

# FLUORESCENCE FAILS: ANALYSIS OF UVA-INDUCED VISIBLE FLUORESCENCE AND FALSE-COLOR REFLECTED UVA IMAGES OF TINTYPE VARNISHES DO NOT DISCRIMINATE BETWEEN VARNISH MATERIALS

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*To determine if the commonly used technique of UVA-induced visible fluorescence could accurately identify varnish materials, a study collection of 221 tintypes with known varnish materials was digitally imaged. The CIE L\*a\*b\* values of the fluorescence in the lightest light and darkest dark areas of the images obtained in Adobe Photoshop<sup>®</sup> showed no correlation between resins present and the color of the fluorescence, and fluorescence failed to differentiate between even quite disparate materials such as shellac and dammar. This commonly used examination technique should not be considered a reliable identification method for varnish materials: if identification of resins is critical, more accurate analytical techniques must be employed. False-color UVA images, a relatively recent addition to the digital imaging repertoire, also failed to differentiate between resins, indicating that the relative absorption/reflection of UVA light by the resins was also insufficiently characteristic to provide identification.*

KEYWORDS: *Fluorescence, UVA-induced visible fluorescence, Tintypes, False-color UVA, Varnish, Shellac, Dammar*

## 1. INTRODUCTION

The tintype, also known as the melainotype or ferrotype, was the most popular type of photographic image in the United States from the 1860s to the early 1900s, due to its low cost and durability (Shimmelman 2007). This status was additionally driven by the social imperatives of the American Civil War and the increased purchasing power of the middle class who sought to document their lives (fig. 1(a)). Thus, tintypes provide a glimpse into the lives of everyday citizens and are of historical and sociological interest.

Tintypes were made using the wet-collodion method first developed by Frederick Scott Archer (Archer 1851), but instead of glass the support material was a japanned metal plate (Smith et al. 1856). In their final state, tintypes are multilayered composite structures. The metal support plate was japanned on one side, with the colored japanning layer providing the darks of the final image (fig. 1(b) and (c)). Plate manufacturers also applied a protective varnish to the verso of the plate to help prevent rusting of the support (Shimmelman 2007). The artist would purchase these plates from photographic supply houses, and then apply the collodion binder as well as a protective top varnish layer to help prevent physical damage and oxidation of the image.

The popularity of tintypes led to the publication of “how to” monographs, such as *The Practical Ferrotyper* by A.P. Trask (Trask 1872) and *The Ferrotype and How to Make It* by E.M. Estabrooke (Estabrooke 1872), which provided instruction in the mechanics of taking tintypes, in how to create pleasing portraits, and in running a commercially successful studio. The most variable step of the photographic process was the artist-applied top varnish: some authors recommended that the artists make their own varnish, while others recommended the use of commercially available varnishes from photographic supply houses (Rogge 2014). These recommended varnishes contain a wide range of components, with different solubilities and solvent sensitivities that should be handled differently by conservators, so identifying the top varnish used in a given tintype is a critical step in its treatment.

Many conservators use UVA radiation in the examination of artifacts. With the advent of digital imaging, documentation of UVA-induced visible fluorescence has become a standard practice, and the newer techniques of reflected UVA and false-color UVA are increasingly encountered in the field. Although initially utilized as an examination and documentation tool to locate areas of overpaint, adhesives, and varnishes, it has become commonly accepted that the color of the visible fluorescence induced by UVA

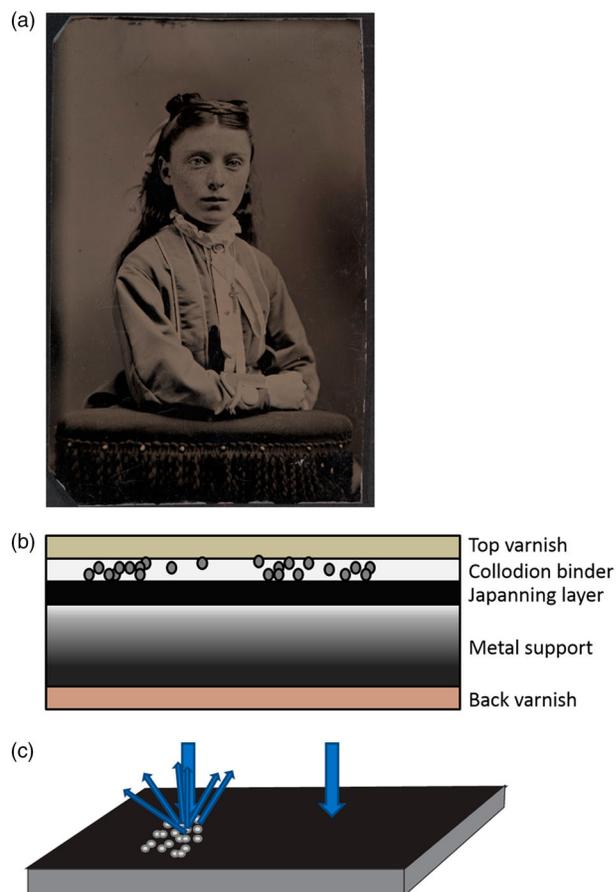


FIG. 1. (a) A 1/6 plate tintype from the study collection; (b) the layer structure of a tintype, image particles are indicated in the collodion layer; (c) darks are caused by the absorption of light by the exposed japanning layer while highlights are caused by diffuse reflectance off the silver image particles.

radiation can help identify varnish materials (Rivers and Umney 2003; Tragni 2005; Grant 2000; Stoner and Rushfield 2012). However, discussions with photograph conservators suggest that misidentification of varnish materials based upon fluorescence color is common and in some cases has led to treatment issues, as varnishes believed to be plant resins based upon blue-green fluorescence exhibited unexpected solubilities.

A previous study utilizing pyrolysis–gas chromatography mass spectrometry (py-GC–MS) to identify the components in the top varnishes of a study collection of tintypes found a wide range of components, some of which were distinct from literature recipes (Rogge 2014). Twenty-four percent of the varnishes had materials specifically recommended for tintypes, 44% of the varnishes had materials recommended for other wet-collodion images, and the remaining 32% of the tintypes were mostly varnished with mixtures of shellac and *Pinaceae* resin, which likely represent commercially available varnishes. This corpus of diverse and

definitively identified varnishes made an ideal collection to assess whether UVA-induced visible fluorescence provides an accurate, non-destructive way to determine varnish identities. Accordingly, digital images of the visible fluorescence of the study collection tintypes were obtained and processed in Adobe Photoshop® to extract CIE  $L^*a^*b^*$  values for the lightest light and darkest dark areas, which were compared to the varnish compositions. The color values showed very little correlation with varnish identity, the only slight correlation being that sandarac-containing varnishes are slightly more yellow (positive  $b^*$ ) in the lightest light regions but the difference is not significant enough for firm identification.

False-color UVA imaging (FCUV) was also explored as another possible means for non-contact, non-destructive identification of varnish materials as it offers a potential method to differentiate between materials similar in appearance (Warda 2011). Reflected UVA images record the absorption and reflection of UVA by an object, and in false-color images the reflected UVA image is combined with the two visible light channels of a normal light image, similar to standard false-color IR images (Warda 2011). This technique was first developed by Aldrovandi et al. (2004) for non-destructive analysis of pigments and has since been applied to easel and wall paintings (Aldrovandi et al. 2005), works of art on paper (Coccolini 2010), and textile dyes (Conti and Keller 2009), but analysis of resinous materials has not yet been reported. To investigate its utility for distinguishing between varnish materials a subset of the study collection was imaged and analyzed. Tintypes with very different varnish materials displayed similar false-color UVA images, and thus this method also fails to identify varnish materials.

The failure of these methods to identify varnish materials does not negate their value for examination and documentation but indicates that they cannot be used as reliable analytical tools for tintypes, and the use of more definitive analytical techniques such as FT-IR or GC–MS is necessary. Because many of the materials studied here are components of varnishes used not only for photographs but also for paintings and furniture, conservators working with those objects may also need to be cautious about using UVA-induced visible fluorescence to identify varnishes.

## 2. MATERIALS AND METHODS

### 2.1. OBJECTS

A study collection of 221 unprovenanced, undated tintypes ranging in size from gems (19 × 27 mm) to 1/6 plates (64 × 89 mm), was purchased from local and online vendors. Based upon the clothing of the sitters

they are presumed to date from the 1860s to early 1900s.

## 2.2. DIGITAL IMAGING

### 2.2.1. NORMAL ILLUMINATION

Normal illumination images of the tintypes were taken with a Nikon D700 camera (36 × 23.9 mm CMOS sensor) with a Nikon AF-S VR Micro-NIKKOR 105 mm 1:2.8 D lens. The camera was white balanced using a neutral gray card (Kodak R-27, 18% gray) and the camera settings were as follows: ISO 200; aperture *f*/8; shutter speed 1/10 s; exposure adjustment -0.2. The RAW (NEF) file was adjusted in Adobe Camera Raw to have a consistent tint of 0 and a temperature of 2850. Illumination was provided by two Cole-Parmer single light guide fiber optic lamps, EKZ 30W/10.8 V/3100 K (MR-16) and a Leica twin light guide fiber optic EJA 150W/21 V/3400 K (MR-16), and the irradiance at the object was 133 footcandles.

To create false-color UVA images, a subset of the collection was also photographed under normal illumination with a UV-VIS-IR modified Nikon D700 camera (36 × 23.9 mm CMOS sensor) with a Jenoptik Coastal-Opt<sup>®</sup> 60 mm 1:4 UV-VIS-IR apo macro lens equipped with a PECA 918 filter. The camera was white balanced using a neutral gray card and the camera settings were as follows: ISO 200; aperture *f*/11; shutter speed 1/10 s; exposure adjustment -0.2. The RAW (NEF) file was adjusted in Adobe Camera Raw to have a consistent tint of -34 and a temperature of 2050. Illumination was provided by two Cole-Parmer single light guide fiber optic lamps, EKZ 30W/10.8 V/3100 K (MR-16) and a Leica twin light guide fiber optic EJA 150W/21 V/3400 K (MR-16),

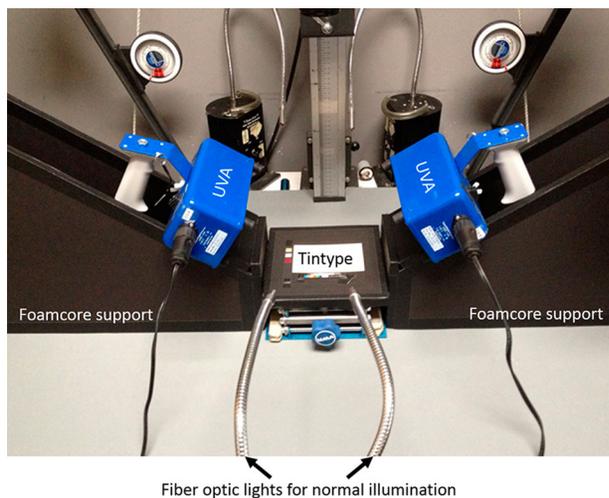


FIG. 2. Lighting set-up for photographic documentation of UVA-induced visible fluorescence; the fiber optic lights for normal illumination are also shown.

and the irradiance at the object was 267 footcandles, which is higher than the 200 footcandle standard recommended amount (Warda 2011) but was found to provide optimal even illumination for these light-stable objects.

### 2.2.2. UVA-INDUCED VISIBLE FLUORESCENCE IMAGING

Digital photographs of the tintypes were taken with a Nikon D700 camera (36 × 23.9 mm CMOS sensor) with a Nikon AF Micro Nikkor 105 mm 1:2.8 D lens equipped with PECA 918 + Kodak Wratten 2E (gelatin) filters. The camera settings were as follows: ISO 200; aperture *f*/8; shutter speed 1.6 s; no exposure adjustment. The RAW (NEF) file was adjusted in Adobe Camera Raw to have a consistent tint of +35 and a temperature of 10 000 K and the white balance was set to shade. Radiation was provided by two UV Systems Inc. Superbright II 3000 series LW lamps with primary wavelengths of 370 nm and the irradiance at the object was 516  $\mu\text{W}/\text{cm}^2$ . The lamps were positioned at a 32° angle on Foamcore supports in order to provide an even wash of radiation across the image surface (fig. 2); this method was adapted from one developed by Chen (2012) for documentation of UVA-induced visible fluorescence. A prototype of the UVA reference target was included in each image to check for consistent lighting.

### 2.2.3. REFLECTED UVA IMAGING

Digital photographs of the tintypes were taken with a UV-VIS-IR modified Nikon D700 camera (36 × 23.9 mm CMOS sensor) with a Jenoptik CoastalOpt<sup>®</sup> 60 mm 1:4 UV-VIS-IR Apo Macro lens equipped with B+W 403 (a Kodak 18A filter may be used instead) + BG38 (B+W 2 mm thick screw-in) filters. The camera settings were as follows: ISO 200; aperture *f*/11; shutter speed 2.0 s; exposure adjustment +0.30. The white balance was set to shade and the tint and temperature were adjusted in the RAW (NEF) format to +2 and 7300 K, respectively and the saturation was set to -100. Radiation was provided by two UV Systems Inc. Superbright II 3000 series LW lamps with primary wavelengths of 370 nm and the irradiance at the object was 536  $\mu\text{W}/\text{cm}^2$ .

## 2.3. IMAGE ANALYSIS

### 2.3.1. CIE $L^*A^*B^*$ ANALYSIS

The DNG files were opened in Adobe Photoshop<sup>®</sup> and saved as TIFF images (9.44 × 14.19 in, 300 dpi) using Adobe RGB 1998 color space. A 3 mm selection circle was used to select and copy three areas of the lightest lights and three areas of the darkest darks of the images to a new layer. The blur tool, set at 100% strength and a size of six pixels, was used to homogenize the selected swatches by sweeping the brush in a

circular fashion from the center of the swatch outward. The color sampling tool set to a  $5 \times 5$  pixel sample size was then used to take three readings from each swatch, and the CIE  $L^*a^*b^*$  values were recorded (Coelho et al. 2006), these values were then averaged and the standard deviations calculated. With the exception of the darkest dark  $a^*$  value, which is very small (average value of 0.7) the standard deviation of a given plate's lightest light or darkest dark  $L^*$ ,  $a^*$  or  $b^*$  value divided by the average was below 0.1, indicating that some variability in the  $L^*a^*b^*$  measurements is present, as is to be expected when measuring values from images. The average values for each tintype were used for graphical data analysis.

#### 2.3.2. FALSE-COLOR REFLECTED UVA ANALYSIS

TIFF images were opened in Adobe Photoshop® and the reflected UVA image was converted into grayscale. The contrast of this image was optimized using Auto Levels, bringing the N8 patch on the color chart to 120 RGB (Warda 2011), and this modified image was saved as a TIFF. The visible light image was then opened and the following channel substitutions were made: G to R, B to G, and UV grayscale to B.

#### 2.4. PY-GC-MS ANALYSIS

##### 2.4.1. SAMPLING

Samples of the varnish layers of the tintypes were obtained by scraping the surface with a 0.5 mm tip microchisel (Ted Pella) or #15 scalpel blade under a stereo-microscope. Care was taken to ensure that the jannanning layer was not co-sampled.

##### 2.4.2. PYROLYSIS INSTRUMENTATION AND METHOD

Samples of 3–5  $\mu\text{g}$  were placed into a 50  $\mu\text{L}$  stainless steel Eco-cup (Frontier Laboratories) and 3  $\mu\text{L}$  of a 25% methanolic solution of tetramethylammonium hydroxide (TMAH) was introduced for derivatization (Heginbotham and Schilling 2011). After 3 minutes an Eco-stick (Frontier Laboratories) was fitted into the cup, and the cup was placed into the pyrolysis interface of a Frontier Lab Py-2020D double-shot pyrolyzer where it was purged with He for 3 minutes. Samples were pyrolyzed using a single-shot method at 550°C for 6 s and then passed to the GC-MS through an interface maintained at 320°C.

##### 2.4.3. GC-MS INSTRUMENTATION AND METHOD

The pyrolyzer was interfaced to an Agilent Technologies 7820A gas chromatograph coupled to a 5975 mass spectrometer via a Frontier Vent Free GC/MS adapter. An Agilent HP-5 ms capillary column (30 m  $\times$  0.25 mm  $\times$  0.25  $\mu\text{m}$ ) was used for the separation with He as the carrier gas set to 1 mL/min. The split injector was set to 320°C with a split ratio of 50:1 and no

solvent delay was used (Heginbotham and Shilling 2011). The GC oven temperature program was 40°C for 2 min, ramped to 320°C at 20°C/min, followed by a 9 min isothermal period. The MS transfer line was at 320°C, the source at 230°C, and the MS quadrupole at 150°C. The mass spectrometer was scanned from 33 to 600 amu at a rate of 2.59 scans per second. The electron multiplier was set to the autotune value.

#### 2.4.4. DATA ANALYSIS

Sample identification was aided by searching the National Institute of Standards and Technology (NIST) MS library, and by comparison to pyrograms and mass spectra of reference materials (Kremer Pigments) and published literature. Specific marker compounds searched for have been previously published by Rogge (2014).

### 3. RESULTS

The tintypes displayed a wide range of fluorescence colors under UVA radiation including blue, yellow, orange, or white (fig. 3). However, color sampling of the lightest light and darkest dark areas of the digital images of the UVA-induced visible fluorescence failed to show any correlation between the CIE  $L^*a^*b^*$  values of the fluorescence and the varnish components (fig. 4). All varnishes exhibit similar ranges of  $L^*$  and  $a^*$  values in the lightest light and darkest dark areas of the image. Sandarac-containing varnishes have a more yellowish tone in the lightest light areas indicated by the positive  $b^*$  values, but the correlation is not significant enough to permit positive identification of this material, and this difference is not present in the darkest dark areas.

Despite the large fraction of the collection that contains shellac in the varnish layer (59%), only two tintypes displayed the orange color considered typical of the insect resin (fig. 5). Instead, most of the varnish materials containing shellac fluoresced a bluish-green, as indicated by the negative  $a^*$  and  $b^*$  values. This suggests that the tintypists were using decolorized shellac to minimize the typical yellowish tonality of the varnish. During the time of these tintypes' manufacture, shellac was most commonly decolorized by bleaching with chlorine gas or sodium hypochlorite or by passage through an adsorbent material such as charcoal (Sutherland 2010). The chlorine bleaching process results in formation of trace levels of chlorinated compounds that are detectable by mass spectroscopy (Sutherland 2010); however, such compounds were not detected in the shellac varnishes on the study collection tintypes. This may be due to the concentrations of these marker compounds being below the detection limit of the instrument, or it may be due to a deliberate choice on the part of the artists to use carbon decolorized shellac. Literature reports on the early production

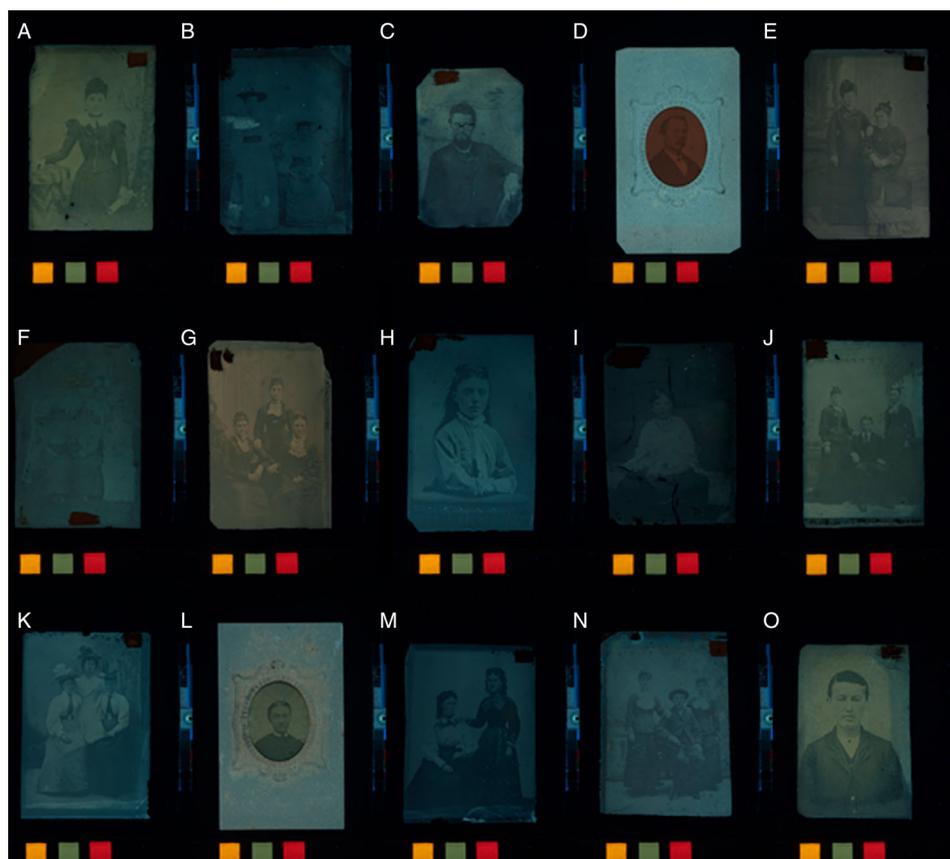


FIG. 3. A selection of tintypes displaying different induced fluorescence colors under UVA radiation. The varnish components of the illustrated tintypes are: (A) sandarac, *Pinaceae*; (B) dammar; (C) dammar; (D) shellac, *Pinaceae*; (E) shellac, *Pinaceae*, sandarac; (F) shellac, *Pinaceae*; (G) shellac, *Pinaceae*, sandarac; (H) shellac, *Pinaceae*; (I) shellac, *Pinaceae*; (J) dammar; (K) shellac, *Pinaceae*, sandarac; (L) shellac, *Pinaceae*; (M) shellac, *Pinaceae*; (N) shellac, *Pinaceae*, sandarac, camphor; and (O) sandarac, *Pinaceae*.

of chlorine bleached shellacs suggest that these become insoluble with age and were unsuitable for use on photographic materials. For instance, H. Greenwood wrote of chlorine bleaching: “This process, though it produces a pale resin of great value for many economical purposes, causes the resin to lose many of those properties that specially fit orange lac for use in photographic varnish.” And “Experimenters with ‘bleached,’ or as it is often called, ‘white lac,’ must know that unless it be properly stored it practically loses its solubility in spirit of wine...” (Greenwood 1882, 683). While E.M. Nash reported on adverse reactions of chlorine bleached shellac with silver image material: “... I studiously avoid the use of chlorine, phosphatic compounds or chromates, as any of these coming into contact with silver or its salts enter readily into combination, forming chloride, phosphates, and chromates of the metal; and solutions of shellacs or gums treated with any of the above chemicals will, to the most casual observer, be seen to be an injury to a print, or in fact in any instance where silver is present” (Nash 1867, 225). Thus, contemporary photographers were well

aware of the importance of varnish quality and may reasonably be supposed to have deliberately used non-chlorine-containing photographic-grade materials.

As UVA-induced visible fluorescence failed to distinguish between such distinct materials as shellac, an insect-derived sesquiterpenoid, and dammar, a plant-sourced triterpenoid-based material, false-color UV imaging was explored. Rather than characterizing the energy released as visible light after absorption of UV radiation, reflected UV images record differences in absorption and reflection of UV by an object. Thus, even though two chemically distinct varnishes may display similar colors of UVA-induced visible fluorescence, it is possible that they could be distinguished by different levels of absorbance/reflectance of UVA radiation. False-color UV images combine a reflected UVA image with two visible light channels, and have shown promise in distinguishing visually similar pigments, dyes, and inks. In order to determine if this method would offer a means to differentiate between the different varnish materials, a subset of tintypes that had different varnish materials but similar

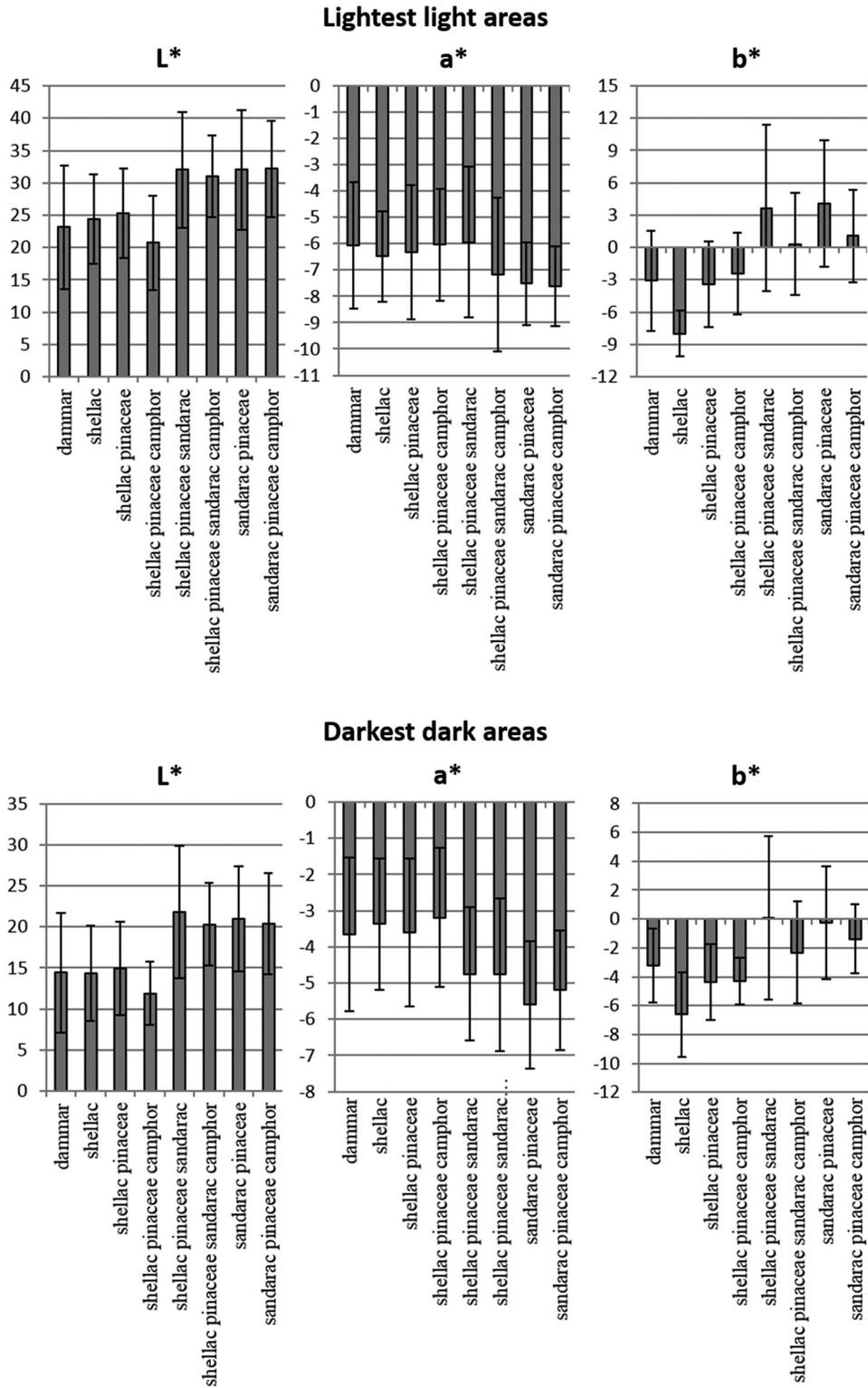


FIG. 4. CIE  $L^*a^*b^*$  values of the lightest light (top) and darkest dark (bottom) areas of the digital images of the UVA-induced visible fluorescence of tintypes, grouped by varnish type as determined by py-GC-MS and averaged within a group. Error bars indicate the standard deviation of  $L^*a^*b^*$  values within a group. Only types with more than three representatives are shown. The number of samples in each group is: dammar (28), shellac (16), shellac and *pinaceae* (68), shellac, *pinaceae*, and camphor (7), shellac, *pinaceae*, and sandarac (38), shellac, *pinaceae*, sandarac, and camphor (16), sandarac and *pinaceae* (19), and sandarac, *pinaceae*, and camphor (23).



FIG. 5. Two tintypes varnished with a combination of shellac, sandarac, and *pinaceae* resin. The left tintype displays the orange fluorescence commonly expected of shellac, but the right tintype does not.

UVA-induced visible fluorescence colors was chosen and imaged. Figure 6 shows FCUV images of two tintypes, one varnished with shellac and *Pinaceae* and

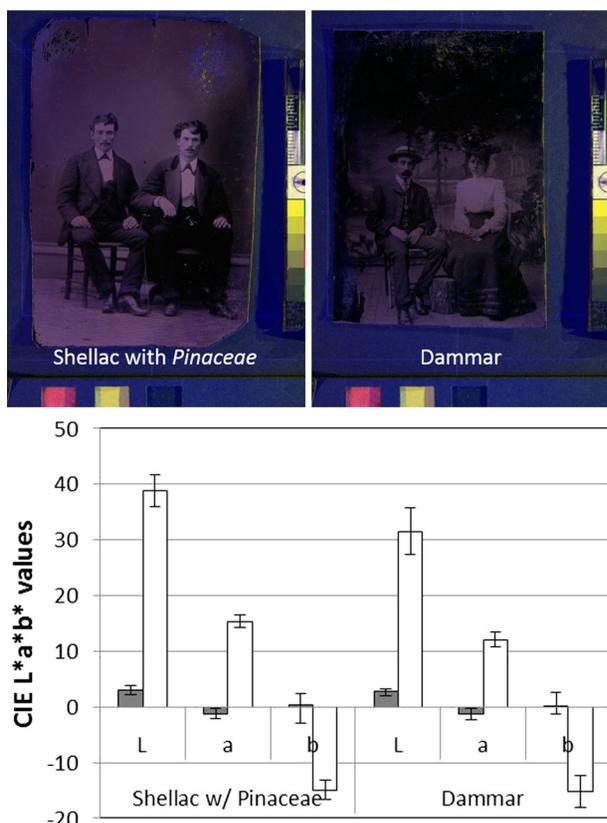


FIG. 6. Top: false-color UVA images of tintypes varnished with shellac and *pinaceae* resin (left) or dammar (right). Bottom: average CIE  $L^*a^*b^*$  values for the lightest lights (white) and darkest darks (gray) of the images above. The false-color images have very similar tonality despite the presence of completely different varnish materials.



FIG. 7. Normal (left) and UVA-induced visible fluorescence (right) images of a tintype. The image on the right clearly shows how the presence of a paper holder altered production of fluorophores.

the other varnished with dammar, which are nearly identical in color; thus, this method too fails to distinguish between insect and plant resin materials.

The failure of fluorescence to distinguish among dammar, shellac, and sandarac, which are triterpenoid, sesquiterpenoid, and diterpenoid containing materials, respectively, is likely due to a variety of causes. Fluorophores in materials can be initially present or can form upon aging: shellac is highly fluorescent as obtained from the insect (Larsen et al. 1990), but many plant varnishes display increased fluorescence upon aging (de la Rie 1982b), and this can be used to detect modern overpaint on easel paintings (de la Rie 1982a). Decolorization can remove the fluorophores initially present (Sutherland 2010), and may also influence the type and quantity of fluorophores created upon aging. Aging conditions may also influence the types of fluorophores produced. For instance, many tintypes were originally housed in carte de visite sized paper holders, although when purchased the tintype shown in Figure 7 did not have such a case. However, the UVA-induced visible fluorescence image of this tintype shows a difference in fluorescence between the edges of the tintype and the central portion and clearly delineates the shape and size of the window of the now-missing holder; the window area is significantly more yellow in tone than the areas that were once covered. The storage and display history of this object are unknown, and the difference in fluorescence could result from different levels of light exposure, materials present within the mount, or both, but it is evident that the life of an object can dramatically influence its fluorescence color.

#### 4. CONCLUSIONS

The color of UVA-induced visible fluorescence of tintype varnish materials is not indicative of the type

of resinous materials present. Dammar, shellac, and sandarac-containing varnishes all display a range of colors under UVA radiation and thus the color of UVA-induced visible fluorescence should not be considered an analytical tool capable of identifying the types of varnish material(s) present. False-color UVA images also do not appear to be capable of varnish identification. These findings do not negate the value of these methods for examination and documentation, but serve as a caveat regarding their use to identify tintype varnish materials.

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#### SOURCES OF MATERIALS

Dammar, shellac, sandarac, Manila copal, amber, mastic, asphaltum, benzoin, colophony, Venetian turpentine, Canada balsam Kremer Pigments

247 West 29<sup>th</sup> St.  
New York, NY 10001, USA  
212-219-2395  
<http://www.kremerpigments.com/>

UV + IR + Visible Camera conversion, MaxMax  
X-Nite CCI filter (BG 38 equivalent)  
MaxMax  
220 Broad St.  
Carlstadt, NJ 07072, USA  
201-882-0344  
<http://maxmax.com/>

Nikon D700 DSLR camera, Nikon AF Micro Nikkor  
105 mm 1:2.8 D lens, Kodak Wratten 2E filter, B+W  
403 (18A) filter,  
B&H Foto & Electronics Corp.  
420 9th Ave.  
New York, NY 10001, USA  
800-606-6969  
<http://www.bhphotovideo.com>

60 mm 1:4 UV-VIS-IR Apo Macro lens  
Jenoptik Optical Systems Inc.  
16490 Innovation Drive  
Jupiter, FL 33478, USA  
561-881-7400  
<http://www.jenoptik-inc.com>

PECA 918 filter  
PECA Products Inc.  
471 Burton St.  
Beloit, WI 53511, USA  
800-999-7322  
<http://www.ir-uv.com>

Leica twin light guide fiber optic EJA 150W/21 V/  
3400 K (MR-16)  
Leica Microsystems Inc.  
1700 Leider Lane  
Buffalo Grove, IL 60089, USA  
800-248-0123  
<http://www.leica-microsystems.com>

Single light fiber optic lamps, EKZ 30W/10.8 V/  
3100 K (MR-16)  
Cole-Parmer  
625 E. Bunker Ct.  
Vernon Hills, IL 60061, USA  
800-323-4340  
<http://www.coleparmer.com>

Superbright II 3000 series LW lights with primary  
wavelengths of 370 nm  
UV Systems, Inc.  
16605 12th Ave. SE  
Renton, WA 98058, USA  
877-689-5142  
<https://uvsystems.com/>

25% methanolic solution of tetramethylammonium  
hydroxide (TMAH)  
Sigma-Aldrich Corp.  
St. Louis, MO, USA  
800-352-5052  
<http://www.sigmaaldrich.com>

Py-2020D pyrolyzer, vent-free adapter, Eco-cups,  
and Eco-sticks  
Quantum Analytics  
3400 East 3rd Ave.  
Foster City, CA 94404, USA  
800-992-4199  
<http://www.lqa.com/home>

7820A gas chromatograph, 5975 mass spectrometer  
HP-5 ms capillary column (30 m x 0.25 mm x 0.25 µm).  
Agilent Technologies  
5301 Stevens Creek Blvd.  
Santa Clara, CA 95051, USA  
877-424-4536  
<http://agilent.com/home>

0.5 mm tip microchisel  
Ted Pella  
P.O. Box 492477  
Redding, CA 96049, USA  
800-237-3526  
<http://www.tedpella.com/>

UV Innovations reference target  
Image Science Associates  
6898 Townline Rd.  
Williamson, NY 14589, USA  
1-888-801-6626  
<http://www.imagescienceassociates.com>

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