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Tip: Local Cleaning with Gels: Acknowledging the Challenges and Successes

INTRODUCTION

In 2016, research was undertaken at the Smithsonian American Art Museum to evaluate and compare three polysaccharide gels: agarose, gellan gum, and xanthan gum. The aim of the study was to provide guidelines on their use in the specific case of local treatment for stained art on paper. A well-known risk of using gels locally is the creation of a wet/dry interface, or tideline. The following is a brief summary of some of the findings of this one-year research project. The full project will be detailed further in another publication. The goal is to provide some concrete hands-on tips for paper conservators with limited experience using gels, and to encourage them to start experimenting.

CONSIDER THE PARAMETERS

First, let us acknowledge that local cleaning with rigid gels can be challenging. Some conservators have developed the necessary experience to successfully perform such treatments and are able to achieve amazing results (Keynan and Hughes 2013; Couvert and Dupont 2013; Sullivan et al. 2014; Barbisan and Dupont 2017). But someone just getting started with rigid gels may want to think carefully about the following parameters.

- Concentration of the gel: this will affect the amount of moisture released into the substrate, as well as the suppleness of the gel. At higher concentrations, there is less risk of creating a tideline. However, the gel will conform less to the surface of the paper, which can result in uneven cleaning.
- Contact between the gel and the substrate: in some instances, it is safer to apply weight on top of the gel to ensure perfect contact. One needs to evaluate how much pressure is appropriate, to avoid creating an unwanted local deformation.
- Thickness of the gel: the thicker the gel, the more water and capillary action. However, cutting a thick block of gel to conform the shape of a stain can be challenging.
- Timing: the appropriate duration of cleaning needs to be determined through testing. Ideally, the gel should be left on the substrate as long as possible to get efficient cleaning, but not long enough to create a tideline.

Striking a balance between all of these parameters and adapting them to a particular scenario is key in designing a successful local treatment with rigid gels.

WHAT GEL? WHAT CONCENTRATION?

Previous research suggested agarose should be favored to perform local treatment (Wolbers 2013). Our experiments, comparing agarose, gellan gum, and xanthan gum, confirmed that statement. Agarose at concentrations from 6% to 10% (w/v) makes it easier to manage the risk of tideline formation (fig. 1). However, agarose does not possess the best cleaning efficiency when compared with other gels at similar concentrations (fig. 2). This can be compensated by the fact that agarose is a nonionic gel, which makes it possible to adjust its pH and conductivity and add chelating agents to increase cleaning efficiency (Stavroudis et al. 2005). Agarose also leaves a small quantity of residues behind compared to other gels (Sullivan et al. 2017). Additionally, areas treated with agarose showed a more regular cleaning when observed under the microscope (fig. 3).

MANAGING THE WET/DRY INTERFACE

Controlling the lateral spread of moisture during local treatment is critical and that control may be achieved through a particular application method. Wet/dry interfaces, sometimes invisible under normal light, have long-term detrimental consequences to the paper (Dupont 1996; Souguir, Dupont, and de la Rie 2008; Jeong, Dupont, and de la Rie 2012, 2014). Various application methods were tested: applying a film of gel, beveling the edges of the gel (Skelton, Rogge, and Bomford 2016), drying between applications, soaking the gel

Tips presented at the Book and Paper Group Session, AIC's 46th Annual Meeting, May 29-June 2, 2018, Houston, Texas

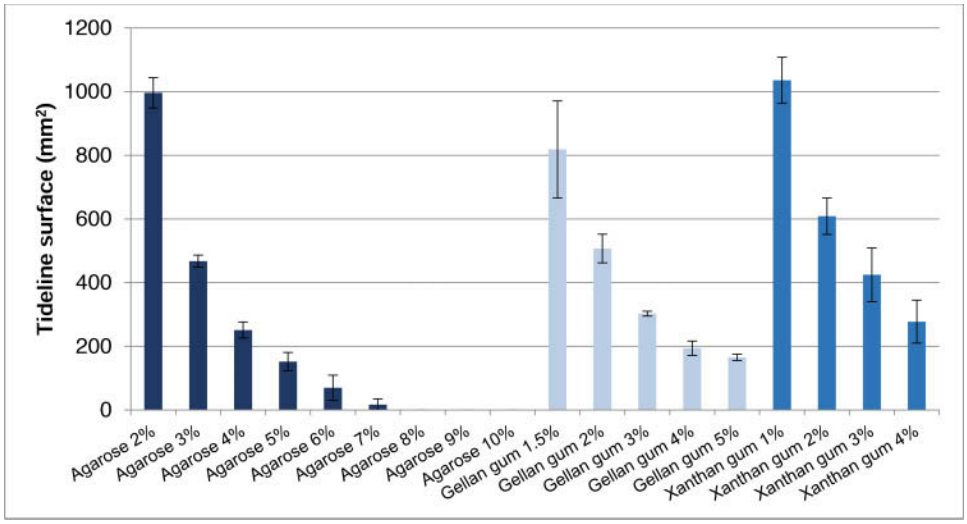

Fig. 1. Comparison of tideline surfaces after contact for 10 minutes between gel and sample. Samples made with Whatman paper (grade 1), toned with a solution of methylene blue (1.5 g/L). Time-lapse recorded with Nikon 800, data extracted with ImageJ software.

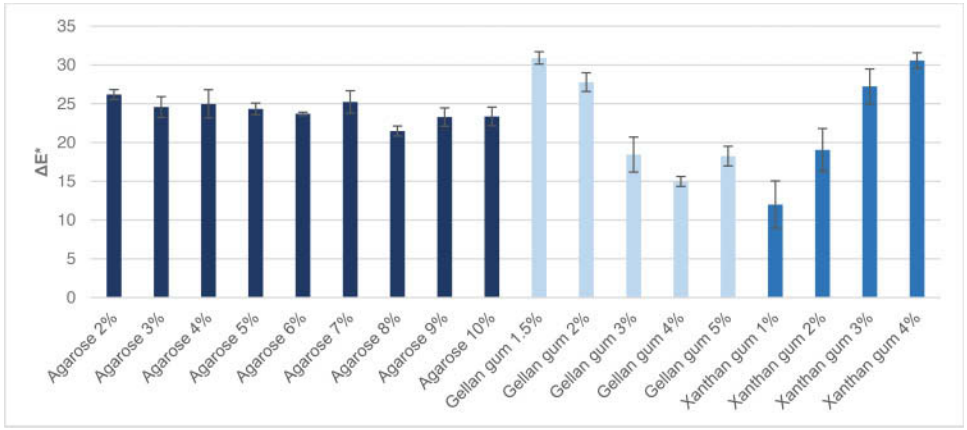

Fig. 2. Comparison of △E* values (CIELAB 1976, D65 illuminant, 10° observer) after cleaning for 2 hours. Readings taken with a spectrophotometer X-rite Exact. Samples made with Whatman paper (grade 1), toned with a solution of methylene blue (1.5 g/L).

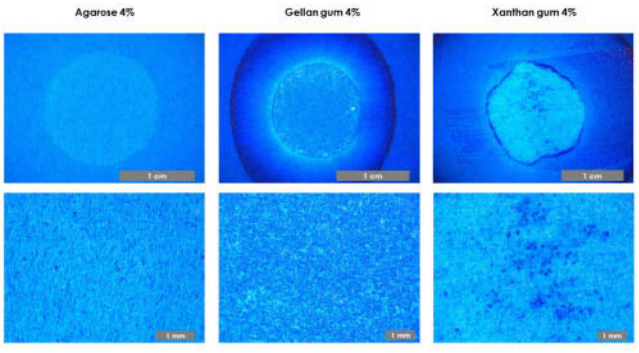

Fig. 3. Images taken under the microscope of samples cleaned with different gels for 2 hours (normal light). Samples made with Whatman paper (grade 1), toned with a solution of methylene blue (1.5 g/L).

in a water/ethanol solution, and humidifying the paper before treatment.

Using a film of gel proved helpful in managing the creation of a wet/dry interface and promoting better contact between the gel and the substrate. Humidifying the paper prior to local treatment seemed to soften the wet/dry interface, which was apparent in UV-induced visible fluorescence photographs (fig. 4). If appropriate for a particular object, prehumidification of the artwork with Gore-Tex or in a humidification chamber before undertaking local treatment with rigid gels is encouraged.

To produce films of agarose gels, one needs to pour the hot agarose on a polyester sheet, place another polyester sheet on top, followed by a board. Apply weight on top and let it cool (fig. 5). However, this method only works for small quantities

Fig. 4. After treatment UV-induced visible fluorescence photographs. From left to right: agarose film (9%) applied for 10 min; agarose film (9%) applied for 1 hour, after prehumidification of the sample for 1 hour; agarose film applied for 10 min, soaked in a water/ethanol solution (70/30) overnight.

of agarose (50 mL). For larger quantities, poor hot agarose in a baking sheet, tip, and rotate to spread.

FINAL TIPS AND RECOMMENDATIONS

- Closely monitor treatment, as tidelines may be created seconds after initial contact between the gel and the paper.
- Regularly check under UV radiation: wet/dry interfaces may not be visible under normal light in the moment, but they are always visible under UV radiation and will turn into discoloration long-term. They should be minimized as much as possible.
- Agarose films are more controllable. They are easier to handle, provide better contact with the substrate, and are easier to cut to the shape wanted.
- Use agarose between 6% and 10% and test which concentration is most appropriate for your project.
- Prehumidification appears to soften the wet/dry interface. It also promotes a more even cleaning, since the paper's fibers are already swollen.
- Drying between applications helps to avoid overwetting.
- Applying weight on top helps produce good contact, particularly for gels at high concentrations (fig. 6).
- Change your gel often. To promote diffusion, using a fresh gel every 10–20 min will speed up the cleaning.

Gels are an amazing addition to the paper conservator's tool kit. As with any new technique, they can be intimidating and require building experience before jumping into treatment. Using a step-by-step approach helps identify what works and

Fig. 5. Steps to make agarose film, from left to right: pour the hot agarose on a polyester sheet; place on top another polyester sheet and a board; apply weight on top (around 2 kg/4.4 lbs.).

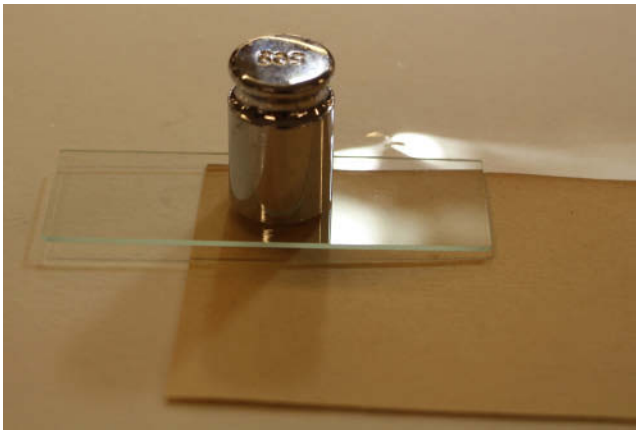

Fig. 6. Testing with microscope slide and 50 g calibration weight.

what does not and hopefully will encourage hesitant paper conservators to start experimenting.

ACKNOWLEDGMENTS

The author would like to gratefully acknowledge the following individuals for their guidance and help: Catherine I. Maynor, Tiarna Doherty, and Amber Kerr (Smithsonian American Art Museum); Amy Hughes (National Gallery of Art); Michelle Sullivan (J. Paul Getty Museum); Nora Lockshin (Smithsonian Archives); Stephanie Lussier (Hirshhorn Museum and Sculpture Garden); Mary Ballard and Dawn Rogala (Museum Conservation Institute); Teresa Duncan (National Gallery of Art); Pam Young (Colonial Williamsburg Foundation); and Noah Smutz (Smithsonian Libraries).

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