfect but looks very much like gold applied with the leaf gold technique (fig. 23 & 24). As this technique was well known at the time-period this would not be surprising.

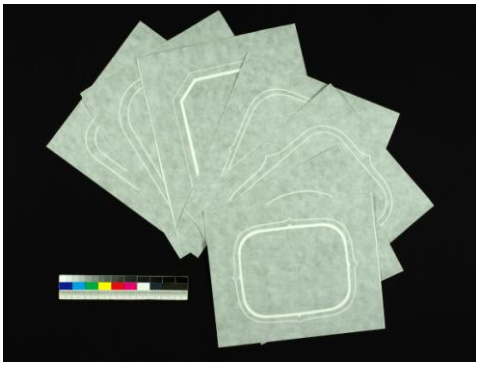

Fig. 29. Multiple variations of decorative cover glasses are permitted by the masking technique.

*Plotter Generated Masks*

The self-adhesive masking film (fig. 29) allows for many variations of décor and direction possibilities. It seems that only the imagination of the user is the limitation. Different types of self-adhesive foil are interesting to investigate. Properties like thickness, adhesion power or resistance to a range of solvents are most interesting for the conservator.

*Binder / Pigment Combinations*

There are surely many binder/pigment variations that might work for this kind of glass decoration. The chosen combination, described in this article seemed easy to handle also in terms of reproduction in several cover glass productions. However, the experiences made during this project proved that there certainly are lots of room for improvement and new variations. Especially the use of contemporary materials gave the impression of improvement in terms of: greater permanence, easier handling and the paradox of a closer look to materials from the 19$^{th}$ century.

For example, in the search for the right black pigment, the use of Spinel black gave the closest look to the black on the original 19$^{th}$ century cover glass fragments. Spinel black belongs to the copper-manganese-iron-system of spinel minerals. This pigment is characterized by a deep black appearance. While other pigments remit at least some part of the light spectrum and appear more or less colored, spinel black remits no more than 1.5% of incoming light at any point of the spectrum. No other pigment achieves this kind of optical blackness. Its good hiding power also gives this pigment a high yield (information from Kremer data sheet: 47400, www.kremer-pigmente.com).

*Strategize*

No system is flawless. It is a good idea to plot/print more masks (for example three) for one type of design. In addition, it is smart to cut and clean several glass sheets in advance. These materials are cheap and, in case of a little mistake, for example during paint application or mask removal, easy to replace. It can also be a good strategy to make two cover glasses in the same time and then use the best one in the end.

| **Pigment/Binder Combinations** | | |
|---|---|---|
| **Gold lines** | **Black background or lines** | **Other colors** |
| **Pigments:**<br>Mica pigments /pearlescent pigments<br>*(Kremer Pigments 50000 – 50990 Pearl Luster or similar from Deffner & Johann - D&J, Germany)* | **Pigments:**<br>Spinel Black<br>*(Kremer 47400)*<br>Bone black<br>*(Kremer 47100)* | **Acrylic paints**:<br>Lascaux Studio or Golden Acrylics |
| **Binders:**<br>B-72 Mixture<br>15% B-72 in 1:1 toluene/ethanol *(Paraloid B-72 D&J 2522000)*<br>Shellac Mixture<br>30% shellac in ethanol<br>*(Kremer 60450)* | **Binders:**<br>B-72 Mixture<br>15% B-72 in 1:1 toluene/ethanol<br>Shellac Mixture<br>30% shellac in ethanol | **Binders:**<br>Lascaux Studio original<br>*(D&J no:1929)*<br>B-72 Mixture<br>15% B-72 in 1:1 toluene/ethanol<br>Shellac Mixture<br>30% shellac in ethanol |
| *! The amount of pigment used in a binder ranged from 5 – 20 %, depending on the specific use. Make a small test on a glass support before the final application, to ensure adhesion.* | | |

**Improvements in the Technique**

A little workshop, organized in the Preus Museum after this project in 2012, showed clearly that there still is great room for several ways to go in terms of binder, pigments, leaf gold application, or methods of paint application. The author of this paper is therefore grateful for any kind of helpful suggestions to improve the work with the reconstruction of daguerreotype or ambrotype cover glasses.

| Overall Evaluation: Materials | | | |
|---|---|---|---|
| **Binders** | **Pigments** | **Glass** | **Application** |
| **Historic Binders** | **Historic Pigments** | **Antique Glass** | **Hand Application** |
| *(shellac, dammar, rabbit glue, gelatin, bitumen, Canada balsam)*<br>• good to use with proven recipes<br>• most historic materials do not pass the PAT<br>• tendency to exfoliation<br>• only shellac and gelatin were used in the final projects | *(ivory black, bone black, carbon black, zinc white, etc.)*<br>• difficult to find the black pigment/pigment tone which is comparable to the black on the historic fragments<br>• mostly unproblematic to use also with the contemporary binders | • good appearance<br>• can be hard to find<br>• breaks easy<br>• often suffers from glass corrosion | • time-consuming<br>• difficult for some application steps<br>• hard to reproduce<br>• good training is required |
| | **Modern Pigments** | **Modern Soda Lime Glass** | **Handmade Mask** |
| **Modern Binders** | *(spinel black)*<br>• spinel-black best resembled the historic black on the original cover glass fragments<br>*(mica pearlescent pigments)*<br>• for the gold lines<br>• worked well and easy to use with different binders | • easy to find in many thicknesses<br>• cheap<br>• easy to work with<br>• glass corrosion can be an issue | • inexpensive<br>• difficult for some application steps<br>• time-consuming<br>• hard to reproduce<br>• can be difficult to make<br>• works well with different solvents (test first) |
| • good to use after testing<br>*Plextol D498*<br>• builds in air bubbles when mixed with pigments<br>*Paraloid B72*<br>• works very well but solvents can harm the masking tape<br>• passed the PAT<br>*Lascaux acrylic paints*<br>• adheres well and is easy to use<br>All modern binder systems had little tendency to delaminate. | | **Borosilicate Glass**<br>• available in many types (also as float glass, cylinder glass / antique look)<br>• can be harder to cut<br>• very resistant to glass corrosion<br>• good resistance to mechanical damage | **Plotter Generated Mask**<br>• easy to produce and reproduce<br>• very cheap<br>• time saving<br>• available almost everywhere<br>• works with different solvents (test first) |

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**Images**

Figures 1-5 & 8-29 Jens Gold
Figures 6 & 7 Tereza Cikrytová

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