Removal strategies for lead-based adhesive

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Introduction

In 2014, *Robert Cecil, 1st Earl of Salisbury*, by John de Critz the Elder [Fig. 1], came to the Department of Conservation and Technology at Courtauld Institute of Art in London for technical examination. The portrait, from a private collection, was examined by Dr. Caroline Rae.[1] It was deemed in poor condition and kept at the Courtauld for further assessment, treatment, and analysis.

The Jacobean-era work (c. 1607) had undergone several conservation campaigns in its lifetime, including a nineteenth-century lining to support several tears and lacunae in the original canvas, adhered using a lead white adhesive.[2] The painting was extremely stiff and brittle with prominent structural deformations, the result of delamination of the lining canvas. The failed lining also contributed to flaking, loss of paint, and propagation of tearing beyond previously treated areas.

Fig. 1: John de Critz the Elder, *Robert Cecil, First Earl of Salisbury*, 1607, before treatment.

The painting's condition was extremely compromised[3] and involved lengthy and careful analysis and treatment. This article will focus solely on the complex process of removing the lining and lead-based adhesive. The process included the use of solvent gels with mechanical action and heat ablation with a Q-switched Nd:Yag laser for the removal of the tenacious lining adhesive.

Analysis and Considerations for Delining

XRF, cross-section analysis,[4] and transmittance absorbance spectrophotometry[5] were used to confirm the presence of a lead-based, non-protein organic adhesive. Lining with lead white pigment and a combination of oil and/or natural resin was common to the nineteenth century, confirmed by recipes in manuscripts from the period.[6] The rapid drying of the adhesive, due to the siccative character of the lead, prevents even application and results in shrinking, loosening of the ground, and delamination.

Removing the lead adhesive and old lining canvas would ward off continued embrittlement of the painting and loss of paint, and allow the deformations to be corrected.[7] Careful consideration and extensive planning were undertaken to evaluate the risks and concerns of delining the painting and relining to a new support. Part of the risk assessment included evaluation of health and safety hazards for the conservator due to the presence of lead.

Healthy and Safety Precautions and Preparation

Prior to delining, two layers of facing tissue were applied as a protective measure to the front of the painting. A layer of varnish, Paraloid B72 in Shellsol A, at twenty-five percent (w/v) followed by a mixture of 2:1 five percent wheat-starch paste and five percent isinglass were applied through wet-strength tissue.[8]

The painting was removed from its strainer and loomed. The brittle deformations protruded forward; an insert of memory foam enveloped in melinex and foam board was used to create a firm but cushioned support that would conform to the shape of the painting. The support fit into the recess of the loom, allowing the painting to be treated face down.

A tent made of high-density polypropylene, PVC pipe, and resealable windows was fabricated. Ventilation was hooked up to the tent. The painting was placed face down in the tent. A mask, gloves, and hazard suit were worn while working within the tent. A HEPA vacuum was used within the window space to minimize airborne particles of lead paint.

Fig. 2: After removal of auxiliary canvas, showing extent of lead white lining adhesive.

Removal of auxiliary canvas

A variety of solvent gels were tested to swell the lead white lining adhesive. The goal was to use the gel as a poultice to swell the adhesive beneath, so that the auxiliary canvas could be released. This would allow access to the thick layer of adhesive so it could be removed.

The following were tested with Carbopol® 934: 100% (w/v) acetone, 100% (w/v) benzyl alcohol, 100% (w/v) n-methyl-2-pyrolidone, 1:1 n-methyl-2-pyrolidone: acetone, 1:1:1 n-methyl-2-pyrolidone:stoddards:benzyl alcohol. Proprietary products, Bartoline™ Water Soluble Paint Stripper, and Nitromors™ were also tested. The gels were compared after being on the surface for forty-five minutes.

Bartoline™, an emulsion with sixty percent benzyl alcohol, was selected. It is a proprietary product but wouldn't contact the original canvas or ground. The removal of the auxiliary canvas revealed a thick and uneven application of lead white based adhesive [Fig. 2].

Fig. 3: After treatment with solvent gel, leaving a skim of the adhesive.

Removal of the Lead White Adhesive

Facing tissue was periodically removed and replaced during testing to determine if any changes happened to the paint film on the front of the painting.

Evaluation of Gels

Based on testing for removal of the auxiliary canvas, a Carbopol® 934 n-methyl-2-pyrolidone solvent gel and mechanical action was compared to a Pemulen™ TR-2 gel made 15% (w/v) Benzyl Alcohol.[9] The Pemulen™ TR-2 gel was more successful. It was applied to the surface, a piece of melinex was placed on top, and the gel was left for increments of 45 minutes.[10] The adhesive became very soft and was removed mechanically, using a number 15 blade with suction from a HEPA vacuum to clear the gel.[11] To prevent risk of damage to the original canvas fibers or ground, a "skim" or thin layer of adhesive remained on the reverse of the canvas.[12] [Fig. 3]

Evaluation of Nd-Yag Laser

Laser ablation was tested using a Lynton Laser Phoenix™ Q-switched Nd-Yag laser from City and Guilds of the London Arts School, under the direction of Dr. Marina Sokhan and Dr. Christina Young. The laser parameters were set at a wavelength of 1064nm, a rate of 10Hz, and energy set to 130w.[13]

The laser ablation took place within a hazard tent while the painting was loomed and displayed vertically on an easel.[14] The lead turned a gray intermediate after thirty seconds.[15] A second pass of thirty to forty-five seconds completely removed the adhesive. [Fig.4] Heat produced by the laser in the far infrared range could darken vermillion[16] used to paint red passages. Designing a heat sink for the front of the painting to overcome this issue was out of the scope of this project.[17]

Fig. 4: Stages of laser treatment, from top: lead white before ablation, gray intermediate, complete removal.

Discussion and Results

Laser ablation completely removed the adhesive, where the gel did not. The risk of darkening pigments was weighed against the possibility of a solvent gel swelling the ground and related damage to the canvas fibres caused by mechanical removal. Laser ablation had a potentially greater health risk due to vaporisation of lead; it's easier to control lead exposure if it's contained within a gel. Additionally, acquiring a laser, including rental or purchasing costs, was considered. The Pemulen™ TR-2 gel with fifteen percent (w/v) benzyl alcohol was the preferred method of removal; this method provided more control in fragile areas and better health parameters.

The canvas started to relax and regained flexibility[18] when the lead adhesive was removed. After the lining adhesive was removed, the facing was removed and all of structural deformations were corrected on a hot vacuum table.

Canvas inserts were placed in areas of lacunae, the painting was relined to sailcloth[19] and fixed to a new stretcher.

Conclusion

Both solvent gels and a Q-switched Nd:Yag laser were successful in the removal of a tenacious lead-based lining adhesive. Each method presented a level of risk. Laser ablation in the far infrared range could darken vermilion in the composition through photothermal interaction. Further testing should consider evaluating thermally conductive materials that conduct heat away from the painting. The gel had the potential to swell the ground, but also afforded more control and better safety parameters.

Delining allowed stabilization of the painting onto a new support and the correction of large planar deformations. Further treatment included filling, retouching, and varnishing: this was completed by former student, Molly Hughes-Hallett, at the Courtauld Institute of Art. [Fig. 5]

Fig. 5: The painting after treatment.

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Notes

1. It is linked to a series of four portraits by John de Critz the Elder, commissioned by Robert Cecil in 1607, and has been recently attributed to the workshop of de Critz through technical analysis and research. See Rae, Caroline, "Anglo-Netherlandish workshop practice from the 1580s to the early 1600s with a focus on the works of John de Critz the Elder and Marcus Gheeraerts the Younger," PhD dissertation, University of London (The Courtauld Institute of Art), 2016.

2. The tacking margins were cut during the lining and the painting was attached to a strainer with nails from the front of the picture plane, several of which were covered with fill and overpaint.

3. Its condition also included multiple layers of degraded varnish, discolored overpaint, and several lead white-containing fills which were out of plane.

4. This included both SEM-EDX and Rhodamine B and Amido Black staining to identify the presence of oil (Rhodamine B) and rule out the presence of protein or animal glue (Amido Black)

5. Spectrophotometry was carried out by Dr. Simon Fairclough on a scraping of the adhesive by the Physics department at Kings

College, London. This was specifically used to determine the wavelength necessary to ablate the lead-based adhesive with an infrared laser.

6. Carlyle, Leslie. *The Artist's Assistant: Oil Painting Instruction Manuals and Handbooks in Britain, 1800-1900, with Reference to Selected Eighteenth-Century Sources* (London:Archetype Publications), 2001.

7. Careful testing carried out on the removal of this adhesive was used to determine if the original canvas could withstand delining and would regain its flexibility, allowing for the correction of planar deformations.

8. This mixture was selected after testing different solutions to include BEVA® gel in stoddards and wax.

9. Richard Wolbers was consulted in determining the right parameters for making this gel.

10. This time was carefully determined after several time-based tests with the solvent gels.

11. Residues were first cleared with water. After the water evaporated, acetone was used to pick up any remaining residues or softened adhesive.

12. Careful testing carried out on the removal of this adhesive was used to determine if the original canvas could withstand delining and would regain its flexibility, allowing for the correction of planar deformations.

13. Lead waste was disposed in a separate lead-waste hazard bag.

14. Spectrophotometry conducted at Kings College, London confirmed the absorption spectrum and wavelength for lead oxide in the sample of lining adhesive, which was then used to set the parameters for laser ablation.

15. This intermediate reverts to white after exposure to oxygen.

16. Its presence was identified with SEM-EDX and XRF by Dr. Caroline Rae and Maggie Barkovic. For more information on De Critz's methods, see Rae, Caroline (2016).

17. A heat sink or cooling apparatus would need to be built to lessen this risk. Matt Cushman was consulted regarded his use of a Q-switched Nd:Yag laser to remove a lead lining at the Worcester Art Museum. He makes considerations for heat sink materials. See Albertson, Rita. et al. "A Case Study in the Removal of a Lead Lining Using a Q-Switched Nd:Yag Laser," AIC Paintings Speciality Group Postprints 25 (2012).

18. While older deformations started to relax, new deformations formed in response to the moisture from the gel. These were addressed after the adhesive was completely removed.

19. BEVA® gel dissolved in stoddards (1:1) was used.

Maggie Barkovic graduated with a postgraduate diploma in the Conservation of Easel Paintings from the Courtauld Institute of Art, London, in 2016. She has a BA in Chemistry from Virginia Tech (2008) and an MA in Art History from George Mason University (2012). She has interned at TU Delft, the Smithsonian Museum Conservation Institute, the Phillips Collection, and the Barnes Foundation. She joined WACC in January 2017 as assistant paintings conservator.