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NO MORE HOLIDAYS: A TIP FOR METAL COATING

TINA GESSLER AND STEVEN PINE

Transparent coatings on polished metals need to completely envelop the surface to provide sufficient protection from corrosion. It can be difficult to detect skips or thin spots in such a coating at the time of application since these coatings are thin, transparent, and nearly invisible when applied skillfully. It is impractical to attempt to assess the overall thoroughness of a coating using methods such as looking for iridescence or using a continuity meter. This tip will discuss an alternative method of coating testing using a small amount of fluorescent laser dye added to the coating material. With the addition of the dye, the integrity of the coating can be assessed in ultraviolet light, as skips or thin spots will not fluoresce. Specifics of using coumarin-based dye(s) with both cellulose nitrate and acrylic coating materials will be presented.

KEYWORDS: Lacquer, Silver coating, Coumarin, Laser dye, Cellulose nitrate, Acrylic

1. THE PROBLEM

Institutions with open exhibit environments, such as historic house museums and living history museums, are often unable to display silver objects within controlled cases for reasons of interpretive disruption or cost. Silver displayed without an environmental barrier tarnishes rapidly. Applying a protective inorganic coating is one viable option to preclude tarnish and reduce the need for polishing, which removes original material, increases handling, and requires extensive staff resources. A perfectly applied inorganic coating can last many years. But how to be sure the coating is perfectly applied? It is difficult to detect skips or thin spots by eye in a nearly invisible transparent coating. Iridescence can indicate a thin spot, but can also mean the coating is contaminated with grease, wax, etc. Using a continuity meter is a solid approach, but will only give information about one small area at a time.

2. THE SOLUTION

The objects conservation labs at the Museum of Fine Arts, Houston (MFAH) and the Colonial Williamsburg Foundation (CWF) have adopted an effective method for testing the integrity of clear coatings. A trace of fluorescent laser dye is added to the coating material so the completeness of the coating can be assessed in ultraviolet light, as holidays or thin spots will not fluoresce. In 1996, Steve Pine at MFAH began testing the laser dye Coumarin 1, also known as C1, as a marker in silver coatings following discussion with Kory Berrett and Richard Wolbers.

The C1 marker fluoresces blue-white, as can be seen in figures 1 and 2. As applied to silver, the thicker the coating, the whiter the fluorescence. This affords a somewhat subjective gauge of film thickness that can be helpful. It is important that the UV light source be strong enough to make the dye fluoresce brightly enough for you to assess the integrity of your coating. Longwave ultraviolet light at about 365 nm is ideal.

Initial tests to arrive at a suitable concentration of the UV marker in a variety of effective metal coatings led the MFAH staff to select Paraloid B-48N. MFAH conservators typically brush coat with six drops of 1% C1 in ethanol for each 300 mL of 7% Paraloid B-48N in toluene. The system has been successfully used on silver at MFAH since 1997. The coating is clear and essentially colorless in visible light and does not fail prematurely.

CWF started testing C1 in Agateen #27 cellulose nitrate-based lacquer in 2013. A slightly higher concentration of dye was found to be needed for spray applications to get sufficient fluorescence to assess the coating, with nine drops of 1% C1 in acetone for each 300 mL of 1:2 Agateen #27 lacquer:#1



Fig. 1. Coumarin 1-dosed (left) and undosed (right) Agateen #27 cellulose nitrate lacquer in visible light (Courtesy of The Colonial Williamsburg Foundation. Photograph by Tina Gessler)

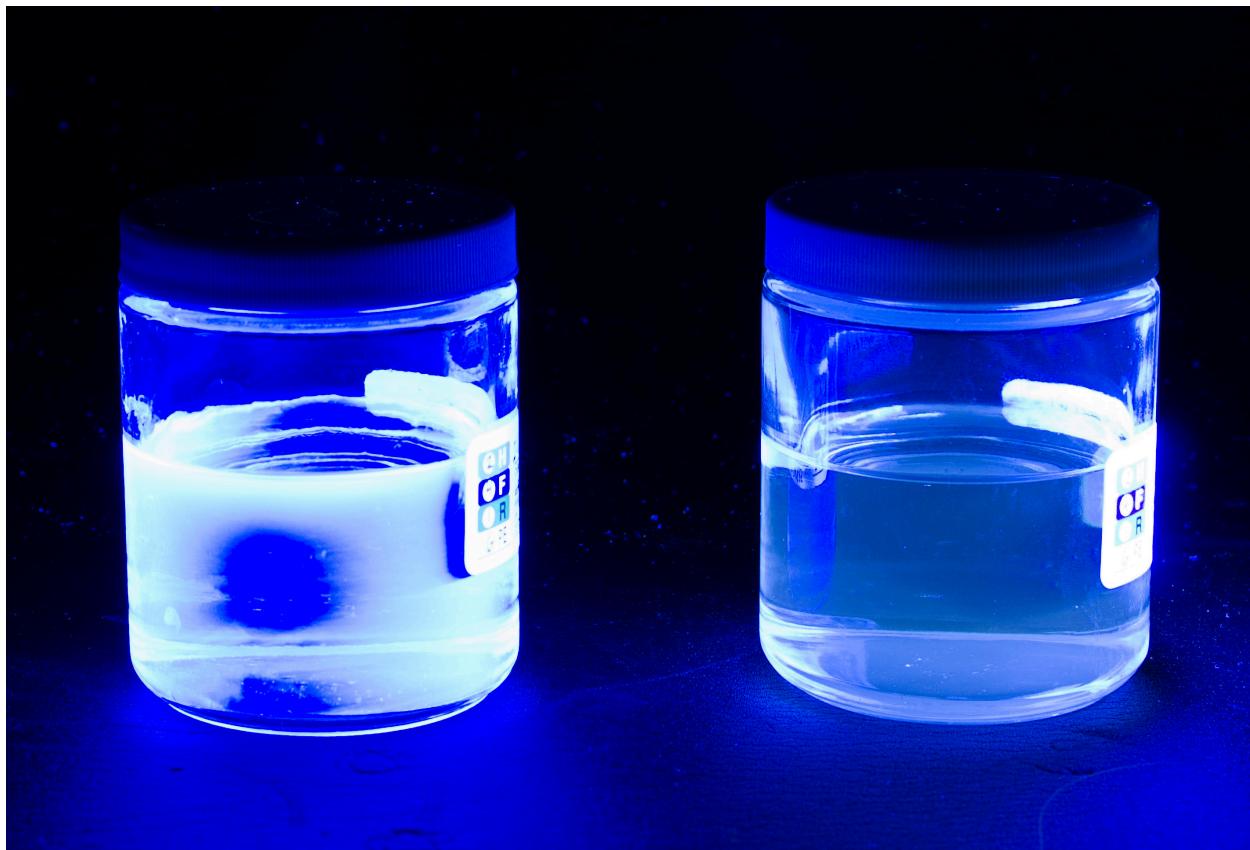


Fig. 2. Coumarin 1-dosed (left) and undosed (right) Agateen #27 cellulose nitrate lacquer in 365-nm longwave ultraviolet light (Courtesy of The Colonial Williamsburg Foundation. Photograph by Tina Gessler)



Fig. 3. Visible light image. Unknown Silversmith, *Salver*, ca. 1795, fused silver plate, $3.2 \times 31 \times 24.5$ cm, Colonial Williamsburg Foundation, 1991-1234 (Courtesy of The Colonial Williamsburg Foundation. Photograph by Tina Gessler)

thinner providing good results (figs. 3, 4). In figure 4, gaps in the Agateen coating, marked by arrows, do not fluoresce and are readily identified even though they do not show in the visible light image.

You don't need a lot of materials to make this technique work. Most importantly, you need to test to get the right concentration of dye in the chosen lacquer and you need a UV light source strong enough to make a thin film fluoresce.

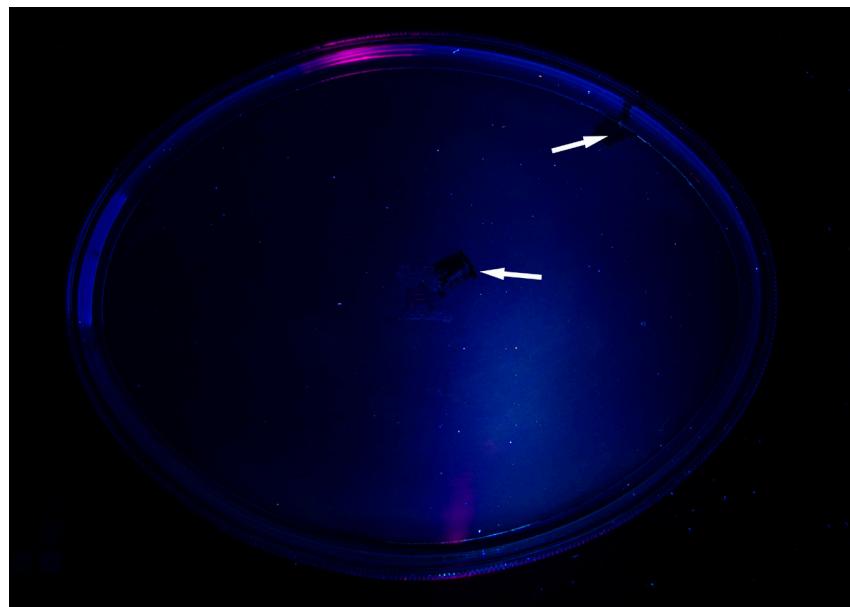


Fig. 4. 365-nm longwave ultraviolet light. Salver (Courtesy of The Colonial Williamsburg Foundation. Photograph by Tina Gessler)



Fig. 5. Modern sterling silver spoons. April 21, 2015. Colonial Williamsburg Foundation study collection (Courtesy of The Colonial Williamsburg Foundation. Photograph by Tina Gessler)

3. FURTHER CONSIDERATIONS

There are many different coumarin-based dyes, some of which are fugitive. In this application, fugitive may be a good thing, since any unwanted color the dye imparts to the coating fades away. For Coumarin 1, the amino group is easily protonated and decoupled from the chromophore, leading to the disappearance of the absorption band at about 373 nm (Drexhage 1976). Practically, this means the fluorescence fades to negligible after about two months under normal laboratory conditions, as seen in figures 5 and 6. In figure 5 are four freshly lacquered spoons and the two furthest left have the C1 marker. Figure 6 shows the same spoons two months later when the fluorescence is nearly gone.



Fig. 6. Modern sterling silver spoons. June 1, 2015 (Courtesy of The Colonial Williamsburg Foundation. Photograph by Tina Gessler)

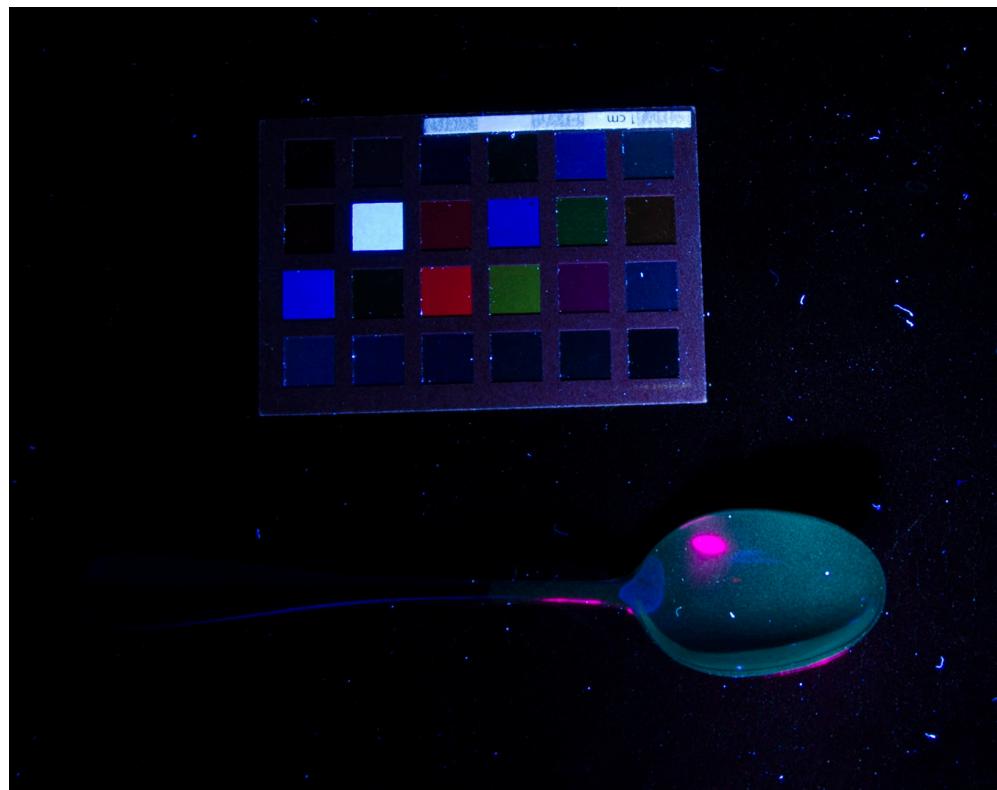


Fig. 7. Modern sterling silver spoon coated with C6-dosed Agateen on its right half only. Colonial Williamsburg Foundation study collection (Courtesy of The Colonial Williamsburg Foundation. Photograph by Tina Gessler)

In addition to C1, there are other dyes to consider whose green or yellow fluorescence might be easier to detect than the white fluorescence of C1. Coumarin 6 and Coumarin 7 both fluoresce green. The spoon in figure 7 was coated on its right half only with Coumarin 6 (C6)-dosed Agateen. C6 seems a good possibility for this application because its green fluorescence is more obvious than the blue-white of C1. Additionally, C6's fluorescence fades relatively rapidly over the course of a few days when exposed to ultraviolet light.

REFERENCE

Drexhage, K.H. 1976. Fluorescence efficiency of laser dyes. *Journal of Research of the National Bureau of Standards* 80A (3): 421–428.

SOURCES OF MATERIALS

Agateen #27 lacquer, #1 thinner
 Agate Lacquer Tri-Nat LLC
 824 South Ave.
 Middlesex, NJ 08846
 732-968-1080
<http://www.agatelacquer.com/>

Coumarin 1, Coumarin 6, Coumarin 7

Sigma Aldrich
3050 Spruce St.
St. Louis, MO 63103
800-521-8956
<http://www.sigmaaldrich.com/>

Paraloid B48N

Conservation Resources International, LLC
5532 Port Royal Rd.
Springfield, VA 22151
800-634-6932
<http://www.conservationresources.com/>

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